



# **Managing Information Technology**

## **Managing Information Technology**

Selected Papers of Bilingual International Conference on  
Information Technology: Yesterday, Today, and Tomorrow

19-21 February 2015

### *Editorial Team*

Sudhanshu Bhushan, A. Saravanan, Alka Bansal, Anitha Saravanan, and Phuldeep Kumar



Defence Scientific Information & Documentation Centre  
Defence Research & Development Organisation  
Ministry of Defence, India

2015

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## PREFACE

With the advent of technological era in 21<sup>st</sup> century, every application area, right from education to industries, have evolved in their operational paradigms and the most indispensable part of this evolution has been the embedding of Information technology (IT) wherever possible.

It is evident that IT has grown tremendously in all these years and still have a large potential not only accelerate the economic growth but also global economic development. To realize this prediction as truth, governments need to take specific measures to promote IT use and make it accessible to every section of the society, along with improving infrastructure, strengthening training and education system and flexible labor laws.

Information technology should be used as a tool to improve the living standards of common people and enriching their lives. IT literacy needs to be enhanced so that ordinary people can derive benefits, both economically and socially. Full potential of IT industry can be strained only when we realize and understand the future perspectives of the industry keeping the past and present in mind.

DESIDOC has organised 'Bilingual International Conference on Information Technology: Yesterday, Today, and Tomorrow' during 19-21 February 2015. The objectives of the Conference are to provide a roadmap which Information technology and its developers have followed in order to make it compatible with every day-to-day activities of the user.

The Conference was extensively publicized on the web and print media. More than 400 papers have been received from all over India and abroad. The Editorial Committee reviewed them thoroughly and short-listed paper based on originality, content and presentation. About 160 papers have been accepted after review and included in the Three Books entitled; Electronic Resources and Digital Services, Artificial Intelligence and Network Security,

and Managing Information Technology. With a view to involve upcoming professionals and to motivate them, it was decided to give sufficient space to them to present their views.

Present book entitled as Managing Information Technology, contains 63 selected full-text research papers and review papers on Application of Information Technology, Internet and Web engineering, Data Warehousing and Data Mining, Advance Computing, Software Engineering, and Electronics.

Under Application of Information Technology, 21 papers are included. These papers dealt with Information Technology (IT) in the context of past, present scenario and future opportunities. E-governance services in Madya Pradesh, role of IT in Handloom weaving, Agriculture, Manufacturing Sector, Dairy industry, Person with Disabilities, Water Management System, Dental practices, Advertising, etc.

Under Internet and Web engineering, 3 papers are included. These papers dealt with web services, Social Tagging, and Client-server application.

Under Data Warehousing and Data Mining, 6 papers are included. These papers dealt with Knowledge Representation for Sanskrit, Big data analysis, Crime analysis, Case retrieval, Content extraction, and Feature extraction from offline signature.

Under Advance Computing, 17 papers are included. These papers dealt with Cloud computing, Augmented reality, Green computing, Scheduling in operating system, 13 papers dealt with the application of Field-programmable gate array (FPGA).

Under Software Engineering, 4 papers are included. These papers dealt with SQL vs noSQL, Software Specification and verification, Event Management System Design, Software testing life cycle.

Under Electronics, 12 papers are included. These papers dealt with VLSI Circuit, X-and

Ku-band, PID controller, EDF amplifier, Solar Cells application, Hot press technique, ARGOW waveguides, Power system, and Patch Antenna.

As the title of the Conference is 'Bilingual International Conference on Information Technology: Yesterday, Today, and Tomorrow', an attempt has been made to provide translation of Title, Abstract, and Conclusion in Hindi language

also. Some authors has provided Translation in Hindi but in most of the cases it was done by professionals.

The Editorial committee acknowledges with profound gratitude, the immense efforts of the contributors and hope that the ideas generated in these papers would be deliberated during the conference for further enriching the future application of Information technology for well being of human being.

10 February 2015

**Editorial Committee**

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## सूचना गहन संदर्भ में एक जीवन कौशल के रूप में संचार Communication as a Life Skill in Information-intensive Context

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### सारांश

तीन महत्वपूर्ण घटकों, अर्थात् (i) उत्पादन (ii) प्रसंस्करण, और (iii) जानकारी का उपयोग, से युक्त 'जानकारी चक्र' को एक त्रुटिहीन रूप में बनाए रखना, संचार के लिए महत्वपूर्ण है। आज के पेशेवरों के लिए, जो प्रतिदिन अपना अधिकांश समय (एक सॉफ्ट कौशल की तुलना में) अपने अत्यधिक मांग वाले ग्राहकों और प्रबंधन, निवेश प्रदाताओं, समिति के सदस्यों, आपूर्तिकर्ताओं, साथियों, वरिष्ठों, मातहतों सहित अन्य हितधारकों के साथ संवाद करने में खर्च करते हैं, 'संचार' तेजी से एक जीवन कौशल बनता जा रहा है। संचार, अगर प्रभावी हो तो, यह सही समय पर सूचना के सही मांगकर्ता, निर्माता और उपयोगकर्ता के बीच सही संपर्क सुनिश्चित करने के लिए जानकारी का एक निरंतर और खुला प्रवाह बनाए रखता है। इस शोध पत्र में इस बात को सही ठहराने का प्रयास किया गया है कि जानकारी के क्षेत्र में लगे पेशेवरों को पेशे में उत्कृष्टता प्राप्त करने के लिए 'संचार' कौशल को सुधारने की जरूरत है।

### ABSTRACT

For the 'information cycle' consisting of three critical components, viz., (i) generation; (ii) processing; and (iii) use of information, to keep on happening in a seamless manner, communication holds the key. Communication is increasingly becoming a life skill (rather than a soft skill) for today's professional, who spends most of his time each day communicating with his highly demanding clientele and other stakeholders including the management, fund providers, committee members, suppliers, colleagues, seniors, juniors, all alike. Communication, if effective, will maintain a constant and open flow of information ensuring right contact between the right seeker, producer and user of information at right time. In this paper, an attempt has been made to justify that professionals in the information sector need to hone 'communication' skills to excel in the profession.

**Keywords:** Communication skill, life skill

### 1. INTRODUCTION

Professionals in the information sector are interfaces between information producers and information users. Role of these interfaces is fast changing from those of facilitators to partners. Their approach has been a lot 'pro-active' rather than 'reactive' or 'passive' if their output has to be externally effective and internally efficient. A closer understanding of the available skills/competencies of the professionals engaged in the information sector reveals that they have miles to go if they have to discharge their roles as expected of them<sup>2</sup>.

To ensure optimum use of information available in a variety of learning resources, effective communication is an essential prerequisite for the individuals working in information resource centres<sup>7</sup>. Information professionals

will have to assume the role of information analysts, synthesisers and interpreters, rather than be contented with acquiring, organising and providing information when asked for. Further, the role of an information professional will include the tasks of scanning, filtering, selecting, organising and packaging the flood of information. In keeping with their changing role from 'gatekeepers' to 'gateways to information,' information professionals should also be performing such tasks as information audits, training in information literacy, information of best practices/competencies and helping their users to navigate through the world of information, more meaningfully<sup>7</sup>. Effective communication skills will hold information professionals in good stead to discharge this role more professionally on lines as expected by their highly demanding clients.

## 2. COMMUNICATION AS A CORE COMPETENCY

The SLA<sup>8</sup> advocates for communication as core and personal competencies for information professionals on following lines:

- Listens first and coaches staff and others to develop their own solutions
- Supports and participates in mentorship programs and succession planning
- Runs meetings effectively
- Presents ideas clearly and enthusiastically
- Writes clear and understandable text
- Requests feedback on communications skills and uses it to make improvements.’

Communication competencies for library and information professionals are also discussed on following lines as identified by European Council of Information Associations<sup>1</sup>

- Oral communication
- Written communication
- Using a foreign language
- Communication sound and images
- Interpersonal communication
- Corporate communication

National Knowledge Commission<sup>6</sup> recommendations also emphasise on the importance of communication skills among information professionals when it advocates for following skill sets for them:

- Library and information handling skills
- Service orientation
- ICT knowledge skills
- Communication and training skills
- Marketing and presentation skills
- Understanding of cultural diversity
- Knowledge mapping skills

Given these guidelines, it is clear that ‘communication’ has been recognised as one of the core competencies for information professionals in the present context.

## 3. COMMUNICATION IN IT ENVIRONMENT

Developments in IT have opened up enormous opportunities for information professionals to reach out to wider audiences and with very many innovative and value-added information products and services. Web 2.0 services such as blogging, RSS feeds, video casting, social book marking, social networking, podcasts and picture sharing. These are becoming more and more popular. These technologies have made it easier for everybody and anybody to create, publish, share, collaborate, influence, and connect with each other on any scholarly pursuit<sup>4</sup>. Information professionals will not only have to be well versed with all these developments but promote their use to facilitate optimum use of the rich resources, facilities, and services, they have put in place.

## 4. COMMUNICATION IN THE CURRICULUM

Information professionals require specialist knowledge on acquiring, organising, storing, retrieving, accessing, and disseminating, sharing and using information. They get the basic nuts and bolts of such knowledge from formal course curricula. But, then when one compares the service level of information professionals with other professional service providers, let us say in banks, hospitals, hotels, and running on competitive lines, the clientele finds a huge gap. To fill this gap and make sure the client leaves with delight, it is essential that conscious efforts are put in place to impart this life skill of ‘communication’ among the professionals at appropriate level.

UNESCO sees the emergence of four roles of information professionals, i.e., creators, collectors, communicators, and consolidators (4Cs).

Curriculum for European schools<sup>5</sup> includes aspects on ‘Communication Skills and Negotiation’ as follows<sup>3</sup>:

- Communication process, types and channels of communication
- Levels of effective communication
- Oral and written communication
- Intercultural communication
- Conflict management sources and types of conflicts, conflict resolution strategies
- Negotiation process and skills; contract negotiations.

However, a look at the model curricula developed by the University Grants Commission<sup>9</sup>, reveals that ‘LIP service’ is paid to helping information professionals hone communication skills. Though a full paper is included on information and communication, but the part related to communication is limited to just to one unit and that too on Information and Communication’ with sub-headings as (Module-1: Foundation of Library and Information Science, unit-3) with coverage as follows:

- Information, characteristics, nature, value and use of information
- Conceptual difference between data, information and knowledge
- Communication of information; information generation
- Communication channels; models and barriers
- Trends in scientific communication.

This means, ‘Communication’ is not given the treatment that it deserves. It is perceived as one of those sets of skills that one can pick up on one’s own. Unlike many other professional disciplines like law, medicine, engineering, management, etc., it is not taught like a core subject in information science schools but just as a peripheral one to the curriculum. Learning from these well received recognised and flourishing disciplines, it is high time that information science schools design, develop, and deliver a set of

application-oriented communication courses for their students and thus prepare them for the role expected of them by the society they have chosen to serve.

## 5. IGNOU'S EFFORT

Indira Gandhi National Open University<sup>5</sup> in its revised Programme Guide for Bachelor's Degree Programme in Library and Information Science (BLIS), which was released in July 2014, has given the subject the treatment it deserves, at least to begin with. The subject is covered under 5 Blocks through 18 units as per details below:

### BLI 225: Communication Skills

#### Block 1 : Communication fundamentals

Unit 1 : The basics

Unit 2 : Social skills

Unit 3 : Introducing the institution

#### Block 2 : Preparing for the job interview

Unit 4 : Your profile

Unit 5 : Preparing your portfolio

Unit 6 : Preparing your curriculum vitae

Unit 7 : The job interview

#### Block 3 : Workplace skills

Unit 8 : Presentation skills

Unit 9 : Telephone skills

Unit 10 : Group discussions

Unit 11 : Body language

#### Block 4 : Writing skills

Unit 12 : Internal communication

Unit 13 : Introducing yourselves

Unit 14 : Communication with customers

Unit 15 : Communication with service providers

#### Block 5 : Advanced writing skills

Unit 16 : Writing proposals

Unit 17 : Writing reports

Unit 18 : Design of survey questionnaire

## 6. MODEL CURRICULA ON COMMUNICATION

May be IGNOU's course, over the years, evolve as a model course incorporating following components and many more as per the changing information landscape:

- Conducting and participating in productive meetings
- Negotiations skills
- Conflict resolution
- Professional etiquettes
- E-mail communications
- Preparing websites, portals, etc.
- Social media communications
- Crisis communication
- Marketing of resources, facilities, and services

- Marketing of information products and services
- Event management
- Investor and PR initiatives

## 7. CONCLUSION

Taking a cue from what other service providers have done to develop communication competencies among their professionals, the information science schools have to wake up and do everything possible for developing this life skill in their products before it is too late. Information professionals have to be real good both in their 'receptive' and 'expressive' communication skills, if they want to play the role of a 'partner' and not just a 'facilitator' for the 'generator' and 'user' of information. So has to be the approach of the information resource centres, for training of their professionals.

### निष्कर्ष

इससे पहले कि बहुत देर हो जाए, सूचना विज्ञान स्कूलों को अन्य सेवा प्रदाताओं द्वारा अपने पेशेवरों के बीच संचार दक्षताओं को विकसित करने के लिए किए गए प्रयासों से प्रेरणा लेकर जीवन कौशल के उत्पादों में विकास के लिए वह सब कुछ करना चाहिए, जो संभव है। सूचना पेशेवर अगर सूचना के 'उत्पादक' और 'उपयोगकर्ता' के लिए मात्र एक 'सुकारक' न बनकर एक 'भागीदार' की भूमिका निभाना चाहते हैं, तो उन्हें, अपनी 'ग्रहणशीलता' और 'अभिव्यक्ति' दोनों संचार कौशलों में वास्तव में अच्छा होना जरूरी है। सूचना संसाधन केन्द्रों का भी अपने पेशेवरों के प्रशिक्षण के लिए ऐसा ही दृष्टिकोण होना चाहिए।

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## सूचना प्रौद्योगिकी – ग्रामीण भारत में प्रभावी बदलाव के लिए Information Technology - for Effective Changes in Rural to India

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### सारांश

सूचना प्रौद्योगिकी एक महत्वपूर्ण उपकरण है, जो ग्रामीण भारत में वाई-फाई की सुविधा के लिए देहा के परिदृश्य को बदल सकता है। वर्तमान संदर्भ में, विभिन्न आईटी उपकरणों को गांव में रहने वाले लोगों को उनके जीवन स्तर बनाने के लिए ही सक्षम नहीं किया गया है बल्कि उन्हें उनके वंचित हालातों पर काबू पाने के लिए कार्यरत किया गया है। ग्रामीण क्षेत्रों के लिए, आईटी तकनीक को सूचना और संचार प्रौद्योगिकी की प्रक्रिया के तहत शिक्षा के अधिकार के लिए गांव के बच्चों को शिक्षा प्रौद्योगिकी और ई-शिक्षा की मदद से पढ़ाने के लिए और एक तरीके के रूप में अपने शिक्षा के अधिकार के लिए संसदीय वायदे को पूरा करने के लिए जोड़ा जाना चाहिए।

### ABSTRACT

Information technology is an important tool, which can change the scenario of the country, for wi-fi in rural India. In the present context, various IT tools are employed for the people living in the villages to make them capable to build up not only their living standard, but also make them eligible to overcome their deprived condition. For rural sector, IT technique should be added to teach the children of villages for right of education under the process of information and communication technology with the help of the education technology and elearning and as a way out to fulfill the parliamentary promise for their right of education.

**Keywords:** Information technology, communication technology, rural, India

### 1. INTRODUCTION

In India, most of the people belong to the villages. Therefore villages have a greater importance for the national growth and integration. But unfortunately, the conditions of villages are very miserable, no one is trying to see towards the deprived conditions of the villages. Everyone look towards the brightness of the city. People living in the villages want to migrate to the city looking for their lively-hood. So many facilities and technologies are provided to the urban areas in priority. Question is, how then the villages will grow? Although Panchayati Raj ensures the decentralization of power for greater accountability and people participation for social development in rural areas. But technological advances are not provided to achieve this goal.

The consumerisation of technology and digitisation of our world have changed our physical world into digital, for how we live, work and interact. The development of smart phones, tablets, laptops computer technology, means we now have a wealth of information on our person whenever and wherever

we need it. Social networks media like facebook, whats app, twitter, etc. are changing the way people use and share information for personal, political, and commercial purposes and up-to-date with what is happening around us. But regretted to say that villages are far away from these technologies. Can we provide all these facilities for villages?

Formerly, the villagers were self-reliant, and as they had few wants and within this, they survived contended life. Gradually the villages fell into ruin. Generally poor people live in the villages. They don't know about the education, health, growth, etc. In many villages, there is no school, no hospital, no public library. So most of the villages are in wretched condition. Lastly we can say, the villages are utterly neglected and in poor state.

Therefore to make the India developed country, we must have attention towards the poor conditions of the villages at the root level. The modern technology has To reach the village for basic and fundamental needs of villages for education, health and livelihood.

Hill<sup>1</sup> argues that learning how to use information technologies is a key requirement for the immediate future; “learning how to handle, evaluate and exploit information, both new and old, is essential both for the short term and the long term future” of education<sup>2</sup>.

Niederman and Rollier<sup>3</sup> agree, suggesting that there are two possible outcomes for the future of education: one being that only four out of five universities would have the capacity to support a significant student population on the web; the other being that there could be an online education of school college, universities enabled by modern communication technologies. For e-learning with new education technology

Powell and Snellman<sup>4</sup> defined Knowledge Economy as “production and services based on knowledge-intensive activities that contribute to an accelerated pace of technological and scientific advancement as well as equally rapid obsolescence.”

Lyon<sup>5</sup> argues that the increased capacity, rapid development and expansion of these information technologies, has led to notions of an ‘information society’. Smart<sup>6</sup> argues that these technological and cultural innovations have caused our society to become increasingly centred around knowledge, instead of the production of goods. All these research papers envisaged that to develop the villages based, education, knowledge and the technology will be required.

In this regard, an attempt has been made to find the difficulties of a particular area ‘Jaitpur-Malhar’ village for the study and tools suggested to develop the villages as a self-sufficient unit with the help of information technology. People living in the villages, they will be able to produce articles of daily necessity in their own villages. Can we imagine to develop each village into a modern city?, so that people live their happily in the pure air and natural beauty with the smart life. In this regard, Government attention has been drawn for ultimate growth of the villages providing the technological advances.

## 2. TOOLS OF INFORMATION TECHNOLOGY

The various steps are described here, i.e., how to increase the education and rojgar in the villages with the help of information technology.

The basic need to grow the villages is to acquire the knowledge economy by the peoples living in the village. Their thinking and attitude can change the life styles gradually and hence the village will automatically grow. The information technology is the only alternative to provide the knowledge in all fields for self development and the development of the society. The four layers of knowledge, that can be fulfilled by the information technology, as shown in Fig. 1.



Figure 1. Four layers of knowledge, that can be fulfilled by the information technology.

India is still moving ahead to assimilate itself in the modern Knowledge Economy brought in by the Information technology Revolution of the 1990s and the signing up of the Intellectual Property Rights under the World Trade Organisation (WTO). Now a days, Information Technology provides the basic framework for the acquisition and creation of knowledge repository on various domains and the application and distribution of knowledge for the development of villages.

To provide the knowledge and growth to the villagers, dynamic information infrastructure required for them. To attain this, develop one smart hall in village. One resource officer should be appointed at the Gram Panchayat, established in a village. Every Sunday he should display the information on the screen with the help of computer and projector, assembling all people at Panchayat. There should be a proper planning for month wise and year wise. It should be elaborated as per the need of the villagers, as per the type of crop production, as per the climate and weather, as per the festival arriving, as per the current event happened at state and National level, so that people get knowledge and aware in all fields for future scope and planning. It can be a part of school function.

Facility of i-Pod and Tablets: for poor home school. One i-pod should be provided to per family initially. Later on, it may be changed in to the tablate with internet connectivity. As per government scheme, Akash Tablates were provided to the students of Engineering in Chhattisgarh and Punjab state. Likewise, these devices can be provided to each family of village, which will in turn educate to all the members of family including children studying in the school or colleges along with the parents.

i-pod should be filled with sufficient educational material as per need of the villages. This should include the knowledge about the agriculture, crop production, animal growth, fisheries, birds, small scale industries, uses of varieties of equipments performing during the

crop production etc. This should also include the subject area at least from LKG to 8<sup>th</sup> class, which will help in teaching the children of the family. Technique in using the i-pod or tablet can be provided with help of mentor, facilitated as per point-(1) One V-SAT set up per village, or a particular area of the village can be planted with wi-fi system for internet facility

Now App is also going to develop for the farmers and women living in the villages. It will make easy for communication in regional language.

Build up laghu udyog (small scale industries) at village, like Dona and patta making, Paper plate making, cup, Match Box, Rice mill, etc. While building these types of small scale udyog, young people will be employed. People living in the villages, they are generally unaware all about these things. So gram panchayat wise appointed officer, who is showing per week activity, he can help the villagers as mentioned in point (1), to provide all information to the villager.



Figure 2. Farmer using ‘whats App’ to know about the crops from resources.



Figure 3. Discussion with the people living at ‘Jaitpur Village’.

What we have observed in the villages ‘Malhar’ during survey, most of the family members had migrated to another place for rojgar, so that they can earn money to survive the family. Therefore with the help of information technology at village, with the add of fund supplied by the government to Gram panchayat, many work can be started at villages. Nobody will migrate to city for work.

Adarsh Gram Yojana—This scheme is going to launched by Honb’le Prime Minister Shri Narendra Modi on 11-10-14. He is going to adopt the gram ‘Kakarahia’ and will take the responsibility for its overall development. Up to 15<sup>th</sup> August 2019, every village will be developed. Every ‘sansad’ will take the responsibility of one village every year for its overall development. Now think, if the leader adopt one ‘village’ every year and apply all tools phase wise as mentioned above, definitely, after 5 to 10 years, every village will be converted into the smart village.

Case study of ‘Jaitpur’ Village under Malhar Panchayat—Here an expectation is presented, per year growth after utilizing various tools of information technology, as per discussion with the people and their demand.

No. of farmer family taken for study—100 (including low, medium and high yielding in respect of crop production) (Data as on 15-09-14). Literacy—30%, Crop production- Paddy per acre—9 quintal, Laghu Udyog—Nil (Table 1).

NGOs in India playing a significant role in spreading the awareness among the people about the rights and responsibilities of the citizen, so it can play a nodal role in disseminating knowledge towards the information technology for the augmentation of rural areas with providing micro finance for self employment and small scale industries.

Table 1. The details of Chhattisgarh state as per census in 2011. State position—26<sup>th</sup> state of India

Description	Rural	Urban
Population (%)	76.76 %	23.24 %
Total population	19,603,658	5,936,538
Male population	9,792,514	3,035,401
Female population	9,811,144	2,901,137
Population growth	17.75 %	41.83 %
Sex ratio	1002	956
Child sex ratio (0-6)	972	932
Child population (0-6)	2,866,474	717,554
Child percentage (0-6)	14.62 %	12.09 %
Literates	11,173,237	4,425,077
Average literacy	66.76 %	84.79 %
Male literacy	78.20 %	91.63 %
Female literacy	55.40 %	77.65 %

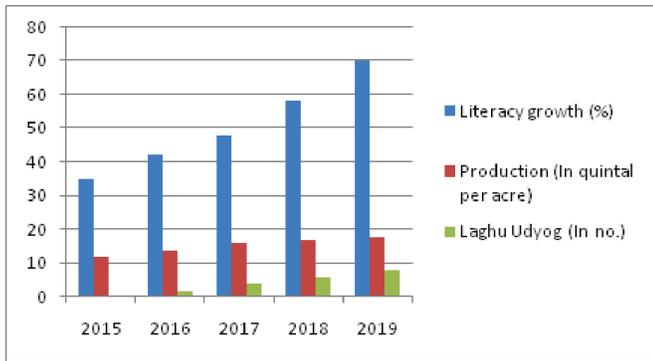


Figure 4. Analysis year-wise (Expected after using IT properly)  
 X-axis- Year; Y-Axis- Literacy growth (In %),  
 Production (In quintal), Laghu udyog (In No.).

Information technology can reduce the non-attainment of school in the age group specially 10 years onwards. As per the survey of 100 families at the village Malhar, Bilaspur, CG, children discontinued their study after class 5<sup>th</sup>, 8<sup>th</sup>, 10<sup>th</sup> or 12<sup>th</sup> class due to the reasons like poverty, population, poor health condition, lack of water and sanitation facility, which makes education less of a priority, even if education is free.

The four main pillar of information technology is indicated in Fig. 5.

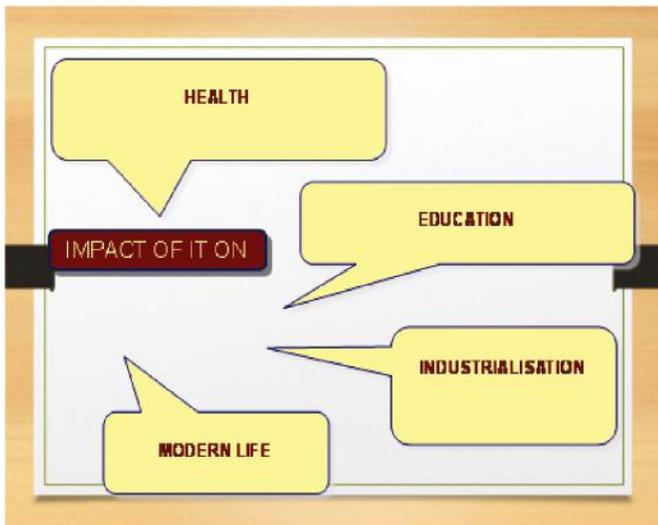


Figure 5. Pillars of Information Technology.

- The focus here required on rural health services like telemedicine
- home education with ipad based education technology and elearning as govt supply
- e-governance link of villages with govt plans, grants, schemes
- skill development tools and training
- right of knowledge then right of information with govt assisted portal.

Information technology of future reveals a lot as indicated in Fig. 6. That should be focused and adaptable for rural needs.

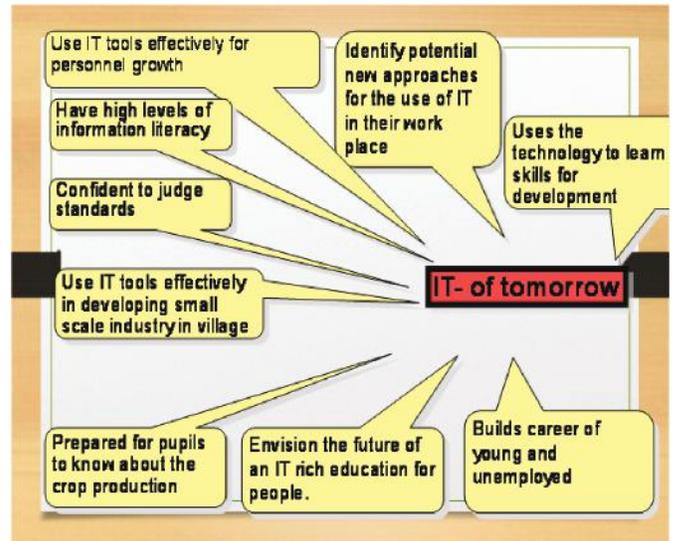


Figure 6. Information Technolgy of future.

### 3. RURAL IT PROJECT

All govt are distiributing free ipad to villages, but if it contains total supporting material for educating not only childrens but parents also that can be designed to be like a home school ion poor home in villages where there is no school.

- It should contain all school material from class 1 to 12 for self learning
- It should contain books and library and links for knowledge and informations as and when required by villagers.
- It should contain voice books for even illeterates
- It should be chargeable with solar energy and water proof
- It should be net connected and govt connected for problem solving, redressal links
- it should contain rural adaptble educating entertainment material
- It should be designed with language adaptable, e-learning, educational technology resources.
- Such resources can be easily developed with above targets with govt assistance and NGOs.

### 4. CONCLUSIONS

Here various tools of IT are described, which can change our society provided that the proper management of information technology. These changes will produce many benefits, create new jobs, promote the growth of new markets and increased national trade and investment.

IT will provide increasing opportunities, options and strategies for education due to their technological literacy, young people can derive cultural capital from their understanding of modern information technologies, and thereby have input into educational change. Our dream to change the village in to ‘Smart Village’.

In the future, education supported by the information technology will become increasingly fruitful for the villages provided that the proper implementation of technological advancement is planned and executed for them.

### निष्कर्ष

यहां सूचना प्रौद्योगिकी के विभिन्न उपकरणों को वर्णित किया गया है जो हमारे समाज को बदल सकते हैं वर्शते सूचना प्रौद्योगिकी का समुचित प्रबंधन किया जाए। इन परिवर्तनों से कई लाभ अर्जित किये जाएंगे, रोजगार के नये अवसर पैदा किये जाएंगे, नये बाजारों के विकास को बढ़ावा मिलेगा और राष्ट्रीय व्यापार और निवेश में वृद्धि हो सकेगी।

सूचना प्रौद्योगिकी की तकनीकी साक्षरता की वजह से अवसरों, विकल्पों, शिक्षा के लिए नीति में वृद्धि प्रदान की जाएगी, युवा लोग आधुनिक सूचना प्रौद्योगिकी के ज्ञान से सांस्कृतिक धरोहर प्राप्त कर सकते हैं और इस प्रकार शैक्षणिक परिवर्तन में निवेश किया जा सकता है। हमारा सपना गांव को 'स्मार्ट ग्राम' में बदलने का है।

भविष्य में, गाँव में शिक्षा को प्रभावी बनाने के लिए सूचना प्रौद्योगिकी का योगदान बहुमूल्य होगा। तकनीक को सही ढंग से अपनाने के लिए उसका सुचारु तरीके से विकास एवं प्रबंधन होना होगा।

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## सूचना प्रौद्योगिकी : कल, आज और कल Information Technology: Yesterday, Today and Tomorrow

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### सारांश

21वीं सदी में तकनीकी युग के उद्भव के साथ शिक्षा से लेकर उद्योगों तक प्रत्येक अनुप्रयोजन क्षेत्र ने अपने संचलात्मक प्रतिमानों को विकसित किया है और जहाँ कहीं भी संभव है वहाँ सूचना प्रौद्योगिकी इस विकास का एक अटूट हिस्सा रही है। यह पेपर सूचना प्रौद्योगिकी के क्षेत्र में आये परिवर्तनों पर चर्चा करता है, इस सशक्त उपकरण के अनुप्रयोजन क्षेत्रों में वर्तमान परिदृश्य का विश्लेषण करता है तथा सतत उद्भवशील एवं विकासशील प्रौद्योगिकी के भविष्य में एक अंतर्दृष्टि उपलब्ध कराने का प्रयास करता है। यह पेपर पाठकों की उस मार्ग मानचित्र के माध्यम से गुजरने में सहायता प्रदान करेगा जिसका पालन सूचना प्रौद्योगिकी और इसके विकासकर्ताओं ने इसे प्रयोगकर्ता की रोजमर्रा की गतिविधियों के साथ संगत बनाने के लिए किया है।

### ABSTRACT

With the advent of technological era in 21st century, every application area, right from education to industries, has evolved in its operational paradigms and the most indispensable part of this evolution has been the embedding of Information technology (IT) wherever possible. This paper discusses the changes the field of information technology has undergone, analyses the present scenario in the application areas of this powerful tool and tries to provide an insight into the future of this ever evolving and developing technology. This paper will help the reader to navigate through the roadmap which Information technology and its developers have followed in order to make it compatible with every day to day activities of the user.

**Keywords:** ICT, IT industry, self- sufficiency, indigenization, BPO

## 1. INTRODUCTION

Information technology (IT) has become an integral part of everyday life. From commerce and government to scientific discovery, healthcare, education, entertainment and environmental management, IT is indispensable and is continuing to fuel further advances in all facets of human endeavours. Along with providing technological basis to every application area, IT provides a powerful foundation for tackling many of the problems that we face in the 21<sup>st</sup> century. These include data modelling and prediction to help manage rapidly graying populations, analysis of satellite imagery to manage deforestation or resource exploration, etc. We have been witnessing rapid advances in IT in recent years, and further advances in IT will help solve, or at least mitigate, many of the problems we are bound to face in the future.

## 2. ADVENT OF INFORMATION TECHNOLOGY

Information technology has evolved with the evolution of human civilization. The developments in the ways of communication and the increasing need of transmitting of information has enabled the researchers and analysts to divide the roadmap of information technology into four time periods, each with its own characteristic features and contributions.

### 2.1 Pre-Mechanical Age (3000 B.C.–1450 A.D.)

As this era was free from machines, this is known as Pre-mechanical age. The first ever attempt to convey information was made through simple drawings and carvings made in rocks, known as Petroglyphs and through Pictographs which were simple sketches which resembled the thing needed to be depicted. These sketches and drawings were later used as symbols for

particular syllables, consonants, and alphabets. The first attempt in this direction was made by Greeks. With the evolution of human brain, and civilization, the rocks were replaced by paper, originally Papyrus, discovered by Chinese and Egyptian. Later, the permanent storage in form of books and scrolls was also initiated. The primitive numbering system was also the contribution of our ancestors. The modern numbering system, traces its origin back to the nine digit numbering system developed by Hindus between 100 and 200 AD and discovery of Zero (0) in 875 AD. This time period also saw the invention of first calculator, known as Abacus.

## 2.2 The Mechanical Age (1450 A.D.–1840 A.D.)

Invention of Printing Press by Johann Gutenberg marked the beginning of mechanical age, which was carried forward by ‘Scale Rule’ which was the earliest analog computer, followed by ‘Pascaline’, invented by Blaise Pascal which is termed as the first mechanical computing machine. These inventions acted as the pioneer for the first prototype of the modern day computers which are the playmakers of ever growing information technology, ‘Difference Engine’ and ‘Analytical Engine’. ‘Difference Engine’ was invented by Charles Babbage who is popularly known as ‘Father of computers’ and ‘Analytical Engine’ was invented by Joseph Marie Jacquard which had remarkable similarities with modern day machines, for instance, Binary Logic and Punch Cards.

## 2.3 The Electromechanical Age (1840–1940)

Discovery of ways to harness electricity was the major advancement which led to the revolution in the field of communication. Using electricity, knowledge and information could now be converted into electrical impulses. Beginning of telecommunications was marked by the invention of voltaic battery, which was taken to a higher level through the advent of telegraph and radio communication. The foundation stone of electromechanical computing was laid by International Business Machine, popularly known as IBM which worked over census machine using punch cards. Another milestone was reached with the invention of Mark 1, which stored information on paper tape.

## 2.4 The Electronic Age (1940–Present)

This age was marked by the advent of properly designed computer machines which was followed by their miniaturization and additional features to support user needs and increasing demands to support new technologies. This age is divided in four generations of digital computing with each generation having their own characteristics and contribution to the development of telecommunications.

- (a) *First generation (1951-1958)* - Characterized by the presence of vacuum tubes, punch cards and the use of machine and assembly language and a compiler.
- (b) *Second Generation (1959 – 1963)* – Characterized by the replacement of vacuum tubes by transistors, punch cards by magnetic tape and disks and high level languages like COBOL.
- (c) *Third Generation (1964 – 1979)* – Beginning the age of miniaturization with the introduction of integrated circuits (ICs) and advanced programming language. These developments led to the establishment of computing giant, Microsoft.
- (d) *Fourth Generation (1979 – Present)* - Initiated by the microprocessors containing memory, logic and control units, i.e., an entire CPU on a single chip. This small step has resulted in great leaps in the area of computing which has facilitated the information technology to never expected horizons, for instance, distributed environment in computing, parallel transmissions, multiple access, complex information processing, etc.

## 3. IT INDUSTRY: PAST TILL PRESENT

As it is evident from the above, information technology has surfaced to the present level after moving through many developmental stages. As Information technology has matured over time, in similar manner, countries have also grown and incorporated IT in their skeletal framework comprising mainly of economic aspects.

Before exploring the footprints of IT embarked in different areas and their impact, we need to look into the two important ethical issues answered by every country which paved the way for Information and Communication Technology (ICT) to become another tool for promoting globalization. These two issues were:

- *Self-Sufficiency* - With the end of the era of colonization, and beginning of globalisation and overseas export-import, every country participating in the global process, entered into the global competition of proving itself as the superpower to its counterparts. And for this, there was an urgent need to be self-sufficiency in every field, which required a foolproof technology to speed up the processing, gathering and storage of relevant information, and here the ICT came to play by deploying quick and efficient methods for information transmission and telecommunication.
- *Indigenisation* – It was another benchmark added to the capabilities of any country. It was in fact an extension to the self sufficiency of countries. By having indigenous technology, countries moved away from relying on foreign technology. This

approach mitigated the risk of intrusion by foreign powers and also fuelled up the economic and political agendas.

Now, we will look into the major play areas of ICT and the changes these have undergone.

### 3.1 Services and Software vs Hardware

The service and software segment of IT industry is more robust than its hardware counterparts. In the earlier years, hardware was the major component in ICT which underwent gradual changes, which led to the enhancements in the field of telecommunications as it added support for new functionalities. The services and the softwares then were limited and quite complex to be understood without formal training. But, with the development of new softwares, which were more user-friendly and interactive, and supported many services which aided day-to-day activities, services and software perspective of ICT took over hardware. Another reason for the same was that the further developments in hardware field have been quite stagnant for the time unlike software and services.

Talking in the terms of economy, export of softwares and related service support is a more promising area than that of hardware after countries have consented on self-sufficiency and indigenisation. This export has provided a well-defined way for the growth of BPOs which not only generate employment, but also help in making international ties.

Keeping the growing trends in this field in mind, countries have eased the labour laws for IT services and softwares. The governments of countries also are extending a lot of support to software firms, unlike to the stringent tax structure imposed in hardware.

But, the time is changing, and with the need for more mini versions, hardware field is again gaining momentum, and countries like India have a great future in hardware sector as Indian IT industry works on the concept of 'learning by doing', so it can move by leaps and bounds by assembling the sophisticated components and providing the finished products to the intended customers.

### 3.2 Export vs Domestic Markets

In the formative years, the IT industry found the potential customers in their country itself. The domestic market was the biggest consumer for all the services, softwares, and hardware produced by the IT industry. But due to limited market boundaries, limited cliental, price specifications and constraints, limited demand, the development in the ICT faced a slowdown which adversely affected the revenue being generated and technological independence of the countries. To mitigate this, the gateways for the export pertaining to ICT were opened. This led to tremendous increase

in both economic and infrastructural agenda of IT industry. With the introduction of export markets, the need of BPO was recognised which in return increased employment opportunities and globalisation ties. But, exporting the products overshadowed the presence of domestic markets and till now, domestic markets are lagging behind in the revenue generation.

To make up for the loss, the BPO facilities are provided 24x7 to the domestic users and other fascinating schemes are also being provided to the domestic client crowd.

### 3.3 Human Capital and Infrastructure

Initial IT industry was constrained to employ only few people as handling the complex hardware and working on complicated software required great expertise which was found in few people only. But, with the development in our education system, and as more and more students started pursuing their career dreams in the field of ICT, IT industry has become the largest employment generator. The collaboration with the international universities and the chances to work abroad in major software giant companies, like Google, Facebook, Microsoft, Amazon, Apple, etc. have also helped in endorsing the IT industry. The major reason behind IT industry being able to hire such a impressive human capital is the large no of subsidiary fields. IT industry is not only about developing softwares, instead it requires manpower in the BPOs, maintenance and support, testing of prototypes, human resource management, personal relationship management, which not only requires engineering graduates, but also needs non-engineering, as well as management minds to work for them. This global acceptance makes IT industry the most sought field.

The ever increasing IT industry requires a great infrastructure to support its huge cliental as well as human capital, which is aided by the government as well as private investors as IT industry has great potential of profit generation.

### 3.4 Economic Development

The IT industry has the potential to raise long-term growth prospectus through increased productivity in almost every sector of economy. With the growth in IT industry over years, it is now capable of not only providing economic growth, but also economic development which depends on global demand, development of potential domestic market, comparative advantages of services and softwares, and impact on governance.

IT is a general purpose technology, which can influence national economy in numerous ways, for instance, by creating employment opportunities, reducing illiteracy, deliver good governance, etc.

#### 4. FUTURE OF IT INDUSTRY

ICT industry is an ever growing industry which has created its own niche in every field, right from political agendas to social conventions. And this proves that this industry can never be stagnant and will always provide some better and new technologies in the coming few years.

Improvements in communication field can be seen in present time itself. By collaborating information technology in mobile devices, providing Bluetooth and Wi-Fi as alternatives to wire approaches of communication, and making systems more and more robust and reliable, are a few advancements evident for now.

Technologies like cloud computing, grid computing, parallel computing, neural networks, soft computing, Bayesian networks, optical communication, virtual displays, 3-D sensitisation etc. are few fields which are being deployed along with ICT to make the world more compressed and transforming the world in a mesh of telecommunications.

It can easily be predicted that in the coming years, IT will surely be an integral part of emerging sectors like biotechnology, pharmaceutical research, nanotechnology, and also the role of IT industry in fields of defence, accounting, meteorology, transportation will increase manifold.

Regarding the social front, IT industry will see more women empowerment and will allow more international ties to work into the firms. In the economic agenda, the Foreign Direct Investment (FDI) in the field of Space Research and Development is the result of the deployment of ICT in the satellites and other aeronautical sciences.

Thus, if stated in a nut shell, the IT industry has still a long way to go, which will surely prove beneficial for global world as well as individual nations.

#### 5. CONCLUSION

The main aim of this paper has been to track the roadmap of IT industry, from the scratch to the present giant form. From analysis and study, it is evident that IT has grown tremendously in all these years and still has a large potential, to not only accelerate the economic growth but also global economic development.

To realize this prediction as true, governments need to take specific measures to promote IT use and make it accessible to every section of the society, along with improving infrastructure, strengthening training and education systems and flexible labour laws.

IT should be used as a tool to improve the living standards of common people and enriching their lives.

IT literacy awareness needs to be enhanced so that ordinary people can derive benefits, both economically and socially.

Thus, the full potential of IT industry can be attained only when we realise and understand the future perspectives of the industry keeping the past and present in mind.

#### निष्कर्ष

इस पेपर का मुख्य उद्देश्य सूचना प्रौद्योगिकी उद्योग के प्रारम्भ से लेकर इसके वर्तमान विशाल रूप तक मार्ग मानचित्र पर नजर डालना रहा है। विश्लेषण एवं अध्ययन से यह स्पष्ट है कि इन वर्षों में सूचना प्रौद्योगिकी ने अत्याधिक प्रगति की है और इसमें अभी भी न केवल आर्थिक प्रगति को अपितु वैश्विक आर्थिक विकास को गति देने की काफी क्षमता है।

इस पूर्वानुमान को सच बनाने के लिए सरकारों को सूचना प्रौद्योगिकी के उपयोग को बढ़ावा देने और इसे समाज के प्रत्येक वर्ग को सहजता से उपलब्ध कराने के साथ-साथ बुनियादी ढाँचागत सुविधाओं में सुधार करने, प्रशिक्षण एवं शिक्षा प्रणालियों तथा लचीले श्रम कानूनों को सशक्त बनाने के लिए विशेष उपाय करने की आवश्यकता है।

सूचना प्रौद्योगिकी का इस्तेमाल आम लोगों के जीवन स्तर में सुधार करने तथा उनके जीवन को समृद्ध बनाने के लिए किया जाना चाहिए। सूचना प्रौद्योगिकी की साक्षरता को बढ़ाने की आवश्यकता है ताकि आम लोग आर्थिक एवं सामाजिक रूप से इसके लाभ प्राप्त कर सकें।

इस प्रकार सूचना प्रौद्योगिकी उद्योग की पूरी क्षमता का उपयोग केवल तभी किया जा सकता है जब हम इसकी पिछली एवं वर्तमान स्थिति को मस्तिष्क में रखते हुए उद्योग की आगामी संभावनाओं का एहसास करें और उनको समझें।

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## सूचना प्रौद्योगिकी : अतीत, वर्तमान और भविष्य Information Technology : Past, Present and Future

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### सारांश

सूचना प्रौद्योगिकी (आईटी) एक ऐसी प्रौद्योगिकी है जो कम्प्यूटर द्वारा सूचना को इकट्ठा करना, प्रसंस्करण करना, भण्डारण करना और जानकारी देना है। हम एक लंबा रास्ता असाधारण समय में तय करके वायरलेस के इतिहास में पहुँच गये हैं। पिछले युग में वायरलेस प्रौद्योगिकियों में भारी वृद्धि दर्ज की गई है। आईटी का विकास कम्प्यूटर की पीढ़ी पर आधारित है, जोकि 0 पीढ़ी से पांचवी पीढ़ी तक पहुँच गया है। सूचना प्रौद्योगिकी ने एकीकृत उद्देश्य 'प्रदर्शन और कार्यकुशलता' को पूरा करने के लिए विभिन्न विकासवादी मार्गों का पालन किया है। सूचना प्रौद्योगिकी सूचना के विभिन्न रूप को दर्शाता है जिनका विभिन्न उद्देश्यों जैसे सम्मेलनों, अनुसंधान और ऑडियो, वीडियो, चैट आदि के लिए होता है। यह आलेख आईटी के अतीत, वर्तमान और भविष्य को परखता है। यह आलेख सूचना प्रौद्योगिकी के अतीत से शुरू करता है। इस आलेख में सूचना प्रौद्योगिकी के विकास और विकास क्रम को दर्शाते हैं। यह सूचना और संचार प्रौद्योगिकी (आईसीटी) से संबंधित है। सूचना प्रौद्योगिकी दुनिया में वर्तमान शताब्दी में अन्य तकनीकों की तुलना में तेजी से बढ़ने वाली प्रौद्योगिकी है।

### ABSTRACT

Information technology (IT) is the technology which uses the computer to gather, process, store and precede information. A long way in an extraordinarily undersized time has been reached in the history of wireless. Over the past era, wireless technologies have undergone massive growth. Evolution of IT is based on the generation about the computer, reached it's about 0G to 5G. Looking past, Information technologies have followed different evolutionary routes targeted to unified objective: performance and efficiency. IT represent different form of information used for different purpose like, conferences, research, and video, audio, chats, etc. This paper examines the past, present and future of IT. This paper begins with the past of the information technology. In this paper we also show the evolution and development of Information technology. It is related to the information and communication technology (ICT). IT extends around the world faster than most other technologies in current centuries.

**Keywords:** Information technology, information and communication technology, generations of computer, social networking sites, information technology infrastructure library (ITIL)

### 1. INTRODUCTION

Information Technology is study of skills. Modern world is characterized by rapid growth and development of information technology (IT) resulting in more dependence of the society, in a wider sense, on the individual knowledge and competence of a person in the IT area. Although this addiction grows on day after day basis, the human right to education and information is not extended to IT area. IT has great potential to improve excellence, quality, efficiency and effectiveness. Supervision IT, human resources present a demanding task for executives. As organizations jumble up between positions involving in-house employment, to agile employment, and to outsourced support for IT, the need to efficiently obtain, supervise and raise appropriate IT human resources assumes greater significance. The

need to develop, maintain, operate, support a portfolio of information systems never disappears. The past decade has seen the regular appearance of information technology as a new computing discipline in educational institutions. In the past, the time between introducing and using new technologies was somewhat long.

The introduction of new Information technologies alters the parameters of the staffing decisions constantly. Despite economic down streams, down turns and downsizing trends, the demand for new IT professionals is expected to grow over the coming years <sup>[1][2]</sup>.

The introduction of new IT in organizations makes the staffing dilemma more demanding, given the lack of acquaintance with the expertise, the education curve connected with its incorporation, the qualified scarcity of experienced human resources. With hurried

development of IT and further deepening of information production, more and more enterprises have realized the tactical value of IT and made great reserves in it. However, during IT implementation procedure, decision-making, conversion degree, and IT performance is often substandard to the expectation. IT has become full-fledged quickly and gratitude to a tremendously dynamic and tight-knit academic group of people, undergone an evolution unlike any other computing regulation.

Information and Communication Technology including issues related to reliability, usability, performance and trust. ICT has the potential to “connection the information gap” in terms of civilizing excellence of education, increasing the magnitude of quality educational opportunities, making knowledge building probable through borderless and unlimited accessibility to resources and people, and getting populations in inaccessible areas to satisfy their basic right to education. As various ICTs become increasingly reasonable, reachable, and interactive, their role at all levels of education is likely to be all the more significant in making didactic outcomes relevant to the labour market, in revolutionizing educational pleased and release, and in encouragement “information literacy.”

## 2. LITERATURE REVIEW

We followed a procedure for a systematic review, described in review paper<sup>3</sup> (based on the Cochrane Handbook for Systematic Reviews of Interventions<sup>[4]</sup>, the University of York’s Centre for Reviews and Dissemination’s guidance for those carrying out or commissioning reviews<sup>[5]</sup>, and consultation with software engineering specialists on the topic and methods.) This procedure specifies the research questions, inclusion and exclusion criteria, quality criteria, data extraction, etc.

### 2.1 Data Sources and Data Collection

The data searching strategy included online electronic data searches and manual searches of various national and international conference proceedings. In this context, following online journals databases were searched

- ASQ Digital Library
- IEEE Explore
- Springer Link and Journals
- Academia.edu
- Research Gate
- Science Direct –Elsevier

In addition we also searched volumes of various conference proceedings-

- ICRTEES 2013
- ICRTEES 2014
- CONFLUENCE 2013
- ICAET 2014

- ACSITEET 2014
- ICACEA 2014
- ICRTC 2013
- SACTA 2014
- SAVOIR MANTRNA 2014
- IC3 2013

### 2.2 Acceptance and Rejection Criteria

The studies which presented quality data on Information Technology or Information and Communication Technology were accepted. Some very old studies were rejected if they were not up to the mark. The author’s main focus was to accept qualitative and quantitative methods based research studies.

### 2.3 Search Strategy

For searching research papers, we used Google search engine and MSN search engine. For this activity, we made some combinations from the area of information technology. Some of those combinations are as follows-

- Information technology
- Information and communication technology
- Evolution of information technology
- Past of information technology
- Generation of information technology

### 2.4 Quality Assessment

For doing quality assessment, the authors did follow the criteria defined in [c]. The three main issues defined in [6] are as follows-

- *Rigor*-Has a thorough and appropriate approach been applied to key research methods in the study?
- *Credibility*- Are the findings well-presented and meaningful?
- *Relevance*.-How useful are the findings to the software industry and the research community?

### 2.5 Data Extraction

At this final stage, data was extracted from each of the study. The data was extracted on the basis of parameters like the research method used, domain, publication etc...The extracted data will be used in several phases of this research work.

### 2.6 Data Extracted

While some of these positions will, no doubt, be filled by overseas providers, a sizeable demand still exists. Projections from Forester Research suggest that the U.S. shortfall will reach more than 6 million jobs by 2015. In a survey of the top concerns of IT executives in 2006, IT human resources were rated the second most important issue<sup>7</sup>. As organizations

seek new efficiencies and as technology permits the incorporation of alternative sources of human resources, new creative staffing options are being added to the traditional options of recruitment, training, and temporary contracting<sup>2</sup>.

In the past, the time between introducing and using new technology was quite long. Today, however, new technology is used immediately after it is introduced, and because we are not always sure about the technology's utility or potential adverse effects, the associated risk analysis is conducted much later. This is a major reason that many companies face monetary and technical risks. Furthermore, companies that have never used software in their products or operation or developed products with in-house software are now dependent on software. This emerging interconnectedness with the software industry is adding to many companies' complexity and their vulnerability to intruders and terrorism<sup>13</sup>.

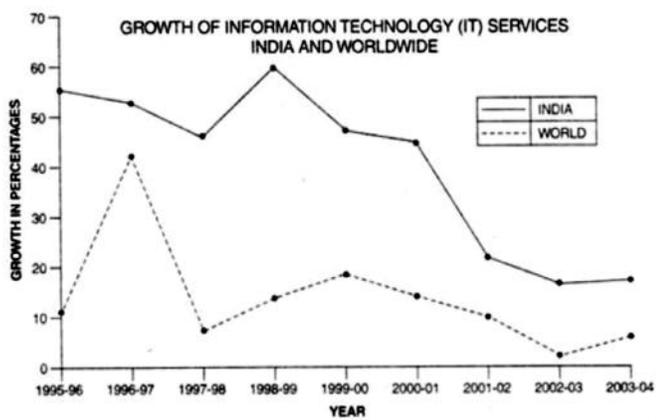


Figure 1. Growth of information technology: India Vs world.

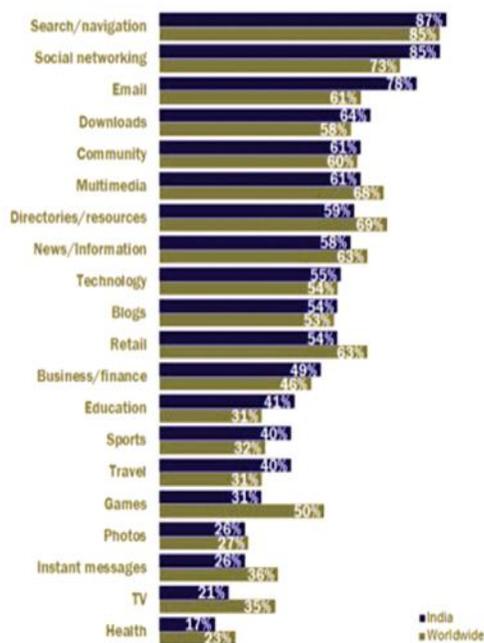


Figure 2. Reach of key online categories: India Vs worldwide.

In fig. 1<sup>8</sup>, one sees the growth of information technology services on basis year wise of. In this figure we find that number of people in India is high relative to the people in whole world. Dashed line shows the growth of IT services in the World and Solid line shows the growth of IT in India.

Figure 2<sup>9</sup>, shows the difference between online categories with the help of percentage in India or World.

Information technology security task forces are shown in Table 1. Here we define the forces as on today and tomorrow.

Table 1. IT security task forces

S. No.	IT Security Task Force	Today	Tomorrow
1	Education and Training	Awareness, SANS	Certifications
2	Policy	Acceptable use	IT Security Policy
3	Identity Management	ID/Password, Moderate Assurance Level	Digital Certificates, High Assurance Level
4	Applications, Data and DB	Central DBA (database administrator), Hosting	Data Classification
5	Physical Security	Control, Some Biometric Entry	Upgrades, Networked Biometrics
6	Desktop	Prescriptive Guidance	Proactive Defense
7	Server	Secure Central Servers	End to end Security for Services Campus wide
8	Network	Web based Wireless AuthN, Device Redundancy	Strong Authentication, Physical Path Redundancy
9	Storage and Backups	Tape, SAN (storage area network), NAS (network attached storage).	Backup to disk
10	Communication	Ad hoc	Systematic

IT security forces is based on the confidentiality, integrity and availability. Confidentiality, integrity and availability are the sources which represent the security for information.

In the past few decades, mobile wireless technologies have experienced 4 or 5 generations of technology revolution and evolution, namely from 0G to 4G. The cellular concept was introduced in the 1G technology which made the large scale mobile wireless communication possible. Digital communication has replaced the analogy technology in the 2G which

significantly improved the wireless communication quality. Data communication, in addition to the voice communication, has been the main focus in the 3G technologies and a converged network for both voice and data communication is emerging. With continued R&D, there are many killer application opportunities for the 4G as well as technological challenges [8].

### 3. SOCIAL NETWORKING SITES

Social networking sites are very wide in today's scenario. In present time the social networking sites are very good for some reasons like these quickly tell about the current news. All friends are close to each other through social networking sites like facebook, whatsapp, we chat, line, chat, hike, etc.

### 4. INFORMATION TECHNOLOGY INFRASTRUCTURE LIBRARY

Information technology infrastructure library is also very common in present time. This is used to capture all the related information regarding IT. In this we also perform the availability management, service level management, risk management, etc.

### 5. PAST, PRESENT, AND FUTURE

The past of IT is shown in figures 1 and 2. In both figures we see that the past of IT in India versus World. Social networking sites, ITIL, etc are the parts which show the presence of IT. The future is based on the generation of IT which comes to the Computer generation.

#### 5.1 Generation of IT

The generation of IT starts from the 0G and till now this is 7G.

0G- This generation is simply based on the wireless technology. 0G refers to the pre-call technique of mobile phones (1970).

1G- In this generation world's first cellular system was launched in Saudi Arabia based on the Analog signals NMT-450 (Nordic Mobile Telephone) (1981).

2G- In this generation Digital Cellular system was launched named as GSM (Global system for mobile communication) Service (1991).

2.5G- In this generation GPRS (General Packet Radio Service) service is launched under the GSM environment (1997).

2.75G- In this generation EDGE (Enhanced Data rates for GSM Evolution) service is launched under the GSM environment in 1999.

3G- In this generation UMTS (Universal Mobile Telecommunications System) service was launched in 2003.

4G- In this generation LTE (Long Term Evolution) advanced WiMAX was launched.

5G- In this generation WWW (World Wide Wireless Web) is developed, start from 2015.

Techniques of 0G to 5G is shown in Table 2. In this table we simply show the techniques which is used in the various generations<sup>10,11,12</sup>.

**Table 2. Techniques used in Generations**

Generations	Techniques
0G	PTT (Push to Talk), MTS (Mobile Telephone System), IMTS (Improved Mobile Telephone Service), AMTS (Advanced Mobile Telephone System), OLT (Norwegian for Offentlig Landmobil Telefoni, Public Land Mobile Telephony) and MTD (Swedish abbreviation for Mobiletelefonisystem D, or Mobile telephony system D).
1G	Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT).
2G	Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA).
2.5G	Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), WAP, MMS, SMS mobile games, and search and directory.
2.75G	EDGE is a superset to GPRS
3G	Make use of TDMA and CDMA. Services like mobile television, GPS (global positioning system) and video conferencing.
3.5G	High-Speed Downlink Packet Access (HSDPA) is a mobile telephony protocol. Adaptive Modulation and Coding (AMC), Multiple-Input Multiple-Output (MIMO), Hybrid Automatic Request (HARQ), fast cell search, and advanced receiver design.
3.75G	High Speed Uplink Packet Access (HSUPA) is a UMTS / WCDMA uplink evolution technology.
4G	"MAGIC" also refers to 4G wireless technology which stands for Mobile multimedia, Any-where, Global mobility solutions over, integrated wireless and Customized services.
5G	Pervasive networks, Cognitive radio technology and Smart antennas.

### 6. RESULTS, ANALYSIS AND DISCUSSION

In this paper, we have focused on the trends of IT in different areas. In figure 3, we define the trends of IT related to the different keywords. In this figure we see that computer generation is never used from 2004 to December 2014.

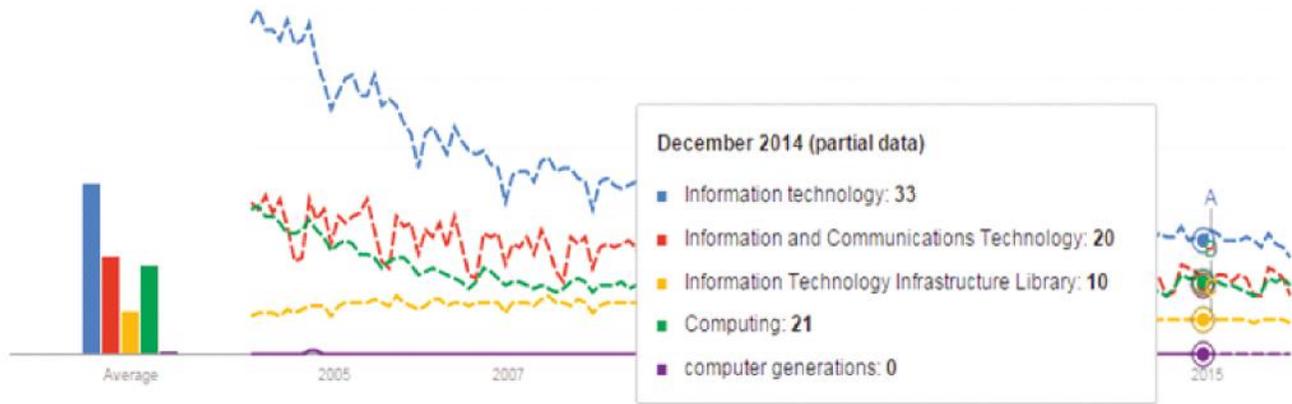


Figure 3. Findings from Google trends through various keywords related to IT: Worldwide.

We also see that in 2004 we used all things related to IT is like Information Technology is 96%, Information and Communication Technology is 44%, Information Technology Infrastructure Library is 11%, Computing is 42% and Computer generations is 0%. But in this figure shows the partial data till December 2014 like Information Technology is 33%, Information and Communication Technology is 20%, Information Technology Infrastructure Library is 10%, Computing is 21% and Computer generations is 0%. This is calculated on the basis of worldwide data.

In Figure 4, we define the trends of IT related to different keywords. In this figure we see that

computer generation is never used from 2004 to December 2014.

We also see that in 2004 we used all things related to IT like Information Technology is 98%, Information and Communication Technology is 46%, Information Technology Infrastructure Library is 15%, Computing is 0% and Computer generations is 0%. But this figure shows partial data till December 2014 like Information Technology is 8%, Information and Communication Technology is 3%, Information Technology Infrastructure Library is 3%, Computing is 12% and Computer generations is 0%. This is calculated on the basis of data gathered for India.

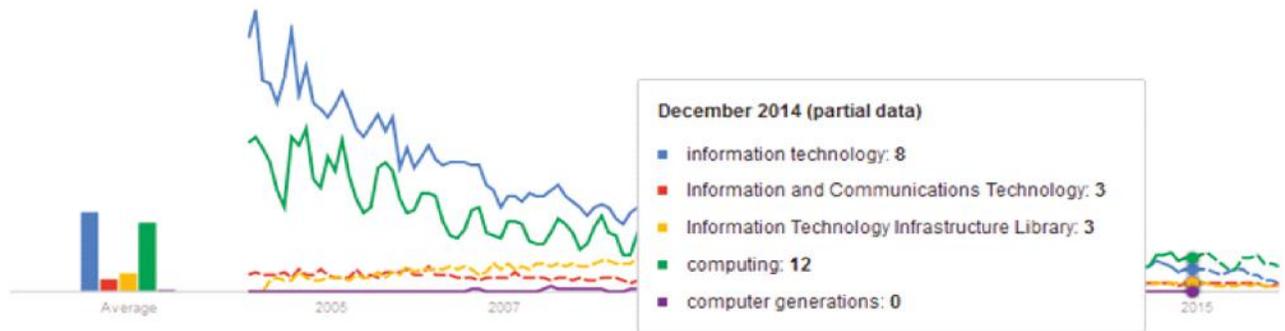


Figure 4. Findings from Google Trends through various keywords related to IT: India.

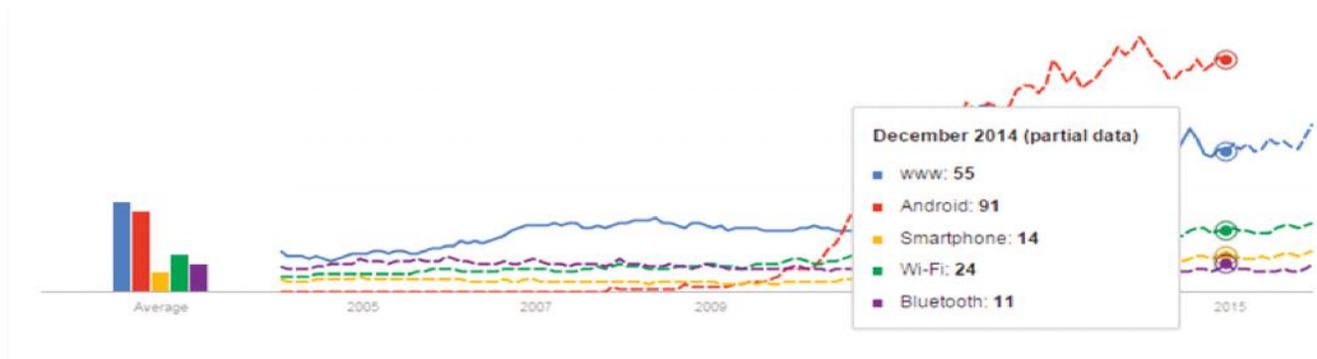


Figure 5. Findings from Google Trends through various keywords related to IT Techniques: Worldwide.

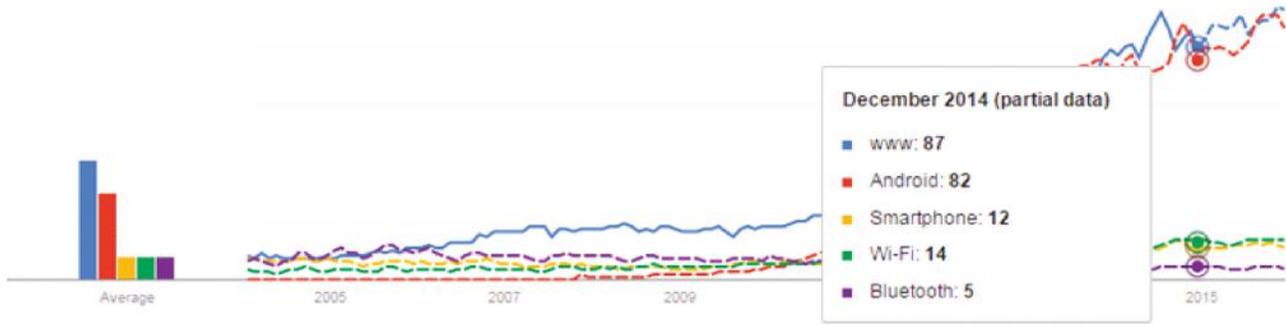


Figure 6. Findings from Google Trends through various keywords related to IT Techniques: India.

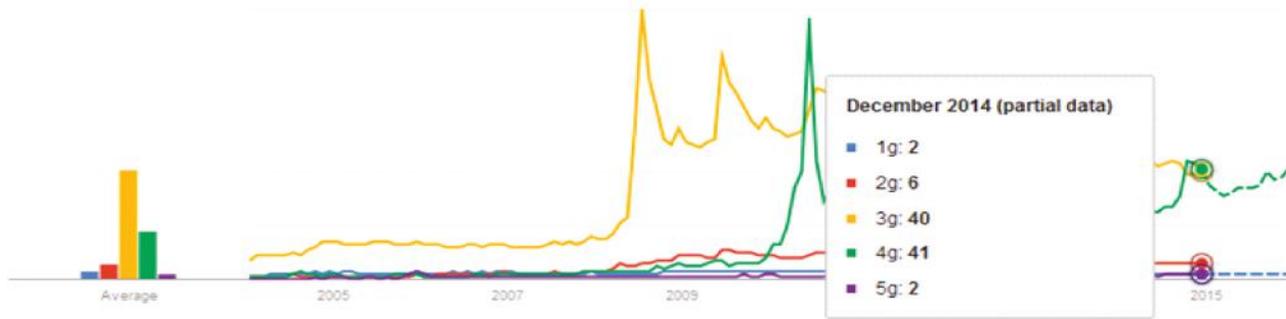


Figure 7. Findings from Google Trends through various keywords related to IT with generations: Worldwide.

Figure 5 defines the relationship among techniques used in IT. In this figure we see that in 2004 the users used the WWW 16%, Android 0%, Smartphone 5%, Wi-Fi 6% and Bluetooth 10%. But this figure shows the partial data till December 2014 like WWW 55%, Android 91%, Smartphone 12%, Wi-Fi 24% and Bluetooth 11. This figure shows the relation Worldwide.

Figure 6 defines the relationship among techniques used in IT. In this figure we see that in 2004 the users used the WWW 8%, Android 0%, Smartphone 8%, Wi-Fi 3% and Bluetooth 8%. But in this figure shows the partial data till December 2014 like WWW 87%, Android 82%, Smartphone 12%, Wi-Fi 14% and Bluetooth 5. This figure shows the relation India.

In figure 7, we define the trends of IT related to the different generations. We see that in 2004 we used different generations related to IT is like 1G is 1%, 2G is 1%, 3G is 9%, 4G is 1% and 5G is 0%. But we also show the partial data till December 2014 like 1G is 2%, 2G is 6%, 3G is 40%, 4G is 41% and 5G is 2%. This is calculated on the basis of worldwide.

In Figure 8, we define the trends of IT related to the different areas. We see that in 2004 we used different areas related to IT is like Internet access is

97%, Expert System is 44%, Artificial Intelligence is 34%, Image Processing is 12% and Neural network is 8%. But we also show the partial data till December 2014 like Internet access is 55%, Expert System is 1%, Artificial Intelligence is 16%, Image Processing is 3% and Neural network is 2%. This is calculated on the basis of data for usage worldwide.

## 7. CONCLUSIONS AND FUTURE SCOPE

In this paper we focus on the past, present and future of Information Technology. We see that the relationship of different techniques, different areas are related to IT. We also describe the past, present and future on the basis of different analyses Worldwide or India wide. Information technology is used in the world like 33%, but in India it is 8%. Information technology is the part which gives all the information regarding all fields. Information technologies are used in Television, Telephones, etc. Information Technology is used in different research areas.

In future we use IT in all the fields related to Image Processing, Neural Networks, etc. In future Information Technology were play a vital role in all fields like medical, generation. 6G and 7G are also planned.

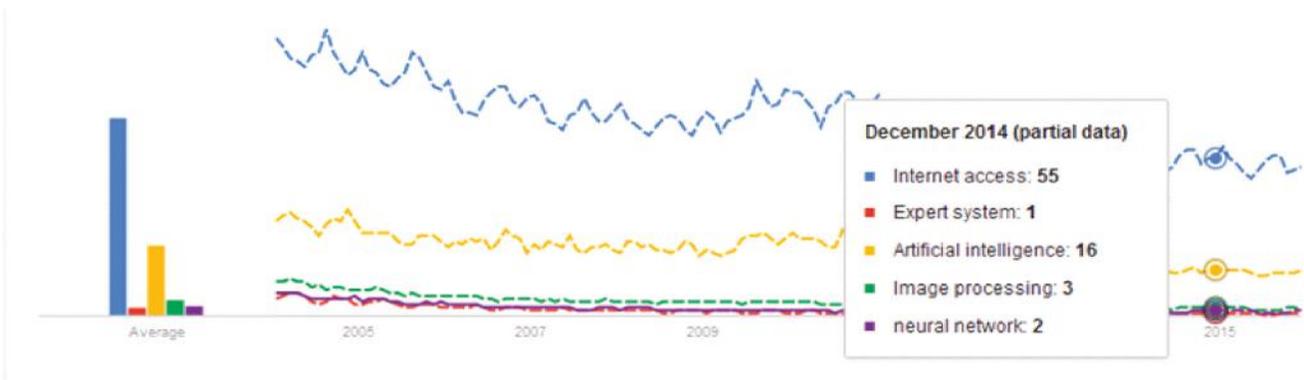


Figure 8. Findings from Google Trends through various keywords related to different areas of IT: Worldwide.

## निष्कर्ष

इस आलेख में हम सूचना प्रौद्योगिकी के अतीत, वर्तमान और भविष्य पर ध्यान केंद्रित कर रहे हैं। इस आलेख में हम देखते हैं कि विभिन्न तकनीकें, विभिन्न क्षेत्र, सूचना प्रौद्योगिकी से सम्बन्धित हैं। हम दुनिया भर या भारत भर के विभिन्न विश्लेषण के आधार पर भी अतीत, वर्तमान और भविष्य का वर्णन करते हैं। सूचना प्रौद्योगिकी का दुनिया में 33 प्रतिशत इस्तेमाल किया जा रहा है, लेकिन भारत में केवल 8 प्रतिशत है। यह आलेख हमें सूचना प्रौद्योगिकी के सभी क्षेत्रों के बारे में जानकारी देता है। सूचना प्रौद्योगिकियों का टेलीविजन, टेलीफोन, में उपयोग किया जाता है। सूचना प्रौद्योगिकी का विभिन्न अनुसंधान क्षेत्रों में प्रयोग किया जाता है।

भविष्य में हम सूचना प्रौद्योगिकी का इमेज प्रोसेसिंग, तंत्रिका नेटवर्क, से संबंधित सभी क्षेत्रों में इस्तेमाल करेंगे। भविष्य में सूचना प्रौद्योगिकी चिकित्सा जैसे सभी क्षेत्रों में एक महत्वपूर्ण भूमिका निभाएगा। 6वीं और 7वीं पीढ़ी की भी योजना बनाई गई है।

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## आज के युग में सूचना प्रौद्योगिकी : ई-गवर्नेन्स, ई-लर्निंग, ई-कॉमर्स, ई-हेल्थ Information Technology in Today's era: E-Governance, E-Learning, E-Commerce, E-Health

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### सारांश

एक समय था जब आयकर जमा करने के लिए व्यक्ति को लंबी लाइनों में लगना और अपनी बारी का इंतजार करना पड़ता था। रिश्तेदार को पैसे भेजने के लिए, मनी ऑर्डर की थकाऊ प्रक्रिया से गुजरना पड़ता था। बैंक खातों से पैसे निकालने के लिए फार्म भरने होते थे। ग्रामीण क्षेत्र के एक व्यक्ति को अच्छा स्वास्थ्य परामर्श प्राप्त करने के लिए शहर जाना पड़ता था। ये सारे कार्य इनमें आईटीसी को ले आने से अधिक आसान और अधिक सुविधाजनक बन गए हैं। "वेस्टर्न यूनियन मनी ट्रांसफर" जैसी फर्मों ने बहुत हद तक मनी ऑर्डर सेवाओं पर अधिकार कर लिया है। पिलपकार्ट.कॉम और जबांग.कॉम जैसी वेबसाइटें खरीदारी प्रक्रियाओं में क्रांति ले आई हैं क्योंकि उन्होंने हमें साइबर मॉल की अवधारणा से परिचित कराया है। इस पत्र का उद्देश्य शासन, स्वास्थ्य देखभाल, वाणिज्य और शिक्षा में सूचना प्रौद्योगिकी के प्रयोग तथा इसे पेश आ रही चुनौतियों की समीक्षा करना है।

### ABSTRACT

There was a time when to pay the income tax one had to stand in long queues and wait for his turn. To send the money to a relative, tedious procedures of money orders were followed. To withdraw money from the bank accounts forms had to be filled. A person in a rural area had to travel to a city to get good healthcare consultation. All these activities have been made easier and more convenient by the introduction of ITC in them. Firms like "Western Union money transfer" have successfully taken over money order services up to large extent. Websites like flipkart.com and jabong.com have become a revolution in the shopping procedures as they have introduced us to the concept of cyber mall. This paper aims at reviewing the use of IT in Governance, Healthcare, Commerce and Learning and the challenges faced by it.

**Keywords:** e-governance, e-learning, e-commerce, e-health

### 1. WHAT IS E-GOVERNANCE?

"E" the prefix of the word E-governance itself gives the meaning of the word, "E-Governance". Like E-mail is for mails using internet and communication technology, similarly e-governance is for governance using communication and internet technology. We can say that it is the application of the information technology and communication technology. This is an efficient and foolproof method of providing the citizens and business groups with the services of the government. E-governance is often mistaken for e-government. E-governance is basically a broader topic that deals with the whole spectrum of networks within government with respect to the use of IT. E-government is a narrower discipline which deals with the enhancement of the online services of the government like e-tax, e- transportation, e-health, and e-commerce. E-governance can be defined as an intermediate application between government services and the government.

### 2. WHY E-GOVERNANCE?

Earlier, to pay the telephone bill, people used to queue up and wait for their chance and only a single counter was active but E-governance has made things simpler for the people. Today, the government services can be availed on a single click sitting in any part of the world. Earlier when internet was not used as widely as it is being used today, a lot of paper work was required to obtain the information from a government body, today we can apply for the information by simply e-mailing or posting a query on the concerned portal, page or website. Today, identification documents issued by the government like passports, aadhar cards, and, PAN card can be issued in a couple of minutes using the ITC technology.

E-governance has the potential to save a lot of time and tedious paperwork and is definitely a much welcomed innovation in the field of governance.

MP Online a portal by the government of Madhya Pradesh provides services like tourism information, application to government universities and colleges, information of entrance examinations for various government departments. Similar portals are being run by other states also.

These portals provide citizens with services from various departments of government like horticulture, agriculture, transportation, tourism, fisheries, PWD, dairy, forest department, etc.

To conclude with, e governance, in today's era, is certainly a remedy to the tedious disease of hectic paperwork and it is an innovative way to manage time in the government procedures and tasks.

### 3. E-GOVERNANCE CHALLENGES

The key challenges with electronic governance are not technology or internet issues but some structural issues that are described in the following sections:

#### 3.1 Lack of Integrated Services

Most of the services which are being issued by state or central government are not interlinked which may be interpreted as a fact that there is a communication gap between the different departments of the government. The information which these departments have might be exclusive to their department but for a citizen or consumer, the information from the various departments might be interlinked.

#### 3.2 Lack of Key People

E governance projects lack key people at both technological and ground level.

#### 3.3 Population

This is arguably the toughest challenge faced by the e governance. The facilities by the government in form of "E" services are available only to the population residing in urban areas as internet is the basis to avail these facilities, whereas internet facilities are not available efficiently in rural areas.

#### 3.4 Language and Literacy

Almost all the online forums are available only in English or Hindi. But a majority of the Indian population still prefers to read and write in their native languages and is unable to interact with these online services. Illiteracy is also a reason for people being unable to avail these facilities as there is no knowledge of using computers at all.

## 4. E-GOVERNANCE IN INDIA

### 4.1 NeGP(National E-Governance Program)

National e governance plan is a plan of government of India to make all government services available to

the citizens via ITC medium. NeGP has been taken up by department of electronics and information technology and department of administrative reforms in public grievances. This project got approval on 18<sup>th</sup> May 2006. The vision of this program is "make all public services available to all the citizens in their respective locality through common service delivery outlets insuring efficiency, transparency and reliability at affordable costs to realize the basic needs of common man."

The approach and methodology adopted for NeGP contains the following elements:

- Common infrastructure: The implementation of NeGP involves setting up of common and support IT infrastructure such as state wide area networks, state data centres, common service centres and electronic service delivery gateways.
- Governance
- Centralized initiative, decentralized implementation
- Public private partnership model
- Integrative elements

### 4.2 State of E-governance in India

National Informatics Centre (NIC), have long been committed to provide state-of-the-art solutions to address the governance needs at all levels.

NIC is providing network backbone and e-Governance support to central government, state governments, UT administrations, districts and other government bodies. It offers a wide range of ICT services including nationwide communication network for decentralized planning, improvement in government services and wider transparency of national and local governments.

Listed below are the few products and services supported by NIC to the e-governance in India:

1. Agmarknet
2. Bhuiyan - Land Records Computerization
3. Value Added Tax (VAT)

### 4.3 What is E-Commerce?

E-commerce basically means electronic commerce. It is a system that allows online buying, selling goods, services and information. It also allows electronic movements that support revenue generation such as promoting the demand of goods and services. In other words, it is the sector of the telecommunication network in which all types of business of buying and selling of goods and services is done via internet and other means of electronic communication. Even today, some considerable time after the so called 'dot com/internet revolution', electronic commerce (e-commerce) remains a relatively new, emerging and constantly changing area of business management and

information technology.

The wide range of business activities related to e-commerce brought about a range of other new terms and phrases to describe the Internet phenomenon in other business sectors. Some of these focus on purchasing from online stores on the Internet. Since transactions go through the Internet and the Web, the terms I-commerce (Internet commerce), I commerce and even Web-commerce have been suggested but are now very rarely used. Other terms that are used for on-line retail selling include e-tailing, virtual-stores or cyber stores. A collection of these virtual stores is sometimes gathered into a 'virtual mall' or 'cybermall'.

#### 4.4 Why E-commerce?

E-commerce is widely needed in today's world. It is a must for all, which is why some of the developed countries have initiated many dealings regarding commerce via internet. Here are some of the reasons why it is really important –

- Buy or sell on websites or online marketplaces.
- Gather the data via social websites like facebook.com.
- Use business-to-business exchange of data, i.e., the data is exchanged for business.
- Make new customers using emails and fax.
- Use B2B buying and selling.
- Provide secure business transactions.
- Provides a wide variety of choices and a huge array of collections, enabling access to products not available in some areas.

The activities of e commerce can be divided in two main sections:

1. E-commerce from companies to individual consumers (business to consumer)  
It represents trade between companies on one hand and individual customers on the other hand. For instance: flipkart.com, myntra.com, etc.
2. E-commerce from companies to companies.  
It represents trade between two commercial firms.

#### 4.5 Importance of e-commerce for consumers

##### 4.5.1 Saves time and effort

In today's life a customer can place an order 24 hours a day throughout the year and at any place. And there is no need to go to a specific place for any product. Some firms like amazon.in give a "one day delivery" with the liberty of getting the good exchanged in 30 days if needed.

##### 4.5.2 Freedom of choice

E trade allows the consumer to select the goods from millions of products available in the cybermall.

An easy comparison of constraints like price, size, design, and color is available.

#### 4.6 E-banking Services

The banking systems have evolved a lot in the past few years. There is very little documentation and paperwork required nowadays as most of the complex processes have been simplified and made easily available online. People no longer need to stand in queues at the banks; all they have to do is login to their banks via internet. Smartphones are playing a great role in this revolution too. A person can do all his banking on a cellphone, including withdrawal and transfer of money.

#### 4.7 E-commerce in India

E-commerce in India is widely growing it is not as much as in United States or United Kingdom but it is growing at a rapid rate. As compared to the other developing countries, in India internet user base is not so strong and is restricted to only 250.2 million till June-2014.

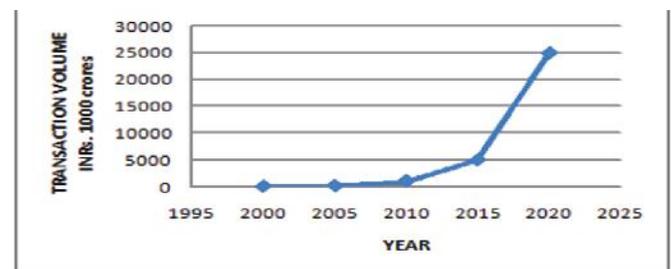


Figure 1. Growth of e commerce transactions in India (Source: FICCI)

Flipkart.com is one of the e-commerce giants in India. It is the biggest online shopping firm that spans a vast variety of products. From electronics to clothes, everything is available. Recently, the prime minister of India took an initiative to help out the khadi weavers in India by signing an MOU with Flipkart, which makes Flipkart an intermediate between the khadi weavers and the khadi consumers. Flipkart now advertises khadi products.

In other countries the main reason of e-commerce being strong is the mode of transaction being online while in India about 80 percent of user base uses "cash on delivery" for payments. But cash on delivery method may harm the e-commerce in the long run and it's necessary to switch the payment method from cash on delivery to online transaction mechanism.

In India e-commerce market is spreading at a fast rate. India has nearly 10 million online shoppers and the number is increasing continuously. Electronics and apparels are the biggest categories in online shopping.

E-commerce has contributed to employment generation as well

## 5. FUTURE SCENARIO

E-Marketer estimates that there are over 220 million people who shop online in China today, and this figure is estimated to grow to 420 million by the end of 2016. The online shoppers in India are 10 million today. So the Chinese market is 22 times bigger than Indian market, and consequently has several e-Commerce companies either already selling products or in line to do so. Only a handful have gone public in India so far.

India maybe behind the curve on the numbers, but they are growing fast, and when they reach the 200-300 million online shoppers, you can safely assume that there will at least be as many e-Commerce players in India as there are in China. We can safely assume that there will be 10-20 big Indian companies in the market soon.

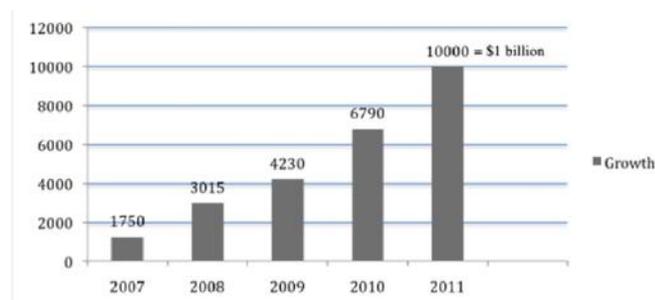


Figure 2. Growth of E-commerce over the years (US\$ millions).

## 6. CHALLENGES FOR E-COMMERCE

*Payment Fraud:* Since all the transactions take place over internet therefore an attack by hackers is the biggest threat to the E-Commerce at present.

The other major challenges for E-commerce are:

*Cash on delivery is the preferred way of payment:* Instead of making a transaction through the online payment portals people find it more convenient to pay by the cash on delivery medium.

*Payment gateways have a very high rate of failure:* Payment gateways do fail often in India which creates a fear of losing the money in the customer. Hence customers, to stay safe, prefer cash on delivery mode.

*The logistics are a problem for delivery to many of Indian towns:* Delivery and transportation facilities to many towns in india adds to the challenges as delivery to such area isn't possible therefore the company prefers to not sell goods to the customers in those areas and loose that market.

*Smartphones:* Feature phones still rule the market as people haven't fully adapted to the Smartphones yet.

## 7. E-HEALTH

E-health is an emerging field in the intersection

of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology. Most notable attribute of e-Health is that it is enabling the transformation of the health system from one that is narrowly focused on curing diseases in hospitals by health professionals, to a system focused on keeping citizens healthy by providing them with information to take care of their health whenever the need arises, and wherever they may be. Hospitals and hospital associations need to be aware of, prepare for, and properly manage, this transformation. It will change, forever, the role of hospitals in the business of producing health. It will make them more efficient, improve quality and strengthen processes. But it will also remove them as the centre piece of the health-care system, and give hospitals a more forward-looking and progressive role.

## 8. IMPORTANCE OF E-HEALTH

- **Efficiency** - one of the promises of e-health is to increase efficiency in health care, thereby decreasing costs. One possible way of decreasing costs would be by avoiding duplicative or unnecessary diagnostic or therapeutic interventions, through enhanced communication possibilities between health care establishments, and through patient involvement.
- **Enhancing quality of care** - increasing efficiency involves not only reducing costs, but at the same time improving quality. E-health may enhance the quality of health care for example by allowing comparisons between different providers, involving consumers as additional power for quality assurance, and directing patient streams to the best quality providers.
- **Evidence based** - e-health interventions should be evidence-based in a sense that their effectiveness and efficiency should not be assumed but proven by rigorous scientific evaluation. Much work still has to be done in this area.
- **Empowerment of consumers and patients** - by making the knowledge bases of medicine and personal electronic records accessible to consumers over the Internet, e-health opens new avenues for patient-centred medicine, and enables evidence-based patient choice.
- **Encouragement of a new relationship** between the patient and health professional, towards a true partnership, where decisions are made in a shared manner.

- Education of physicians through online sources (continuing medical education) and consumers (health education, tailored preventive information for consumers)
- Enabling information exchange and communication in a standardized way between health care establishments.
- Extending the scope of health care beyond its conventional boundaries. This is meant in both a geographical sense as well as in a conceptual sense. E-health enables consumers to easily obtain health services online from global providers. These services can range from simple advice to more complex interventions or products such as pharmaceuticals.
- Ethics - e-health involves new forms of patient-physician interaction and poses new challenges and threats to ethical issues such as online professional practice, informed consent, privacy and equity issues.
- Equity - to make health care more equitable is one of the promises of e-health, but at the same time there is a considerable threat that e-health may deepen the gap between the "haves" and "have-nots". People, who do not have the money, skills, and access to computers and networks, cannot use computers effectively. As a result, these patient populations (which would actually benefit the most from health information) are those who are the least likely to benefit from advances in information technology, unless political measures ensure equitable access for all. The digital divide currently runs between rural vs. urban populations, rich vs. poor, young vs. old, male vs. female people, and between neglected/rare vs. common diseases.

## 9. CURRENT E-HEALTH SCENARIO IN INDIA

The Indian health care services are highly skewed in favour of urban population which is 28% of Indian population. Nearly one million Indians die every year due to inadequate healthcare facilities and 700 million people have no access to specialist care and 80% of specialists live in urban areas. There has been undue delay in implementing e-healthcare in India due to following reasons:

- Absence of competition in health sector for long time healthcare is handled by Public Health System (PHS) with no competition.
- Weak customer with low bargaining power.
- Non-existence of funding system like insurance or social security agency.
- Strong professional culture among doctors hostile

to new ICT applications.

- Doctors and nurses believe on their skill than on computer.
- Lack of computer-aid in medical and nursing education.

### 9.1 E-Health Challenges

India faces a number of obstacles in the improvement of effective e-Health solutions. Divisions between health-professions, the public-private sectors, facilities, levels of government and cultural communities generally mitigate against large national inter-jurisdictional projects in the public sector, and new large-scale investments in the health sector. The technologies themselves, as well as their deployment, are challenging matters. There are questions about how to properly automate the health-system, which technical standards are to be adopted, Is the current level of technology and technological sophistication of the providers and public sufficient to the task.

Socioeconomic, cultural and geographic influences limit connectivity, performance and possibilities of Internet. Public and professional acceptance of the new technologies in the place of old ways -such as, keying up a live on-line Internet consultation instead of sitting in a waiting room- is essential. Clearly, large financial and human resources must be invested in e-health to realize the full potential of the technology. Evidence suggests that e-Health is at least 10 years behind other information management intense sectors, such as banking.

### 9.2 E-Learning

E-learning basically means education via the Internet, network, or standalone computer. E-learning is essentially the network-enabled transfer of skills and knowledge. It also refers to using electronic applications and processes to learn. E-learning applications and processes include Web-based learning, computer-based learning, virtual classrooms and digital collaboration. Content is delivered via the Internet, audio or video tape, satellite TV, and CD-ROM.

### 9.3 Benefits of E-Learning

There are many significant advantages for the student who learns online. Here are just a few to consider:

#### 9.3.1 Convenience and portability

- Courses are accessible on your schedule
- Online learning does not require physical attendance
- Learning is self-paced (not too slow, not too fast)
- You're unbound by time - courses are available 24/7

- You're unbound by place - study at home, work, or on the road
- Read materials online or download them for reading later

### 9.3.2 Cost and selection

- Choose from a wide range of courses to meet your needs
- Degree, Vocational, and Certificate programs
- Continuing Education
- Individual courses
- Wide range of prices to fit your budget
- Go back to school to get a degree, learn a new skill, learn a new craft, or just have fun!
- From art to zoology you can do it all online in a price range to fit your budget.

### 9.3.3 Flexibility

- Online learning accommodates your preferences and needs - it's student-centered
- Choose instructor-led or self-study courses
- Skip over material you already know and focus on topics you'd like to learn
- Use the tools best suited to your learning styles

### 9.3.4 Higher retention

- Online learning will draw you to topics you like and enjoy. Studies show that because of this and the variety of delivery methods used to reach different types of learners, retention is frequently better than in a traditional classroom.

### 9.3.5 Greater collaboration

- Technology tools make collaboration among students much easier. Since many projects involve collaborative learning, the online environment is far easier (and often more comfortable) to work in since learners don't have to be face-to-face.

### 9.3.6 Global opportunities

- The global learning community is at your fingertips with online learning. The technologies used give online instructional designers the ability to build in tools that take you to resources you may never see in a traditional classroom.

## 10. CONCLUSION

Business in the electronic form is one of the most blooming sectors in India at the time. It has been a gamechanger in the past few years in the business field and now has a great impact in the same. It has improved the life of a common man to a great extent, saving precious time and energy. Use of information technology in commerce section saves a lot of time, energy and paperwork. ITC in governance has provided

a platform to the people to do all government based works sitting in their homes on a click of mouse. All the works that required forming long queues is now being done over internet. Saving time is saving money therefore use of ITC some way or the other saves money. Healthcare facilities can now be made to reach people living at every corner of the world as a doctor's consultation is now available on internet. Websites like khanacademy.com and youtube.com have stored video lectures for students of various courses. To conclude it is genuine to accept the fact that use of information technology in daily life has made all the tedious tasks simpler and cheaper.

## निष्कर्ष

इस समय भारत में इलेक्ट्रॉनिक स्वरूप में व्यापार एक सबसे अधिक फलता-फूलता क्षेत्र है। यह पिछले कुछ वर्षों से व्यापार के क्षेत्र में क्रांतिकारी परिवर्तन लाने वाला रहा है और अब इस पर इसका अत्यधिक प्रभाव है। इसने बहुमूल्य समय और ऊर्जा की बचत कर बहुत हद तक आम आदमी के जीवन में सुधार किया है। वाणिज्य के क्षेत्र में सूचना प्रौद्योगिकी के उपयोग से बड़ी मात्रा में समय, ऊर्जा और कागजी कार्यों की बचत होती है। शासन-व्यवस्था में आईटीसी ने लोगों को अपने घरों में बैठकर माउस के एक क्लिक पर सरकार से संबंधित सभी कार्यों को आसानी से करने के लिए एक मंच प्रदान किया है। ऐसे कार्य जिनके लिए लंबी लाइनें लगानी पड़ती थी, अब इंटरनेट पर किए जा रहे हैं। समय बचाने का अर्थ है पैसे बचाना और इसलिए आईटीसी के उपयोग का अर्थ है किसी न किसी रूप में पैसे बचाना। अब स्वास्थ्य देखभाल सेवाओं को विश्व के प्रत्येक कोने में रह रहे लोगों तक पहुंचाया जा सकता है क्योंकि डॉक्टर का परामर्श अब इंटरनेट पर उपलब्ध है। खानाएकेडमी.कॉम और यूट्यूब.कॉम जैसी वेबसाइटों ने विभिन्न पाठ्यक्रमों के विद्यार्थियों के लिए वीडियो लेक्चर स्टोर किया हुआ है। निष्कर्षतः, इस तथ्य को स्वीकार करना सही होगा कि दैनिक जीवन में सूचना प्रौद्योगिकी के उपयोग ने सभी थकाऊ कार्यों को सरल और सस्ता बना दिया है।

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## ई-गवर्नेस सेवा – मध्य प्रदेश सरकार की लोक सेवा प्रतिबद्धता E-Governance Services : Lokseva commitment of Madhya Pradesh Government

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### सारांश

ई-गवर्नेस कई देशों में एक शक्तिशाली गवर्निंग उपकरण के रूप में उभर रहा है। ई-गवर्नेस सेवाओं की राजनीति योजना और उनके काम के परिवर्तन की दिशा में भारत में सरकारी संगठनों द्वारा विचार विमर्श किया गया है। लेखक द्वारा के PSGDGA Act 2010ए तहत मध्य प्रदेश के ई-गवर्नेस के लोकसेवा घटक की वर्तमान तथा भविष्य के परिदृश्य में चर्चा करेंगे। लेखक द्वारा सुझाये गये सुधार ई-संसाधनों के बेहतर प्रबन्धन तथा बेहतर सरकारी ई-संसाधन खोज उपकरण बनाने में मदद मिल सकती है।

### ABSTRACT

e-Governance is fast emerging as a powerful governing tool in many countries. e-Governance services have been mooted by government organizations in India towards strategic planning and transformation of their working. In this paper, we discuss the scenario – present and future - of the Lokseva component of e-governance services of Madhya Pradesh under the Public Service Delivery Guarantee Act (PSDGA), 2010. We also indicate some points where improvements suggested by us may lead to better management of the e resources and help in making the government e resources a better knowledge discovery tool.

**Keywords:** e-Governance, e-district, Lokseva, public service delivery guarantee act, public private partnership

## 1. INTRODUCTION

The US e-government Act of 2002 defines 'electronic Government' to mean (section 3601):

'The use by the Government of web-based internet applications and other information technologies, combined with processes that implement these technologies, to-

(A) enhance the access to and delivery of Government information and services to the public, other agencies, and other Government entities; or

(B) bring about improvement in Government operations that may include effectiveness, efficiency, service quality, or transformation'.<sup>1</sup>

Every citizen of any nation in general and India in particular, requires – at some point, some document from the government in order to authenticate claims made by him/her at different stages of their life in a plethora of situations.

Such documents from the government are obtained by the citizen based on his application along with a prescribed nominal fee after some standard procedures are followed by him in accordance with the applicable rules. The data is generally recorded by government agencies and is generally verifiable. In an economy riddled with poverty, it is an enormous burden on the citizens to forego daily wages to obtain government services, if it involves considerable direct or indirect expenses or time.

In this paper, we discuss the scenario—present and future of the Lokseva component of e-governance services of Madhya Pradesh e-district project under the framework of Public Service Guarantee Act.

## 2. EARLIER SCENARIO

When we take a retrospective look at the earlier scenario, we find that from the conventional administrative

systems in vogue required a service seeker to undertake multiple visits to the district headquarter/tehsil for the completion of any simple transaction regarding documents and redressal of grievances. From the point of view of the common man, the perception generally floated was that the typical hierarchical bureaucratic functioning of the government office makes it nearly impossible or extremely time consuming to obtain even simple services like domicile, caste, death and birth certificates.

Though the service provider and the government seem to be the driving force, the conventional administrative mechanism was constrained by its inability to reach out to the citizens at a comfortable convenience level.

The major bottlenecks of the conventional system were:

- a) Dependence on clerks/lekhpal for the records.
- b) No specified time frame for delivery of service and hence delay in obtaining the services.
- c) Problem of approaching the headquarters from remote places.
- d) Hampering of the daily routine of a common man due to requirement of repeated visits to avail service.
- e) Low transparency level.
- f) Lack of mechanism to trace the status and progress of application.
- g) Lack of effective monitoring of the concerned officials.

### 3. E-GOVERNANCE

With the development of ICT and growing acceptance of computer enabled transactions e-Government services have been mooted by government organizations towards strategic planning and transformation of their working with aiming at:

- A citizen focus while realigning government service delivery
- Improvement in transparency, accountability and trust in the government functioning.

The purpose is to achieve improved citizen experience in Government transactions at reduced time, costs and administrative burden for government agencies.

e-Governance is expected to enable the government to discharge its functions more effectively. However, this would require the government to change its processing tools and improve its e-resource management enabling authentic flow of information with ample and secure access impartially to all citizens. This would also need better citizen response to the services provided by the government agencies

Based on technical, organizational and managerial feasibilities Layne and Lee (2001) described a four stage growth model for e-government as being composed of –

- Cataloguing (Information)
- Transaction
- Vertical integration (Interactive)
- Horizontal integration (Strategic, interactive) or transformation

In order to leverage the benefits of Information Technology and to provide more and more services and information in an efficient, reliable and transparent manner to the public – even at the lowest level of service delivery related to the various departments and agencies of the State and Central Government as a part of e-governance initiative - the Government of Madhya Pradesh started a chain of computerized SAMADHAN Centers.

The SAMADHAN project sought to redefine public service in terms of prompt delivery of services sought by citizens. This was being rendered as a one stop service through multiple delivery channels like physical centers, electronic kiosks and web. Initially there were 10 service counters at the district headquarters. The service provided can be seen in Figure 1.

Perceived advantages of SAMADHAN project:

- a) Reduced dependence on clerks/lekhpal for the records.
- b) Stated specified time frame for delivery of service (as mentioned on the acknowledgement slip) and hence reduction in time to obtain the services.
- c) Reduction in number of visits to headquarter or SAMADHAN Kendra.
- d) Improvement in the transparency level.

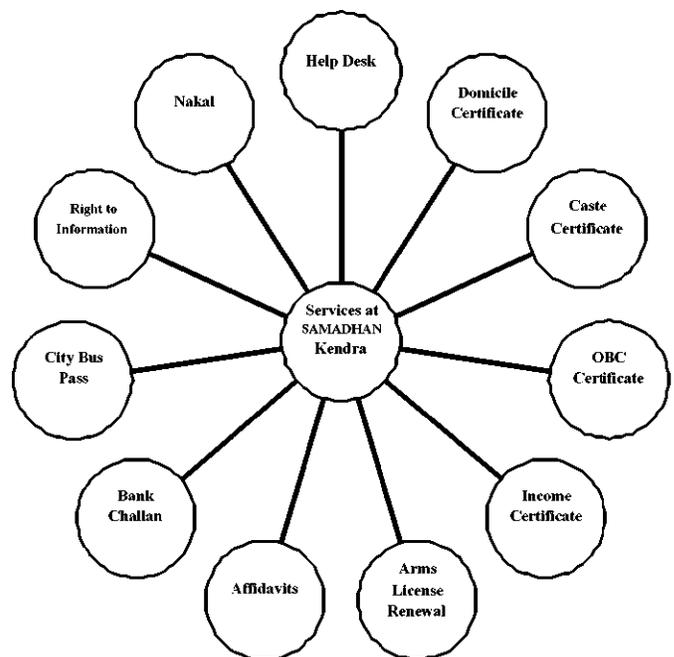


Figure 1. List of Services at SAMADHAN Kendra Source: [www.indore.nic.ac.in](http://www.indore.nic.ac.in).

**4. FUNCTIONING OF SAMADHAN KENDRA SHOWN IN FIGURE 2**

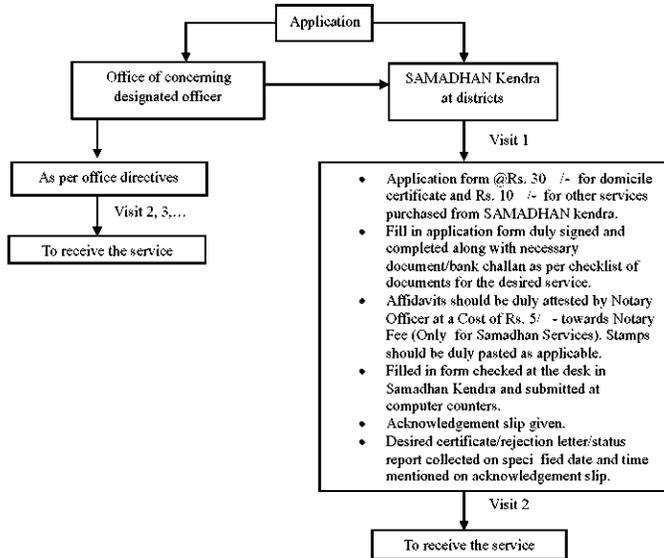


Figure 2. Functioning of SAMADHAN Kendra.

**5. LOKSEVA**

Incorporating advantages of SAMADHAN and adding to it a very important aspect of providing explicit guarantee in terms of time bounds and provision of penalty if the services are not provided within the stated time limit and/or unsatisfactory level of service, Government of Madhya Pradesh has gone one step further and on September 25, 2010 introduced the Madhya Pradesh Lok Sewaon ke Pradan Ki Guarantee Adhiniyam, 2010 (hereafter called The Public Service Delivery Guarantee Act (PSDGA), 2010 in this paper as per the webportals [www.dit.mp.gov.in/en/edistrict](http://www.dit.mp.gov.in/en/edistrict), [www.mpinfo.org](http://www.mpinfo.org) or Lokseva in short). The adhiniyam was duly amended in 2011.

**6. OPERATIONAL MODEL**

Lokseva is a public-private partnership (PPP) of e-Governance initiative under the umbrella of both the district administration as well as the National Informatics Centre (NIC) at the state level for realizing the PSDGA, 2010.

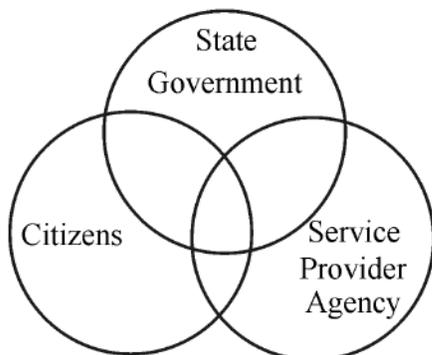


Figure 4. Stakeholders of Lokseva Model.

The operational model involves the three key stakeholders – (a) the State Government, (b) the service provider/IT entrepreneurs and (c) the citizens.

**6.1 The State Government**

The State Government responsible for framing of the Lokseva adhiniyam and local government (DM’s office) is responsible for the implementation of the adhiniyam at the grass root level and selection of service provider agency for the implementation. The government (DM’s office) or the e-governance society is only responsible for providing the infrastructure in terms of the Lokseva Centre space. The technical know-how (software) is the responsibility of the National Informatics Center (NIC).

**6.2 The Service Provider Agency**

The Service delivery agency is to be selected through open bid in a transparent way for a period of 3 years. The Service provider is solely responsible for the human resource and hardware (Computer, Printer, Scanner, furniture etc.). The service provider would be self motivated to generate revenues and therefore promote the services in a professional manner.

The revenue for the Lokseva Kendra comes from the users who pay prescribed fee for accessing the services. A nominal part of the generated revenue shall be shared with e- governance society.

**6.3 Citizens**

The citizens form the target customer base in terms of ultimate beneficiaries of the Lokseva model. The citizens save remarkable amount of cost and effort in getting government services through the guarantee given by the PSDGA, 2010. The PPP mode of operation ensures the long term sustainability at one end and the financial viability on other.

**7. SERVICES OFFERED BY LOKSEVA KENDRAS**

A wide range of services of various government departments are guaranteed under the PSDGA. Around 20 departments and more than 100 services are facilitated through Lokseva Kendras. Services not only listed under Lokseva but other services are also provided in some of the districts. Some of the common services provided by the Lokseva kendras are to provide:

- Caste Certificates
- Income Certificates
- Domicile Certificates
- Arms License

As per the recent orders of State Government income certificates may be self declared but there is also a provision of obtaining one from Lokseva Kendra.

The Act serves as a guideline to administration and makes it more people-centric, transparent and

effective in terms of service delivery. Presently, the Act covers more than 100 services of around 20 departments. After implementation in Madhya Pradesh the Act has been replicated in 14 states.

**8. OBJECTIVES**

The objectives of Loseva facility can be broadly summarized as:

1. To explore the possibilities of seamless inter and intra departmental integration of State Government and District Administration in terms of providing services to general public through automated process of internal administrative workflow.
2. Provide citizens with an alternative online mechanism to obtain notified services.
3. Reduce the possibility of delay or denial of service by devising an effective grievance redressal mechanism.

Government projected Lokseva is a resultant of the commitment made to provide a system of governance which is not only transparent but, credible and accountable towards the public in general. It encompasses civil, political as well as economic and social rights by accountable and efficient public administration for the endowing support for development of citizens. Major flow of Functioning of Lokseva Kendra can be seen from Figure 3.

We now discuss the current status of this new commendable citizen centric venture by Madhya Pradesh Government and provide our suggestive comments for sustainable improvement of this kind of service in the future of e-governance. PSDGA is meant to provide increased accountability and transparency towards public services and a major reduction in corruption among the government offices.

One aspect that makes e-governance measures sustainable and prone to further development is the empowerment of common man to-

- i. Enforce the flow of government information to citizen
- ii. Verify and ask question if not satisfied.

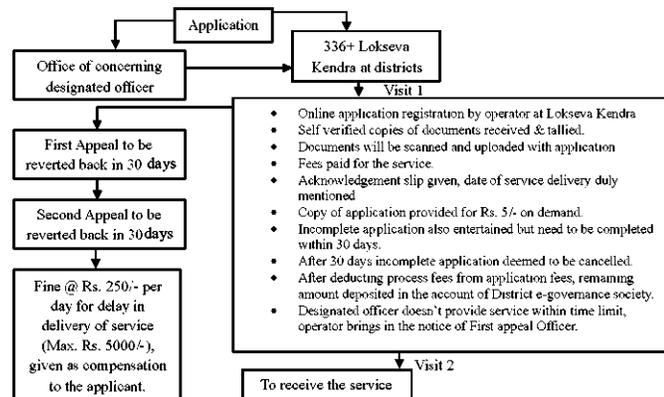


Figure 3. Functioning of Lokseva Kendra.

A major point which the common man would find to his advantage in Lokseva is that it endows accountability to government functionaries which enforces the government employee responsible to do his/her duty with full sincerity and deliver public services within the prescribed time limit mentioned in PSDGA and/or otherwise pay fine for non delivery of service. Thus Lokseva has taken a leap much beyond the earlier e-governance efforts that were limited to providing existing services electronically.

The main feature of this act is the provision that a government employee not delivering a prescribed service at a satisfactory level within specified time-limit is liable to pay fine and a part of that fine is to be given as compensation to the applicant.

Accordingly this has resulted in penalization and compensation in the state (MP) till year 2012, around 137 officers/employees were fined a sum total of Rs. 2 lakh 52 thousand 420 for not adhering to the PSDGA and compensations made available to the applicants were around Rs. 1 lakh 86 thousand. (Source: www.mpinfo.gov.in).

**9. SUSTAINABILITY**

Richard Heeks (2002) provided the following figure for the trend of success rate for the e-Government projects in developing/transitional countries.

- 35% are total failures
- 50% are partial failures
- 15% are successes

He further asserted that the experience of some of the Governments shows that real crux of convergent/integrated delivery of public/private services lies in re-engineering of government/business processes (40%) and change management (45%) rather than technology including hardware and software (15%).

- Viability of the Lokseva lies in the power of accountability on a wide range of services and departments.
- State-wide implementation of Lokseva not only results in good governance but also in permanent change in government service delivery model.
- Complete transparency via online tracking of the application status.
- Services are given under the specified time limit clearly reflected by the statistics.
- Is in line with the e-Governance four stage growth model.

**10. ACHIEVEMENTS**

- The revolutionary law has been honored with UN Public Service Award for the year 2012.
- The Act has been replicated in 14 states.
- Around 20 departments and more than 100 services facilitated through Lokseva Kendras.

### 11. BENEFITS AND IMPACT

Since the notification of the PSDGA, 2010 a total of 1,87,44,918 (including 70155 incomplete) complaints have been filed by the people, out of which 1,53,47,171 (84%) were resolved amicably.

### 12. THE CHALLENGES AHEAD

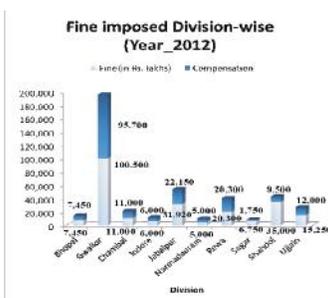
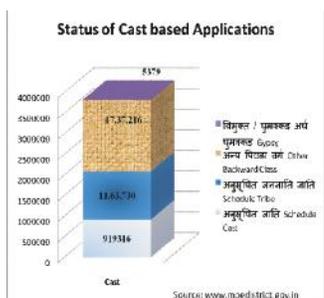
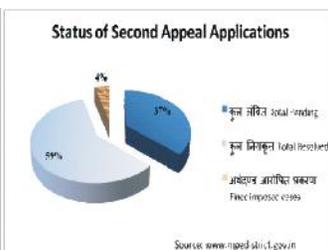
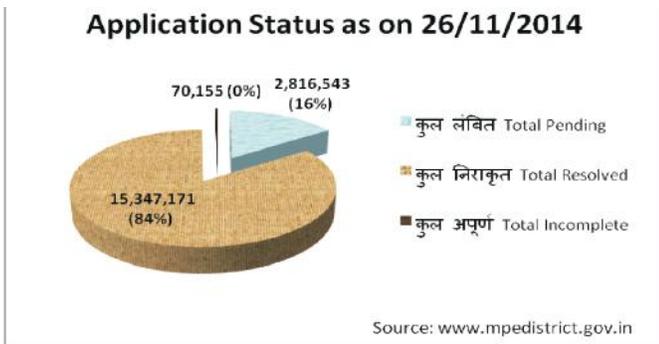
Success of Lokseva is apparent from the statistics provided in the above mentioned figures and the benefit in terms of spread of awareness in citizens about service delivery guarantee and service delivery within time-limit. The government officers and employees not doing their work properly are liable to be punished. The Lokseva project is apparently successful in terms of figures, awards, perceived benefits shown by government agencies. However, is still a challenging task drawing optimum benefits from the scheme. We put forth some constructive suggestions:

1. Spreading the network of Lokseva Kendra from district level down to tehsil, block and even at village level would ensure greater convenience to a wider class of citizen.
2. More Kiosk - For the sustainability of the project, government may add kiosks, and induce small entrepreneurs to provide services to the networks. This would improve physical proximity between the service provider and the citizen and result in

- reduction of indirect expenses.
3. E-services - Presently service delivery is through designated Kendra or centers only. For the effective and efficient governance availability of 24x7 services through online portals and customer care practice could be exercised.
4. Appropriate measures for customer satisfaction in terms of quality should be developed, implemented in a transparent manner and feedback should be used to streamline and improve the service mechanism.
5. Online Application and Transaction facility from any point may be the next step to the success of Lokseva e.g. a citizen should be allowed to submit an application on internet from a computer at any time.
6. Similar projects may be merged or withdrawn completely from the government sites, e.g. there is still a samadhan link on Indore district website<sup>[10]</sup> and Bhopal district samadhan center site<sup>[11]</sup> despite the implementation of Lokseva in these districts.

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## मध्यप्रदेश में ई-गवर्नेन्स : तेज, सुविधाजनक और लागत प्रभावी सेवा प्रदायगी E-Governance in Madhya Pradesh : Fast, Convenient and Cost Effective Service Delivery

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### सारांश

ई-गवर्नेन्स समाज और आम जनता के लिए बेहतर शासन-व्यवस्था की कुंजी बन गया है। यह ई-शासन कार्यान्वयन के लिए और इसके कार्यान्वयन से संबंधित मुद्दों के लिए पद्धतियों और समाधान पर ध्यान केंद्रित करता है। भारत सरकार ने शासन व्यवस्था को ई-शासन में बदलने के लिए राष्ट्रीय ई-गवर्नेन्स योजना (एनईजीपी) शुरू की है। इसके मुख्य घटक हैं- राज्य आंकड़ा केन्द्र, राज्य-व्यापी एरिया नेटवर्क और साझा सेवा केन्द्र। मध्यप्रदेश में, ई-गवर्नेन्स एमपीऑनलाइन पोर्टल के माध्यम से कार्यान्वित किया जाता है, जिसे टाटा कंसल्टेन्सी सर्विस द्वारा विकसित किया गया। इस पोर्टल का उद्देश्य नागरिकों और अन्य हितधारकों के लिए मध्यप्रदेश सरकार द्वारा प्रदान की जा रही सूचनाओं और सेवा हेतु एकल पटल उपलब्धता प्रदान करना है। इस पोर्टल के माध्यम से मध्यप्रदेश सरकार राज्य में सूचना प्रौद्योगिकी संबंधी सूचनाओं के संबंध में व्यापक, सटीक और सूचना का एकल स्रोत प्रदान करती है। मध्यप्रदेश सरकार अंतर्वस्तु के कवरेज, डिजाइन और प्रौद्योगिकी की दृष्टि से ऑनलाइन पोर्टल का नियमित आधार पर संवर्धन करने और उसे समृद्ध बनाने का कार्य जारी रखने का लक्ष्य रखती है।

### ABSTRACT

E governance has become the key to better governance for the society and common people. It focuses on the practices and solution for e-government implementation and the issues related to its implementation. The government of India has launched the National e-Governance plan (NeGP) to transform governance into e-government. Its core components are state data center, state wide area network and common service center. In Madhya Pradesh, e-governance is implemented through an online portal, which was designed and developed by Tata consultancy service. The objective of the portal is to provide a single window access to the information and service being provided by the government of MP for citizens and other stakeholders. Through this portal Madhya Pradesh government is providing comprehensive, accurate and one-step source of information about IT related information in the state. MP government set up a goal to continue the enhancement and enrichment of online portal in terms of content coverage, design and technology on a regular basis.

**Keywords:** E-governance, MP online, portal, information technology

### 1. INTRODUCTION

E-Government refers to the use of information and communication technology by different sections of the society to provide and improve government services, transactions and interactions with citizens, businesses, and other sectors of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information,

or more efficient government management. It consists of the digital interactions between a citizen and their government (C2G), between government and government agencies (G2G), between government and citizens (G2C), between government and employees (G2E), and between government and businesses/commerce (G2B)<sup>1</sup> which make government more accountable, transparent and cost-effective. The resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions. The Govt. of

India has launched the National e-Governance Plan (NeGP) to transform governance into e-Governance. The NeGP comprises three core components:

- State Data Centre (SDC)
- State Wide Area Networks (SWAN)
- Common Service Centre (CSC)

In Madhya Pradesh, NICT is setting up 2158 common service centers (CSC). They have also established separate CSC project teams in Indore and Ujjain division at district and block level for better and smooth implementation of policies of project.

## 2. ACTIVITIES OF E-GOVERNMENT

Within C2G, G2G, G2C, G2E, and G2B, four kinds of activities take place<sup>2,3</sup>.

1. Pushing information over the internet, e.g.: regulatory services, general holidays, public hearing schedules, issue briefs, notifications, etc.
2. Two-way communication between the agency and stakeholders. In this model, users can engage in dialogue with agencies and post problems, comments, or requests to the agency.
3. Conducting transactions, e.g.: lodging tax returns, applying for services and grants etc.
4. Governance, e.g.: to enable citizen transition from passive information access to active citizen participation by: informing the citizen, representing the citizen, encouraging the citizen to vote, consulting the citizen, and involving the citizen.

## 3. DISADVANTAGES OF E GOVERNMENT

The main disadvantages concerning e-Government is the lack of equality in public access to the internet, illiteracy, electricity problem, reliability of information on the web, False sense of transparency and accountability, Hyper-surveillance, cost (computer and internet connections) and hidden agendas of government groups that could influence and biased public opinions. There are many considerations and potential implications of implementing and designing e-government, including disintermediation of the government and its citizens, impacts on economic, social, and political factors, vulnerability to cyber attacks, and disturbances to the status quo in these areas<sup>4</sup>.

## 4. ADVANTAGES OF E-GOVERNMENT

The ultimate goal of the e-Government is to be

- Provide information of public services to citizens in an efficient and cost-effective manner.
- To maintain transparency in government policies.
- To reduce the cost and time.
- To implement these tasks efficiently with more convenience to individuals.

- To increase the involvement of citizens in government policies.
- To increase the involvement of citizens in general elections.
- To reduce corruption.

## 5. MADHYA PRADESH E-GOVERNMENT

The Madhya Pradesh government is shifting the government working culture to paper less by adopting e-government. Department of Information and Technology government of Madhya Pradesh has started “MP Email policy 2014”<sup>5</sup>. The objective this policy is to provide information access to all citizens at an affordable cost. The MP government is started MP online portal to carry out various processes related to MP citizens. MP Online has presence in all 51 districts, over 350 tehsils of the state delivering its services through more than 10000 KIOSK. MP Online provides a number of services for various government departments related to admission into various educational boards, online assessment for recruitment, counseling for admission into various colleges, bill payments, reservation for forest excursion booking, donation for religious services and admission process into various universities<sup>6</sup>. Similarly MP government, through its official website government started online service of various departments to provide the information to citizens. These include<sup>7</sup>.

- Transport department- Online permit system- stage carriage temporary permit (inter state), online permit system - stage carriage permanent permit (inter state), Online permit system- stage carriage temporary permit( regional), online permit system - stage carriage permanent (regional), objection on permit application, check permit application status, learner driving license (new), permanent driving license (new), permanent driving license duplicate /lost, permanent driving license conversion, permanent driving license renewal, dealer point enrollment system, e – Sewa, sample test (learner license).
- Commercial tax department - VAT Registration, CST Registration, PT Employer Registration, PTPerson Registration, Hotel Tax Registration, BT Registration, Returns, and Declaration Form.
- School education - Free bicycle distribution scheme (year 2011-12), inclusive education for children with disabilities [secondary Stage (IEDSS)], Sudama Pre-Matric Scholarship Scheme, Swami Vivekanand Post-Matric Merit Scholarship Scheme, Sudama Scholarship Scheme, Dr A P J Abdul Kalam Encouragement Scheme for brilliant student, Other Scholarships for Military School - Rewa, Sanskrit Scholarships Scheme, Incentive scheme for talented children, and Free Text-book Scheme.
- Higher education- Distribution of free text books

and stationery to students (who belong to Scheduled Caste and Scheduled Tribe), Integrated Scholarship, Scheme of scholarship for the children of landless agricultural workers to gain professional education, Ph.D. Research Scholarship for SC and ST students, *Gaon ki Beti Yojana*, *Pratibha Kiran*, *Vikramaditya Free Education Scheme* for talented poor students of general category.

- Technical education - Computer Training Scheme to increase employability among young men and women (for SC and ST categories), Rural Engineer Scheme, Scholarship Scheme for students, who belong to general poor family.
- Women and child development - *Ladli Lakshmi Yojana*, Mangal Diwas Yojana, Prenatal assistance scheme for very poor women (*God Bharai*). MP government website [ladlilakshmi.com](http://ladlilakshmi.com) has received scoch order of merit award on 19 September 2014.
- Public relations- Journalist Welfare Fund
- Culture - Financial assistance to necessitous authors, artists and their dependents, assistance from Madhya Pradesh Artists and Welfare Fund.
- Medical education - Scholarship Scheme for the students, who belong to general poor family.

## 6. CONCLUSION

A clear road map with a set of milestones is outlined by the Government of India with the ultimate objective of transforming the citizen-government interaction at all levels to the e-Governance mode by 2020. Services produced at a reduced cost, or made more widely available are becoming a feature of these e-Governance experiments. Madhya Pradesh government is adopting the paper less culture by using e-Governance. The MP government has started MP online portal to provide information at district and tehsil level through kiosks.

## निष्कर्ष

भारत सरकार द्वारा नागरिक-सरकार की अन्योन्य क्रियाओं को सभी स्तरों पर वर्ष 2020 तक ई-गवर्नेन्स मोड में बदल देने के अंतिम उद्देश्य के साथ एक स्पष्ट कार्य-योजना की रूपरेखा तैयार की गई है जिसमें कई मील के पत्थर हैं। घटी हुई लागत पर सेवा को प्रदान किया जाना, या उन्हें अधिक व्यापक तौर पर उपलब्ध कराया जाना इन ई-गवर्नेन्स प्रयोगों की विशेषता बन रहे हैं। मध्य प्रदेश सरकार ई-गवर्नेन्स का उपयोग करके कागज विहीन संस्कृति अपना रही है। मध्यप्रदेश सरकार ने छोटे केन्द्रों (कियोस्क) के माध्यम से जिला और तहसील स्तर पर सूचनाएं प्रदान करने के लिए एमपी ऑनलाइन पोर्टल शुरू किया है।

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# सूचना प्रौद्योगिकी का अनुप्रयोग – हथकरघा बुनाई में बुने डिजाइन का उत्पादन Application of Information Technology in Woven Design Generation in Handloom Weaving

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## सारांश

हथकरघा बुनाई में बुनी हुई डिजाइन का उत्पादन बाहरी डिजाइन स्रोत से करघा (लूम) शेटिंग प्रक्रिया में एक प्रकार का जानकारी हस्तांतरण है। अलग-अलग समय अवधि के दौरान इसे विभिन्न तरीकों से किया जाता रहा है। प्राचीन काल में, जानकारी हस्तांतरण दस्ती तौर पर किया जाता था। (धागा समूह द्वारा) इसके बाद हथकरघा बुनाई में जानकारी हस्तांतरण के लिए अदाइ/जंगू और छिद्रित कार्डों की विधि को अपनाया गया। ये वे तरीके हैं जिन्हें शेटिंग प्रभाव उत्पन्न करने के लिए बुनाई डिजाइन डेटा स्थानांतरित करने के लिए प्रयोग की जाने वाली आज की सूचना प्रौद्योगिकी की श्रेणी का माना जाता है। इस आलेख का मुख्य उद्देश्य यह बताना है कि आरएस 485 सीरियल बस इंटरफेस सहित मल्टीमीडिया मेमोरी कार्ड के साथ इलेक्ट्रॉनिक कार्ड लेस जैकार्ड के स्वदेशी विकास का उपयोग कर सूचना प्रौद्योगिकी को भविष्य के परिदृश्य में हथकरघा बुनाई डिजाइन उत्पादन के लिए प्रभावी ढंग से कैसे अपनाया जा सकता है।

## Abstract

The woven design generation in handloom weaving is a kind of information transfer from external design source to loom shedding process. It has been carried out by various methods during different time periods. During ancient period, the information transfer occurred manually by hand work. Next Adai/Jungu (by thread group) and punched cards have been adapted for information transfer on handloom weaving. These are the methodologies which are considered as today category of information technology in order to transfer woven design data to make shedding effect. The main objective of this article is how effectively information technology would be adapted for handloom woven design generation in tomorrow scenario by using indigenous development of Electronic Card less Jacquard with Multimedia Memory card with RS485 Serial Bus interface

**Keywords:** Information technology, woven design, shedding, Jacquard, RS485

## 1. INTRODUCTION

An electronic jacquard mechanism uses electro-mechanical system to lift the warp threads found on the loom. Developed system has no perforated cards for generating woven designs; instead raw binary information is read from the multimedia memory card. The developed device reads the multimedia memory card and does the appropriate warp lifting and the design is generated in the Handloom Weaving. The weft thread insertion is done manually.

Hence, this system would involve very low recurring cost for new designs of large size which often changeable. Now, the technology supports for larger size in a compact form. Hence there is no limitation on variety of designs.

The developed system supports the maximum hooks capacity up to 16384 (means 16384 pixels in width of designs). The client-server architecture is formed with a single server (Master controller) and maximum of 256 nos. of RS485 clients. Every RS485 client is capable of controlling 64 hooks. Based on this architecture the system could support up to 16384 hooks.

## 2. EMBEDDED SYSTEM IMPLEMENTATION 2.1 Background

The main purpose of the Electronic Card less Jacquard is to reduce the time consumption in preparing the woven designs and transfer it into a handloom. Also to make the handloom weaver's into comfortable weaving mode.

In the conventional weaving practice, punched cards are being used to generate the design on the woven fabric. Due to this, frequent design changing is quite impossible and it involves more recurring cost to prepare the punched cards.

By frequent design changing, it would create a way for competent marketing. Hence, the handloom weaving community people livelihood gets improvement.

Figure 1 shows the general architecture of an electronic card less Jacquard for tomorrow technology.

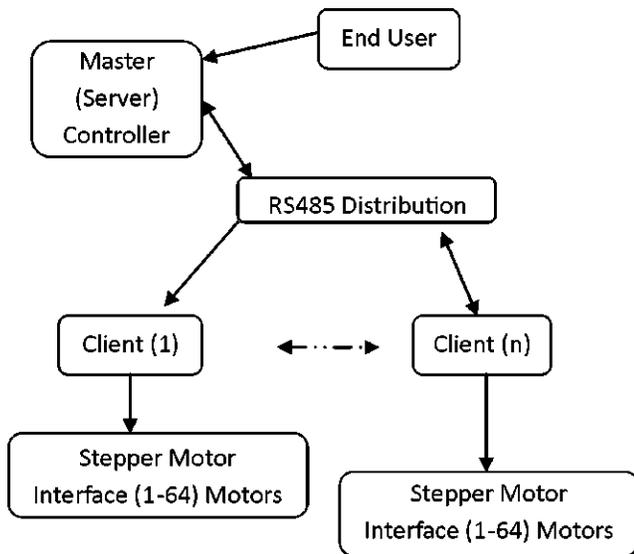


Figure 1. System Architecture of Electronic Card less Jacquard (Tomorrow).

### 2.2 Master (Server) Controller Features

The master controller has been developed using LPC2148 Microcontroller. The master controller has been organized to facilitate several functions like initialize, forward, reverse, play, pending movement, flag resetting, navigation step value adjustment, and pending movement step value adjustment to control the shedding device.

The master controller has a display to show the size of the design information (width and height) along with current row number, mode of operation such as discrete and continuous and working status.

The master controller has a multimedia memory card interface to access the design source upon the user play request or foot pedal operation. Once the woven design information is retrieved from the input source it is segmented into several parts which are equal to the number of client modules cascaded and broadcasted with client identification over RS485 bus interface.

The master controller embedded firmware incorporates the file allocation table – file system for accessing the woven design information. The secured digital/multi media memory card is playing a vital role in keeping

and performing file operations. The block level file accessing method is implemented using fseek, fread file system functions.

The master controller has been designed with real time clock interface using DS1307 chip using I2C interface, UART1 is assigned for RS485 Serial Bus interface in Half-Duplex mode, SSP1 (Synchronized Serial Port) is used for SD/MMC card interface, liquid crystal display interface uses 4-Bit data mode for 4x20 text display and switches for input interface.

```
for (Pos=0;Pos<24;Pos++)
Data [0][Pos]= bdata [DCnt++] } Data parsing for 64
Data [0][24]='\0';           } Motors and 8
                               } Stepper Motors I/O
                               } interface board is
                               } needed. For every I/O
                               } interface board 3 byte
                               } data is required.

for (Pos=0;Pos<24;Pos++)
Data [1][Pos]= bdata [DCnt++].
Data [1][24]='\0';
```

from the above code segment shows the woven design data parsing in embedded “C” language is illustrated.

### 2.3 RS485 Distribution

The Control Panel performing its functions as a Server in order to control the RS485 Clients. Every RS485 Client is configured with its ID. While controlling the RS485 Clients by the control panel (Server), it uses ID of the respective RS485 Clients to transfer data and command. Once the RS485 client completes its operation, the acknowledgement is sent by the RS485 client to server. After receiving the acknowledgement by the server (control panel), it is ready for next operation. The woven design data transmission over RS485 takes place in the following format to buffer the design pattern before execution.

CID (1 to 256)	Rotation (F / R)	D1	D2	D3	D4	D5	D6	D7	D8	PC
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Figure 2 . Woven design data transmission format for buffering using RS485 Serial Bus.

### 2.4 Client Features

The client controller also developed using LPC2148 Microcontroller. The client controller main purpose is to receive the woven design information from master controller through RS485 half duplex interface.

After receiving the woven design information, it performs parsing and delivers it to the Stepper motor interface in TTL logic mode. Every client controller has 8-Pin DIP Switch and it is configurable.

As and when the data comes, the client controller locates the client ID from parsed data and it is compared with client ID found in the hardware. When there is a match then using the received woven design, data it is transferred to Stepper motor interface.

The client controller features are controlled through master controller by the RS485 data communication.

**Table 1. Woven Design data transmission detail**

CID (1 to 256)	Maximum 256 Nos. of Clients could participate
Rotation (F / R)	F denotes Forward Rotation R denotes Reverse Rotation
D1	First LSB
D2	Second LSB
D3	Third LSB
D4	Fourth LSB
D5	Fifth LSB
D6	Sixth LSB
D7	Seventh LSB
D8	Most Significant Byte
PC	Pulse Count for the direction (Forward or Reverse)

The status of the data reception, acknowledgement transmission and stepper motor operation is display on the LCD module.

**2.5 Stepper Motor Synchronization**

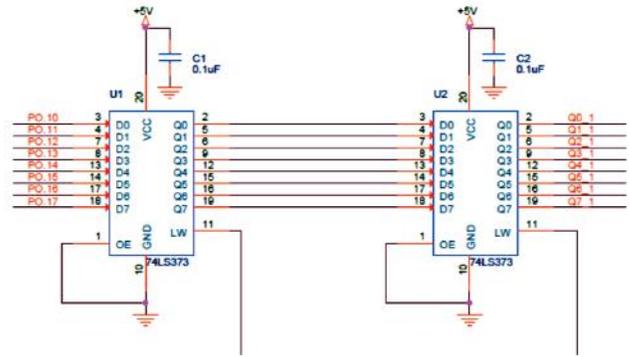
A Stepper motor converts electronic pulses into proportionate mechanical movement. Each revolution of the stepper motor’s shaft is made up of a series of discrete individual steps. A step’s defined as the angular rotation produced by the output shaft each time the motor receives a step pulse.

The step angle represents the rotation of the output shaft caused by each step, measured in degrees. The direction of rotation is determined by applying the pulses to either the clockwise or counterclockwise drive circuits. Rotor displacement can be very accurately repeated with each succeeding pulse.

In this development every Stepper motor I/O interface board is capable of controlling 8 numbers of stepper motors. In the formation of shedding, irrespective of the number of stepper motors all are happen to execute simultaneously. To achieve this effect double level layer digital logic system has been implemented.

Based on the number of pulses configured as per the user requirement in the formation of shedding, every pulse is sent to the I/O interface by the microcontroller to the first layer of the latch system and subsequently a common enable signal is sent to the second layer of the latch systems. This process is repeated for configured number of pulses.

The Fig. 3 shows that U1 is layer 0 and U2 is layer 1 to send the data to the stepper motor driver logic. The layer 0 is selected by Decoder Logic (74LS138) and layer 1 is selected by the common signal.



**Figure 3. Stepper motor synchronization logic.**

**2.6 TTL Logic Data Transfer (Client controller Side)**

Transistor-transistor logic (TTL) is a digital logic design in which bipolar transistor is act on direct-current pulses. Many TTL logic gates are typically fabricated onto a single integrated circuit (IC). A TTL device employs transistors with multiple emitters in gates having more than one input.

TTL is characterized by high switching speed (in some cases upwards of 125 MHz), and relative immunity to noise. Its principle drawback is the fact that circuits using TTL draw more current than equivalent circuits using metal oxide semiconductor (MOS) logic. Low-current TTL devices are available, but the reduced current demand comes at the expense of some operating speed.

Every client architecture is capable of controlling 8 stepper motor I/O interfaces and every stepper motor I/O interface is capable of controlling 8 nos. of unipolar stepper motors (every individual stepper motor is given a 12V DC power supply).

This electronic card less Jacquard uses positive logic for selection.

After latching the 8-bit data to the first level latch one after another, at last using the P0.20 pin of the client architecture the second level latch is enabled for the stepper motors simultaneous movement effect. This data latch and P0.20 pin enabling will be repeated for the number of steps as per the requirement. Figure 4 shows the decoder logic to select the latch.

**Table 2. Decoder logic pin input for stepper motor interface**

Port Pin Number	Purpose
P0.28, P0.29, P0.30	Decoder input for selecting the stepper motor I/O interface for data transfer

**3. REAL WORLD IMPLEMENTATION**

This electronic card less Jacquard system would help the handloom owners/entrepreneurs/potential investors and they would get a fair idea of various benefits, viability and profitability while implementing

**Table 3. Data latching**

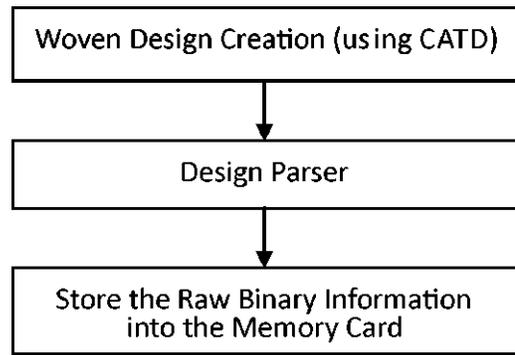
Port Pin Number	Purpose
P0.18	Data latching – Decoder logic - pin input for Stepper motor I/O interface
P0.19	
P0.21	
P0.10	Input data lines for two stepper motors. (Every stepper motor requires 4 lines for its movement)
P0.11	
P0.12	
P0.13	
P0.14	
P0.15	
P0.16	
P0.17	

this. The developed system design transformation mechanism is shown in Fig. 5.

The embedded technology based electronic card less Jacquard for handloom weaving controls the warp threads by Bottom-Closed shed mechanism, which in turn generates woven designs. The total capacity of the developed Electronic card less Jacquard shall be configure up to 16384 hooks by cascading 128 hooks module. This information technology tomorrow uses a modular construction. Every Jacquard module consists of 64 hooks.

**4. RESULTS AND DISCUSSIONS**

Electronic card less Jacquard loom leads to new business venture by manufacturing ornamental fabric. This model enables the student community from



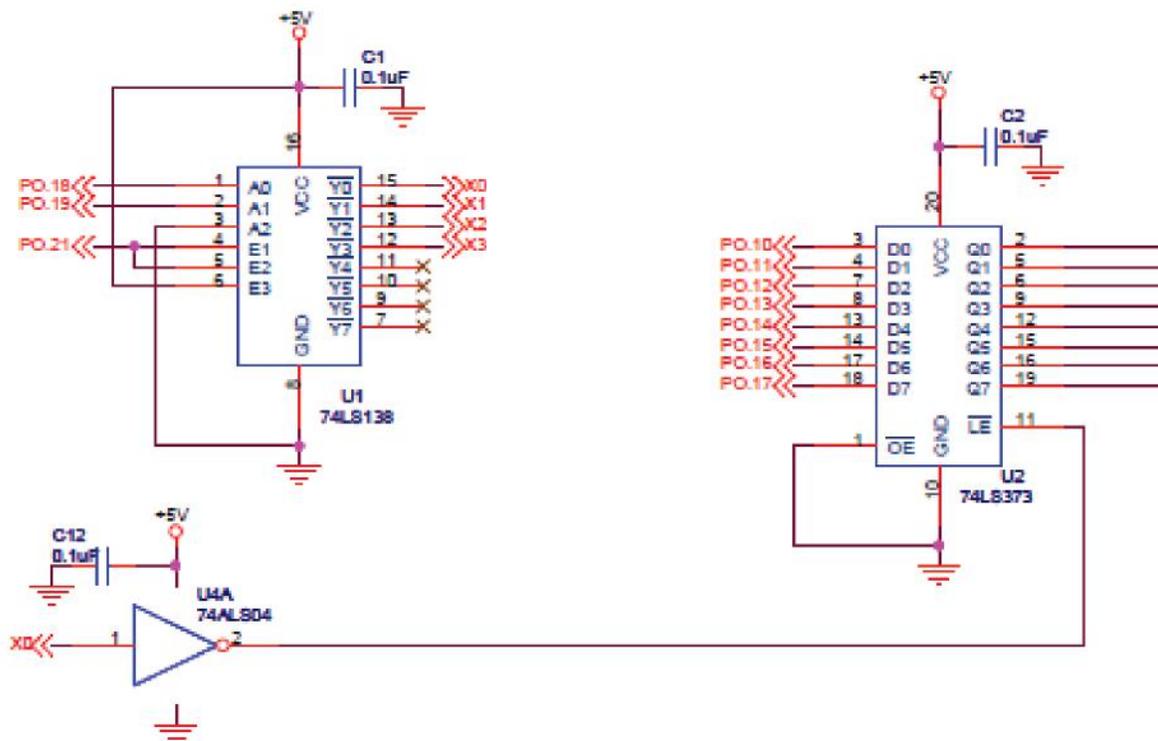
**Figure 5. Design conversion process.**

Textile faculties by the dynamic design adaptation in weaving principles.

Electronic card less Jacquard has been developed with feather touch enabled switch/pedal switch. By this way the weaver would feel very comfort (without physical strains) while weaving and also there is an improvement in their productivity. This implementation causes the weavers to work without health hazard problem.

Electronic card less Jacquard enables the weaver to generate shedding movement according to the woven design information without using heald frames.

By the conventional method of punched cards system, it is quite impossible to keep the punched cards for the larger designs due to its more occupation and weight. Also during the rainy season the perforated cards will not roll in smooth manner, since the punched cards are made up of paper particle.



**Figure 4. Decoder model data latching for stepper motor.**

In the conventional method, when a new design is introduced the total set of cards of the Jacquard has to be replaced and this involves a lot of money. Due to the above practical intricacies the weavers are less likely to introduce new designs with their increasing recurring cost. As a result, they will not be able to compete in the market without frequent new designs.

Due to this product development process no punched cards are required, since the SD/MMC storage module is used to keep large woven designs. Hence for every production (fabric) a new design is introduced. Hence, this mode of weaving leads them to have business competency.

The information technology, would bring our Indian handloom industry to the modernized development in terms of comfortable weaving with livelihood improvement. Figure 6 shows the sample woven design used by the information transfer on the Electronic Card less jacquard.

Figure 7 shows the typical construction of a 128 hooks electronic Jacquard for handloom weaving using embedded technology.

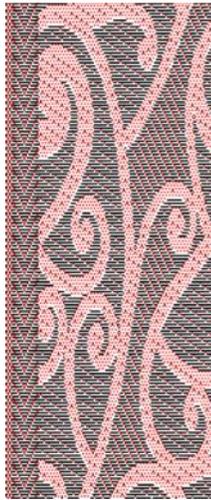


Figure 6. Sample Woven Design.

## 5. FUTURE SCOPE

The information technology, in handloom weaving, based on the woven design size the jacquard size in terms of hooks gets varied. In future this development shall be adapted for rich woven designs. Hence, this working model can be enhanced to support 512/1024/2048/4096 hooks etc,



Figure 7. Complete view of 128 hooks electronic cardless Jacquard.

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## डेयरी उद्योग में स्वचालन Automation in Dairy Industry

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### सारांश

सूचना प्रौद्योगिकी किसी भी विषय में जटिल समस्याओं के समाधान प्रस्तुत करने में सक्षम है। इसने खाद्य प्रसंस्करण एवं डेयरी के क्षेत्रों जैसे इंटरनेट द्वारा ऑनलाइन उत्पादन की निगरानी, संवेदी मूल्यांकन, गुणवत्ता एवं प्रक्रिया नियंत्रण आदि में भी महत्वपूर्ण योगदान दिया है। गत दशकों में डेयरी क्रय, प्रक्रिया तथा वितरण संबंधी कार्यों का यंत्रीकरण एवं स्वचालन होने से कार्य तीव्रता से होने लगा है। यद्यपि यंत्रीकरण का प्रमुख उद्देश्य मजदूरी के अत्याधिक खर्चों में कमी लाना ही था तथापि धीरे-धीरे विधेयकों द्वारा लागू किए गए सुरक्षा मानकों पर भी ध्यान आकर्षित होने लगा। आजकल खाद्य उत्पादन से जुड़े सुरक्षा प्रावधान डेयरी उत्पादन के यंत्रीकरण एवं स्वचालन में मुख्य भूमिका निभा रहे हैं।

### ABSTRACT

Information technology has emerged as a frontier know how for addressing complex problems related to any subject. IT has played a significant role in food and dairy processing as well, particularly online production monitoring, image processing, sensory evaluation, quality control, process control, etc., in addition to routine applications such as word processing and graphics. Over the last few decades, unit operations pertaining to procurement, processing and distribution in the dairy and food sector is inclining towards mechanization and automation very rapidly. The main driving force at the beginning for mechanization was economic reasons, such as labour costs. Gradually, safety considerations, mandated by legislatures, entered the scene. Nowadays food safety policies became the major factor for the mechanization and automation of the process of food production.

**Keywords:** Automation, dairy industry

### 1. AUTOMATION MEANING AND DEFINITION

The word 'Automation' is derived from Greek words Auto (self) and Matos (moving). The process of performing an activity by a mechanical device may be referred to as automation. In general, automation could be considered as a process that started with machines doing the heavy work, while humans maintained the function of telling the machines what to do. However, automated systems achieve significantly superior performance than what is possible with manual systems, in terms of power, precision and speed of operation.

Automation may be defined as a set of technologies that results in operation of machines and systems without significant human intervention and achieves performance superior to manual operation.

### 2. TYPES OF AUTOMATION SYSTEMS

Based on the flexibility and level of integration in manufacturing process automation systems can be categorized as follows

#### 2.1 Fixed Automation

Fixed automation system is commonly used in case of high volume production with dedicated equipment, which has a fixed set of operation and designed to be efficient for this set. Continuous flow and discrete mass production systems use this automation. e.g. distillation process, conveyors, paint shops, transfer lines, etc. A process using mechanized machinery to perform fixed and repetitive operations in order to produce a high volume of similar parts.

#### 2.2 Programmable Automation

It is used for a changeable sequence of operation and configuration of the machines using electronic controls. However, non-trivial programming effort may be needed to reprogram the machine or sequence of operations. Investment on programmable equipment is less, as production process is not changed frequently. It is typically used in Batch process where job variety is low and product volume is medium to high, and sometimes in mass production also. e.g. in steel rolling mills, paper mills, etc.

### 2.3 Flexible Automation

It is used in flexible manufacturing systems (FMS) which is invariably computer controlled. Human operators give high-level commands in the form of codes entered into computer identifying product and its location in the sequence and the lower level changes are done automatically. Each production machine receives settings/instructions from computer. These automatically loads/unloads required tools and carries out their processing instructions. After processing, products are automatically transferred to next machine. It is typically used in job shops and batch processes where product varieties are high and job volumes are medium to low.

### 3. INTEGRATED AUTOMATION

Integrated automation system is a complete automation of the manufacturing plant. The process functioning is controlled through computer system and under coordination through digital information processing. It includes technologies such as computer-aided design and manufacturing, computer-aided process planning, computer numerical control machine tools, flexible machining systems, automated storage and retrieval systems, automated material handling systems such as robots and automated cranes and conveyors, computerized scheduling and production control. It may also integrate a business system through a common database. In other words, it symbolizes full integration of process and management operations using information and communication technologies. Typical examples of such technologies are seen in advanced process automation systems and computer integrated manufacturing (CIM).

### 4. NECESSITY OF AUTOMATION

Eventhough food safety and security concerns are the major driving force for the implementation of automated system in the food processing plants; the industry faces other additional emerging drivers that further accentuate the importance of implementing automation as soon as possible. Integrated automation can help food and beverage manufacturers address these below emerging trends while providing important safety benefits.

- Customer or consumer demands
- Labour availability and reliability issues
- Labour laws
- Regulatory requirements
- Supply-chain management

### 5. ADVANTAGES OF AUTOMATED SYSTEMS

Automated systems have got the following advantages over the manual controlling systems

- Production of consistent quality goods
- Reduction in production costs
- Flexibility to meet market demands
- Adoption to constantly changing legal demands
- Ensures high and consistent product quality
- Increases production
- Reduces losses
- Guarantees a safe operation
- Ensures manpower savings
- Allows for efficient production planning, execution and reporting

Overall, the aim of automation in a dairy or food processing plant or any production unit is to meet the company need to produce goods safely, in a cost-effective manner, with high and consistent quality and in the appropriate quantities to meet market demand.

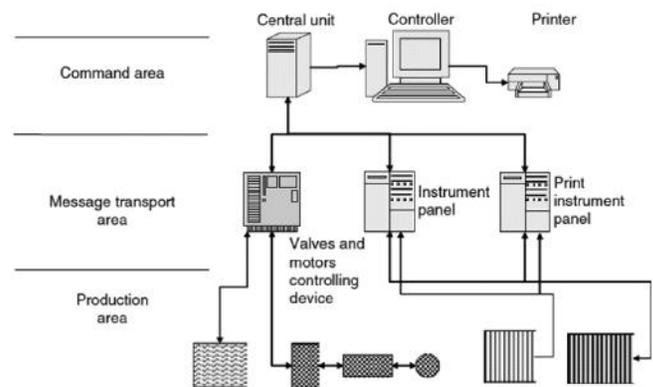


Figure 1. Typical automated system in the dairy plant

### 6. ARCHITECTURE OF AUTOMATION SYSTEM

ERP – Enterprise resource planning

MES – Manufacturing execution system

PC – Production control

Various components in an industrial automation system can be explained using the automation pyramid as shown above. Here, various layers represent the wideness (in the sense of no. of devices), and fastness of components on the time-scale.

**Sensors and Actuators Layer:** This layer is closest to the processes and machines, used to translate signals so that signals can be derived from processes for analysis and decisions and hence control signals can be applied to the processes. This forms the base layer of the pyramid also called ‘level 0’ layer.

**Automatic Control Layer:** This layer consists of automatic control and monitoring systems, which drive the actuators using the process information given by sensors. This is called as ‘level 1’ layer.

**Supervisory Control Layer:** This layer drives the automatic control system by setting target/goal to the controller. Supervisory Control looks after the equipment, which may consist of several control loops. This is called as ‘level 2’ layer.

**Production Control Layer:** This solves the decision problems like production targets, resource allocation, task allocation to machines, maintenance management etc. This is called 'level 3' layer.

**Enterprise control layer:** This deals less technical and more commercial activities like supply, demand, cash flow, product marketing etc. This is called as the 'level 4' layer.

## 7. CONCLUSION

Automation can address the critical issues of product safety and security both proactively and reactively with its integrated logistics, material handling and warehousing systems. Proactively, automated systems reduce the number of people with direct access to products. This alone can improve product reliability significantly while reducing the risk of catastrophe. Reactively, automated systems include up-to-the minute track-and-trace functionality. This key feature of automation can easily facilitate any recalls that may be required. But beyond enhancing food safety and security, a fully integrated automation system can provide many compelling business benefits. Advanced automation systems increase visibility into food-manufacturing operations by improving the transparency and traceability of vital business information. The result is lower labour costs, increased productivity, reduced scrap and waste, and meeting, and even anticipating, the continually increasing societal and legal demands.

## निष्कर्ष

स्वचालन द्वारा डेयरी उद्योग के हर एक क्षेत्र में सुरक्षित उत्पादन एवं समेकित संचालन सम्भव हो सकता है। इसके लिए न्यूनतम कार्मिकों की आवश्यकता होती है। यह जोखिम को कम करते हुए उत्पादन की विश्वसनीयता को बढ़ाता है। स्वचालन द्वारा प्रतिक्रिया होने वाली घटनाओं का पता चलता है जिससे प्रक्रिया संबंधी विभिन्न सुधार सम्भव हो सकते हैं। आधुनिक स्वचालन तंत्र सुरक्षित उत्पादन एवं समेकित संचालन के साथ-साथ खाद्य उत्पादन से जुड़ी सभी प्रक्रियाओं में पारदर्शिता भी लाता है जिससे बेहतर व्यापार हेतु महत्वपूर्ण जानकारीयों उपलब्ध होती है। इसकी सहायता से सामाजिक माँग की आपूर्ति हेतु लागत में कमी एवं न्यूनतम छीजत द्वारा अधिक उत्पादन सुनिश्चित किया जा सकता है।

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## भारत में विविध कुक्कुट उत्पादन के लिए प्रबंधन परम्पराएँ Management Practices for Diversified Poultry Production in India

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### सारांश

भारत जैसे विकासशील देश में, कृषि उत्पादन में उद्यमिता विकास आर्थिक वृद्धि, सामाजिक स्थिरता और समानता में महत्वपूर्ण योगदान कर सकते हैं। कर्मशक्ति मांग के पशु-उद्यमों वाली मिश्रित खेती को ग्रामीण लोगों में कृषि आय और घर के पोषण की निश्चितता बढ़ाने के लिए प्रोत्साहित करना चाहिए। ग्रामीण आबादी की सामाजिक आर्थिक स्थिति में सुधार करने के लिए कुक्कुट क्षेत्र में बहुत संभावनाएँ हैं। भारत में कुक्कुट (पोल्ट्री) विविधीकरण के लिए बहुत गुंजाइश है, चूँकि यहाँ पर तुर्की, बटेर, गिनी मुर्गी और बत्तख आदि जैसे पक्षियों की कई प्रजातियाँ पायी जाती हैं जिनसे विशेष रूप में ग्रामीण क्षेत्रों में निशुल्क क्रम में अर्ध वृद्धिकर प्रणालियों में लाभ प्राप्त किया जा सकता है। निशुल्क क्रम मुर्गी पालन प्रणाली में सुविधाओं और उपकरणों के लिए कम निवेश की आवश्यकता होती है और घर के पीछे वाले आंगन (पिछवाड़ा) और व्यवसायिक उद्यम दोनों के लिए आर्थिक रूप से भी ये एक व्यवहार्य और लम्बे समय तक रहने वाले पक्षी हैं। प्रस्तुत लेख में एक संक्षिप्त तरीके से इस तरह की विविध प्रजातियों के लिए प्रबंधन प्रथाओं का वर्णन किया गया है।

### ABSTRACT

In developing country like India, entrepreneurship development in agricultural production can contribute significantly to economic growth, social stability and equity. Mixed farming involving demand driven animal's enterprises should be promoted to increase farm income and household nutritional security in rural peoples. Poultry sector has an enormous potential to improve the socio-economic status of rural population. There is considerable scope for poultry diversification in India, as there are several species of birds like turkey, quail, guinea fowl, duck etc. that can be reared profitably in free range or semi intensive systems especially in rural areas. Free-range poultry rearing method requires low investment in facilities and equipment's and it is a viable and sustainable bird both for backyard and commercial venture in economic point of view. This article is describing the mangemental practices for such diversified species in a concise manner.

**Keyword:** Poultry production, animal enterprise, poultry management

### 1. INTRODUCTION

In developing countries like India where the majority of population belongs to rural and agricultural background, mono-species farming cannot meet the requirement of these farmers. For sustainability mixed farming model is economically viable. Mixed farming involving demand driven animal's enterprises should be promoted to increase farm income and household nutritional security. Traditionally poultry production mainly involves rearing of chicken. But looking at the present scenario, diversification or alternate poultry production in India is gaining momentum and attention from the farmers, entrepreneurs, professionals and researchers. It is used for food, game, fancy, pet, and also for research purposes. Diversification of poultry such as Turkey, Quail, Guinea Fowl, Emu, Duck and Pigeon are the precious genetic resources

for diversified poultry production system in India. Poultry farming is labor intensive, requires minimum capital and ensures quick returns. Present article covers the various managemental practices of these alternate poultry species available in the country.

### 2. TURKEY PRODUCTION

Turkey is mainly reared for meat and is quite popular in many western countries. In recent Turkey birds in India have also gained some popularity as an alternative to broiler chicken. Still it is at the stage of infancy and need to be popularized among farmers to provide diversified food and employment to rural youth.

#### 2.1 Varieties of Turkeys in India

Turkeys are not classified into breeds, However,

there are seven standard varieties of turkeys viz. Large White (Broad Breasted White), Bronze (Broad Breasted Bronze), Beltsville Small White, Bourbon Red, Black, Slate and Narrgansett.

## 2.2 Rearing and Management

The management of turkey poults (young chicks) is almost similar to that of chicken. Turkey poults grow very rapidly and for the best performance they should never be over crowded. One sq. foot of floor space per poult is recommended during the first 3-4 weeks and thereafter up to 8th week; the floor space is to be increased to 1.5 sq. ft per poult. Thus, a compartment of 10x10 ft will be suitable for housing 100 poults up to 4 weeks of age and thereafter, they may be transferred to a compartment of 10x15 ft for further floor brooding until 8th week. From 8th to 12th weeks of age, the floor space should be increased to 2 sq. ft. per growing poult and thereafter until 16th weeks of age, the minimum floor space allowance is 2.5 sq.ft per poult. After 16th week onward they require 3-5 sq. ft. per turkey. For small type turkeys, the floor space requirements may be reduced slightly. The building should have good floor that can be easily cleaned and disinfected. Cement floors are preferred for the purpose. Turkeys are generally reared on range or in deep litter system, as cage system is not much popular except for small flocks or for research. The advantages of deep litter system compared with range system include excellent protection against predators and adverse weather, lower land cost, low labour cost, disease prevention and convenience of management.

## 2.3 Nutrition and Feeding

The turkey is a very rapidly growing bird. Achieving such rapid growth rates requires high nutrient intake. The turkey has very low fat content compared to other commercial avian species. For this, turkey diets have a narrower energy to protein ratio than those of other species do. Most of the nutritionist, because of lack of information, uses the same ME value and available amino acid values of ingredients for turkey as are used for chicken. This is not correct as the turkey obtained relatively more energy from ingredients high in fiber than that of the chicken. Nation Research Council (1994) recommended 28% protein and 2800

Table 1. Feeding programme for growing poults

Age of poult (weeks)	Type of feed	Protein (%)	Energy (Kcal/kg)
0-6	Starter diet	28	2800
6-8	Grower-First diet	26	2800
8-20	Grower-Second diet	22	3000
20- Market	Finisher diet	14	3300

kcal/kg energy during starter period (0-6wks) which changes gradually to 14% protein, and 3300 kcal/kg energy at finisher stage (20-24 wks). The feed can be presented either as mash, pellets or as combination of protein supplement plus grain. Turkeys require more protein, minerals and vitamins than chicken to support the fast growth and therefore, turkey rations are costlier than chicken rations. Since energy and protein requirement of the two sexes vary, they must be separated at the time of hatch and reared separately for obtaining better results.

Turkeys are good foragers. If good green fodder is available on the range, there will be less consumption of expensive food there by reducing the cost of feeding programme. Generally a tender alfa alfa, white dutch clover, young tender grass, green grain sprouts chopped into short lengths and fed once or twice daily are good for poults. Even if the fresh lawn clippings, garden vegetables and outer leaves of cabbage can be fed to poults. When roughage materials are fed the insoluble grits should be provided to the birds. Research conducted at Central Avian Research Institute, Izatnagar revealed that green berseem can be fed to the growing poults and laying birds by replacing 30-35% of conventional feed without affecting the production levels.



Figure 1. Turkey rearing on different types of floor

## 2.4 Health Cover

Normally, losses from diseases are not much of a problem with small turkey flocks, however, losses occur occasionally. Commercial flock owners should expect a mortality of somewhere between 3 and 5 %. Turkey are relatively more resistant to some of the diseases compared to chicken. Infection from Marek's disease and infectious bronchitis are extremely rare. Ranikhet disease, fowl pox and coccidiosis occur only in mild form. The most common diseases are fowl cholera, fowl typhoid, blackhead, and infectious sinovitis and round worm infestation. Vaccination in turkeys is mostly carried out to prevent important viral diseases.

## 3. QUAIL PRODUCTION

In the chicken dominated poultry industry, Japanese quail provides better means of diversification and will be proving to be complimentary. Japanese quail has some distinct characteristics like fast growth, early sexual maturity, short generation interval, high

adaptability, high rate of lay and requires very less feed and space. It is resistant to common poultry diseases like Ranikhet disease. Further, quail is a better converter of feed into eggs that producing twice as much egg mass per kilogram body weight. Several attributes of this species making it ideal for rural poultry production for creation of rural employment and protein source to rural farmers.

### 3.1 Breeds/Varieties

The yellowish speckled quails introduced originally from USA. CARI Izatnagar have developed six varieties viz; CARI Uttam, CARI Pearl, CARI Ujjawal, CARI Sweta, CARI Brown and CARI Sunheri with different plumage pattern that have more body weight, complete white feathers and bigger egg yield than the traditional varieties.

**Table 2. Different quail varieties developed at CARI**

Varieties	Type	Body weight (5th week) g	Hatchability (on total egg set)
CARI Uttam	Meat type	240	70-75%
CARI Pearl	White egger	140	70-80%
CARI Ujjawal	White breasted	175	65%
CARI Sweta	White feathered	155-165	50-60%
CARI Brown	Brown feathered	180-185	60-65%
CARI Sunheri	Brown feather white breasted	182	68%

### 3.2 Rearing and Management

The quail farm should be located at a distance not less than 2.5-3.0 km. away from wildlife and forest area where there is human habitation between the farm and wildlife/forest notified area. Quail can be reared successfully both in battery and on floor pens. However, battery system of rearing appeared to have an edge over the floor system since it reduced mortality and improved body weight and egg production etc. Quail can be housed in multideck colony or battery cages (5-7 tiers). Hence, large number of birds can be accommodated in a small place. Rearing space required in floor type is 0.2 sq.ft /adult quail and in cage (battery) system is 0.16 sq.ft /adult quail. A floor area of 200-250 cm<sup>2</sup> should be offered. 2-3 cm and 1.5-2.0 cm linear feeding and watering space respectively are recommended for each bird. In litter system 3-5 cm thick layer of suitable litter material is spread on the floor of houses. Twenty-four hours of light was found to be essential brooding up to 2nd week of age, which can be reduced to 12 hours. The room temperature should be a minimum at 21°C (70°F) and 40-70 percent relative humidity is also desired. 14 to 16 hrs of photoperiod appeared to be adequate

**Table 3. Various housing requirement of quail**

Item	Chicks (0-3 week)	Grower (4-5 week)	Adult (> 6 week)
Temperature (O C)	37-38	21-22	21-22
R.H %	60-65	55-60	55-60
Floor space (sq. cm)	100-140	140-160	180-200
Feeder space (linear cm)	2	2.5	3
Water space (linear cm)	1	1.5	2

to optimize production and reproduction.

### 3.3 Brooding

In quails 0-3 weeks period is called brooding period; however in winter brooding period extended up to 4th weeks. Quail is not the best starter in their life and will really need some tender loving care to go them safely through the first week of life. A 75 cm<sup>2</sup> floor area per quail under the hover with similar floor space per bird is recommended for 3-6 weeks old chicks under cage system, whereas, it should be 200-250 cm<sup>2</sup> when grown under litter system of housing. The brooding of day old quails can be done using infra red bulbs or gas brooders and traditional brooding system. Starting temperature is 100°F followed by reduction of 50°F in every 4 days up to 3 weeks of age till it reaches the room temperature. A 2 cm and 1cm linear space per chick at the feeder and waterer respectively is recommended during brooding period.



**Figure 2. Types of housing system for quails**

### 3.4 Nutrition and feeding

Proper nutrition is one of the most important factor in quail production. Feed ingredients used in chicken ration may also be used for quails. However, the demands for some of the nutrients particularly proteins, minerals like manganese, zinc, copper, iron etc., and vitamin requirement is higher in quails because of its fast growth. Among the essential aminoacids, lysine, methionine and cysteine in starter/grower diet and methionine and cysteine in layer diets are usually limiting. A diet of 25 - 27 per cent protein and 2800 Kcal ME/kg energy is recommended for optimal growth up to 3 weeks of age. For growing period of 4-5 weeks, 24 percent protein with the same energy level is recommended. Layer quail should be fed a diet with 22 percent protein and have 2700 Kcal ME/kg.

### 3.5 Health cover

In quails the disease pattern remains the same as that of chicken. Our experiences suggested that they are more resistant than chicken. Quails do not require any vaccination and deworming in their life. Because, quails are reported to be resistant to Ranikhet disease and ascariasis (round worm). The commonly encountered diseases are coccidiosis, necrotic enteritis and aspergillosis.

## 4. GUINEA FOWL PRODUCTION

Guinea fowl is much popular among marginal farmers, tribes and pastoralists due to its inherent hardiness, low input requirements and excellent forage-utilization capacity. Since one of the main sources of food for wild guineas is insects, they have gained popularity for use in reducing insect populations in gardens and around the home, especially because, unlike chickens, they do not scratch the dirt much and do very little damage to the garden. Other people raise them for their unique ornamental value. Guinea fowl is considered to possess relatively higher level of tolerance for rigorous tropical climatic conditions.

### 4.1 Breeds/varieties

The descriptions of guinea fowl breeds/ varieties are essentially based on the plumage colour variations. Pearl, Lavender and White are the three main varieties recognized world over. Akin to those similar feather colour Kadambari, Chitambari and Swetambari have been developed at the Central Avian Research Institute, Izatnagar through selective breeding from a wide base stock of indigenous Guinea fowl.

### 4.2 Rearing and Management

Guinea fowls can be reared either in free range, semi-free range or intensive system. When kept intensively, low light intensity should be used to reduce possible flightiness. Traditionally, Extensive system of rearing method is more common in India and most popular in rural areas. Free range guinea fowl constitutes an important resource for resource-poor farmers, especially in developing countries. Average flock size varies widely (15-200) in guinea fowl producing pockets. While in semi-free range system birds were enclosed by a wire fence 1.5 to 2 m height to evade the predator attack. Management is entirely through incorporation of family labour; two persons can easily manage even a large flock. The birds usually rely on the fallen grains, leaves, weeds, root-bulbs, fruits and various insects. Supplementary feeding, if any, usually consists of waste grains, household waste and crop residues. These birds can also be raised in the modern intensive system characterized by high input, good husbandry, hygiene and supply of balanced feed,

however this system is confined largely to Government/public sector farms. In this type of rearing birds do not have access to an outdoor enclosure and 3 to 5 birds can be kept in one square meter area but the houses must be equipped with perches.

### 4.3 Breeding Management

Guinea fowls are mostly seasonal birds and lay eggs during summer months. The laying season also vary from latitude and local weather patterns. The Pearl and Purple usually have the longest laying season and the lighter colors have the shortest. The number of eggs a guinea hen will lay depends on her breeding and management. A hen that is of a good stock and is carefully managed may lay 100 or more eggs a year.

### 4.4 Nutrition

In the wild, guinea fowl eat a variety of foods but most important are weed seeds, and waste grain which fall to the ground after harvesting of crops. Some common guinea fowl diet includes: fruits, berries, seeds, grass, spiders, insects, worms, molluscs and frogs. Since one of the main sources of wild guineas is insects, guineas have gained popularity for use in reducing insect populations in gardens and around the home, especially because unlike chickens, they do not scratch the dirt much and do very little damage to the garden. Suitably formulated diets (starter, grower and finisher) for guinea fowl are available from commercial feed mills. It is recommended that they should be given only mash or crumbles instead of pelleted feed. They will not eat much supplemental feed if they are finding plenty to eat on their own. However, only give whole or cracked grains as a treat or supplement, but not too much. The starter diet should be fed to 4 weeks of age, followed by grower diet 1 to 10 weeks of age, then the second grower diet up to the time that the birds are marketed or until they are selected for breeding. The starter diet should contain 24% protein and should be fed for the first 4 weeks. Grower ration of 20% protein should then be fed until 8 weeks of age and a finisher diet containing 16% protein fed until market age (14-16 weeks). At this age they should have reached average live weight of 2 kg. Breeding birds are switched to the breeding diet approximately 2 weeks before eggs are expected. These diets will be supplemented by range feed. A good commercial breeder mash, which contain 22 or 24% protein, should be fed to laying guinea hens.

### 4.5 Health cover

Domestic guinea fowl do not suffer from many pests and diseases as compared to chickens and other

poultry. Guinea fowls, though hardy and resistant, are susceptible to viral diseases such as ranikhet; bacterial infections (*E.coli*); protozoan diseases (coccidiosis) and verminous infestations (round worms).

## 5. EMU PRODUCTION

Emu is native to Australia, but spread all over world and mostly concentrated in USA, China and Australia. Emu population in India has touched to almost above 50,000. Emu belongs to a group of wingless bird called Ratite and has ability to withstand wide climatic conditions. Emus are less susceptible to most of the poultry diseases. They can be productive for more than 30 years. Emu meat is an excellent alternative for health conscious consumers. Emu oil has anti-inflammatory property and helpful in alleviating arthritis. Emu farming can be recognized as profitable venture for rural youths to generate income and to provide nutritional security to rural mass. There is no organized market for Emu meat or its products which may be due to lack of awareness and non-availability of sufficient emu population.

### 5.1 Housing and feeding and management of adult Emus

Emus are reared in open paddocks which will have chain link fencing of 2x2 or 3x3 enclosure with 2 ft. concrete wall construction on this chain link mesh of 6 ft. ht. is erected. Night shelter is optional with usual asbestos sheet roofing of 6 to 8 ft. Feeding is given in feed troughs which are usually hung on the fence and water is given in specially designed water tank or troughs with good drainage. Feeding is done twice daily and water to be provided adlib.

### 5.2 Breeding Management

Emus attain sexual maturity by 18 to 24 months. Breeding occurs during winter season of the geographical areas (October to February in India). They are monogamous indicating one male for one female. In natural habitat, the female mates with the male during breeding season and gives a clutch of eggs. Later, male sits for brooding on these eggs for a period of 52 days without food and water. However, the female continues to breed with new partners during the whole breeding season. The chicks hatched out follow the male emu rather than the female.

In commercial farming emus are paired in separate enclosures after maturity depending on the compatibility of the pair. Emu generally gives eggs during evening between 5.30 to 7.00 p.m. Each adult emu after three years can give an average egg production of 30 eggs during breeding season between Octobers to February. At Central Avian Research Institute, Izatnagar, recently Emu has been introduced with an aim to carry out

research on nutrition, management and development of artificial insemination technique in emu.

### 5.3 Hatching of Emu eggs and chick management

Emu eggs are emerald green in colour weighing about 600 to 800 grams. The incubation period in emu is about 52 days. The incubational requirement of Emu eggs is different from that of chickens. The dry bulb temperature inside the incubator should be 96 to 97oF and while wet bulb temperature is maintained at 78 to 80oF (about 43% relative humidity) up to 48th day with regular turning mechanism at every one hour. Emu chicks hatch out on 52nd day naturally; sometimes assisted hatch is also carried out manually by helping the chick to come out by opening the shell at the head and toe positions. The normal hatchability is about 80%.

Emu chicks weigh about 370 to 450 grams (about 67% of the egg weight). For the first 48 to 72 hours, emu chicks are restricted to Hatcher itself for absorption of egg yolk and proper drying. The brooding shed would be prepared well in advance with thorough cleaning and disinfection and flooring should be covered with gunny bags to prevent slipping of legs of young chicks. Emu chicks have long legs and are very active, slippery flooring will make emu chicks to have hip dislocation resulting in irreparable damage. Arrange a set of brooder for about 25 to 40 chicks giving four sq.ft. per chick for first three weeks. Provide brooding temperature of 90o F for the first ten days and 85oF till three to four weeks. Provide feed and water with a brooder guard of 2.5ft height. Feed starter mash for first 8 weeks. Provide sufficient run space for the chicks to have healthy life.

Hence, floor space of 40ft x 30 ft is required for about 40 chicks with outdoor space. As emu chicks grow they require bigger size of waterers and feeders and increased floor space for run. Feed the bird's grower mash till 42 weeks of age. 10% Greens (carrot, papaya, cucumber) can be offered, deworm the birds



Figure 3

once with broad spectrum anthelmintic /ivermectin and vaccinate with R2b at 8th week and repeat at 40th week against Ranikhet disease. Provide 40ft x100 ft space for 40 birds.

## 6. DUCK PRODUCTION

Ducks occupy an important position next to chicken farming in India. They form about 10% of the total poultry population and contribute about 6-7% of total eggs produced in the country. Ducks are mostly concentrated in the Eastern and Southern States of the country mainly coastal region with non-descriptive indigenous stocks, which however are poor layers. Ducks have several advantages over other poultry species, in particular their disease tolerance. They are hardy, excellent foragers and easy to herd, particularly in wetlands where they tend to flock together.

### 6.1 Breeds

Different breeds of ducks are usually grouped into three classes: meat or general purpose; egg production; and ornamental. Meat breeds include the Pekin, Muscovy, Rouen and Aylesbury. Egg breeds include the Khaki Campbell, Indian Runner and the brown Tsaiya, . Four breeds of duck viz, Moti, Desi (native), Khaki Campbell and White Pekin are maintained, multiplied and propagated in coastal areas by the Regional Centre Bhubaneswar of Central Avian Research Institute, Izatnagar.

### 6.2 Housing and management

Ducks do not require elaborate houses. The house should be well ventilated, dry and rat proof. The roof may be of shed type, gable or half round. It may have solid or wire floors. The wire floors are not popular with breeders. Under semi-intensive system the house should have easy access to outside run as the ducks prefer to be outdoors during the day time and even during winter or rains. Generally the proportion of night shelter to outside run is 1/4:3/4. The run should gently slope away from the houses to provide drainage. Normally a continuous water channel of size 50 cm wide and 15-20 cm. deep is constructed at the far end, on both sides, parallel to the night shelter, in the rearing or layer house. Though duck is a water fowl and very fond of water, water for swimming is not essential at any stage of



Figure 4. Rearing system of ducks

duck farming. However, water in drinkers should be sufficiently deep to allow the immersion of their heads and not themselves. If they cannot do this, their eyes seem to get scaly and crusty and in extreme cases, blindness may follow. In addition, they also like to clean their bills periodically and wash them to clear off the feed. While in meat strains a slight increase in body weight of ducks at seven weeks of age has been noticed (weight advantage of swimming ducks to non-swimming ducks is 0.3%), but for egg laying strains, swimming is a disadvantage.

Ducklings may be reared in intensive, semi-intensive or range system. Under intensive system, allow a floor space of 91.5 feet in deep litter and 29.5 feet in cages, up to 16 weeks of age. Under semi-intensive system, a floor space 45.7 feet per bird is allowed in night shelter and 30 to 45.7 feet as outside run area per bird up to the age of 16 weeks. The temperature under the hover should be 30oC for the first few days. The temperature can be reduced by about 3oC for every 2-3 days. During summer, provision of heat for brooding can be stopped when the ducklings are 8-10 days of age whereas during rainy and cold season it may have to be continued for a longer period (2-3 weeks). Ducklings can be brooded using battery brooders as well. Though multi-tier battery brooders can be used single tier battery brooders are easier to manage. Ducks lay their eggs in the early morning. An average duck egg weighs about 65-70 g. Ducks normally lay when they are about 5-6 months of age. Peak production is obtained 5-6 weeks after commencement of lay. A photoperiod of 14 hours is considered optimum for inducing high egg production. Layer ducks must be provided with nest boxes. A nest box measuring 30 cm wide, 45 cm deep and 30 cm high would be sufficient. One nest box for every three layers has to be provided.

### 6.3 Feeding

Ducklings can be fed with a mash containing 20% protein and 2750 kcal/kg ME up to 3 weeks of age and a mash containing 18% protein and 2750 kcal/kg of ME from 4 th to 8 th week of age. The feed or feed ingredients should be free of mould/fungal growth and aflatoxin. Ducks may be grown on dry mash, a combination of dry and wet mash or pellets. Ducks prefer wet mash due to difficulties in swallowing dry mash. The pellet feeding, though slightly costly, has distinct advantages such as saving in amount of feed, minimum wastages, saving in labour, convenience and improvement in sanitary conditions. Ducks are good foragers. The use of range, pond or supplementary green feed, reduces the feed cost. Ducks should never have access to feed without water. During the first eight weeks, birds should always have access to feed,

but later on they may be fed twice a day i.e. first in the morning and then late afternoon. Khaki Campbell duck consumes about 12.5 Kg. of feed upto 20 weeks of age. Afterwards the consumption varies from 120 gm and above per bird per day and depending upon the rate of production and availability of greens. The feed should have 18% protein and 2650 K cal/kg of ME. The feeder space suggested is 10 cm/duck. Under intensive system a floor space of 3710 to 4650 cm<sup>2</sup> per duck is essential, but in cages it can be reduced to 1350 cm<sup>2</sup>. In semi-intensive system, a floor space of 2790 cm<sup>2</sup> in the night shelter and 929 to 1395 cm<sup>2</sup> as outside run per bird would be adequate.

#### **6.4 Breeding management**

The most important points in selecting breeders viz: large body size for the breed, vigour, egg production. Breeders can be selected on body weight at six to seven weeks of age. It is wise to select about 20% more ducks and drakes than required. Unhealthy-looking birds can then be culled as they mature. Other factors to consider when selecting breeders are conformation, feed conversion, and rate of feathering. It is preferable to have drakes one month older than ducks, although

birds of similar age perform satisfactorily. One drake to five or six ducks is usually sufficient. Excessive treading may injure ducks and this can be prevented by removing one or more males. Injured ducks, if penned apart, normally recover and return to full lay. Breeders are best brought into production between seven and eight months of age. Stock should be mated at six to seven months of age or one month before hatching eggs are required. Drakes will usually mate with any duck.

#### **6.5 Health Cover**

Ducks are generally resistant to many diseases than other poultry. In practical duck rearing the diseases of importance are duck plague, pasteurellosis and aflatoxicosis. Ducks are highly susceptible to aflatoxicosis and can lead to 100% mortality. The only method of prevention of aflatoxicosis is to eliminate the use of feed or feed ingredient having fungal or mould growth. Effective vaccine against duck plague is now available. Duck virus hepatitis is another disease and that could cause heavy mortality of ducklings, when they occur.

## सूचना प्रौद्योगिकी से कृषि में क्रांति Information Technology in Revolutionizing Agriculture

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### सारांश

सूचना प्रौद्योगिकी किसान के निषेचन कार्य को स्वचालित करने में एक महत्वपूर्ण भूमिका निभा सकती है। इससे एक मानव श्रम की क्षमता और उत्पादन में वृद्धि को बढ़ावा मिलेगा। इस दिशा में, ग्रीनहाउस छोटे से सीमित स्थान में वर्षदौर सब्जियां उगाने के लिये एक महत्वपूर्ण साधन साबित होंगे। इस उद्देश्य के साथ, इस पत्र में, एक स्वायत्त रोबोट बनाया गया है। एक ग्रीनहाउस में, विभिन्न पोषक तत्वों की जरूरत के साथ पौधों को फर्टीलाइज किया जाता है। इसको आई आई टी बॉम्बे के प्रोफेसरों के मार्गदर्शन में विकसित किया गया है। यह रोबोट अपने आप में एक कम निवेश लागत में अत्यधिक सघन ग्रीनहाउस के सभी पौधों की खाद की संभावनाओं को आवश्यकतानुसार पूरा कर सकता है। ग्रीनहाउस में निषेचन स्वचालन प्रदर्शित करने के लिए एक फाईबर्ड वी रोबोट मंच मॉडल को प्रोटोटाइप निर्माण करने के लिये इस्तेमाल किया गया है।

### ABSTRACT

Information technology can play a vital role by automating the fertilizing task of a farmer. This will lead to increase in the efficiency and output of a single human labor. In this direction, Greenhouses prove a means to grow vegetables all round the year in a small confined space. With this motive, in this paper, an autonomous robot has been discussed which has been developed under the guidance of professors of IIT Bombay, capable of fertilizing plants with different nutrient needs, in a greenhouse. This robot can in itself cater to the needs of all opening up possibilities of highly dense greenhouses with varying plant varieties at a low investment cost. A FIREBIRD V<sup>1</sup> robotic platform has been used to build prototype to demonstrate the fertilizing automation in a model greenhouse.

**Keywords:** Greenhouse, robot, FIREBIRD V, fertilizer

### 1. INTRODUCTION

Information technology can play a vital role by automating the fertilizing task of a farmer. This will lead to increase in the efficiency and output of a single human labor. In this direction, to increase its agricultural productivity in order to become a self-sustained nation, Greenhouses prove a means to grow vegetables all round the year in a small confined space such as even rooftops of buildings in cities, in a controlled environment. Moreover this helps in reducing the distribution costs. As of now instead of transporting them from far away farms or warehouses, they can be made more easily and abundantly accessible.

Automated robots can monitor the health of plants growing in the greenhouse, and then decide the amount of fertilizers needed by each plant. By indigenously developing such autonomous systems, India can reduce its dependence on imported systems,

moreover providing cognitive development opportunities to college students.

With this motive, in this paper, an autonomous robot has been developed under the guidance of professors of IIT Bombay, capable of fertilizing plants with different nutrient needs, in a greenhouse. Thus the earlier limitation wherein plants with similar nutrient requirements were needed to be grown in a greenhouse, is no longer an obstacle as now the intensive human labor is not required to monitor the varying requirements of the plants in a dense greenhouse. This robot can in itself cater to the needs of all opening up possibilities of highly dense greenhouses with varying plant varieties at a low investment cost. This robot can be mass produced to cut down on its production costs, thus bringing the advantages of economies of scales to the farmers in form of a low price device capable of maintaining a greenhouse. A FIREBIRD V robotic platform has been

used to build prototype to demonstrate the fertilizing automation in a model greenhouse.

### 1.1 Building Modules

The major building blocks in the robotic system that needs to be designed have been identified as follows:

- Analog IR proximity sensors, position encoders (velocity & position), battery voltage & current monitor (smart battery charging)
- SENSORS: White line sensors, Sharp IR range sensor(distance sensing up to 80 cm), analog IR proximity sensors, position encoders (velocity & position), battery voltage & current monitor (smart battery charging)
- Actuators: DC motors, servo motors (mechanical arm)
- Indicators: Status display LCD, buzzer, indicator LEDs
- Power Supply: Battery power, adapter for auxiliary power
- Communication: RS-232 serial communication port, USB communication for in-system programming, wireless ZigBee Module
- AVR-based Processing Unit: Atmega 2560<sup>[2]</sup>(master

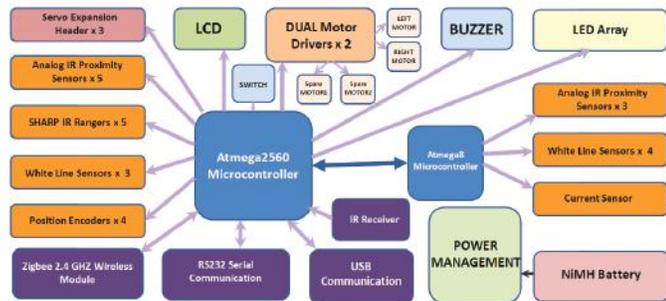


Figure 1. FIREBIRD V robot.

microcontroller), Atmega 8<sup>[3]</sup> (slave uC) to make control decisions like shortest path, fertilizer dispensing control, etc.

- Interfacing Unit: USB drivers, motor driver (IC-L293D), Servo pad connected to ADC lines of uC.

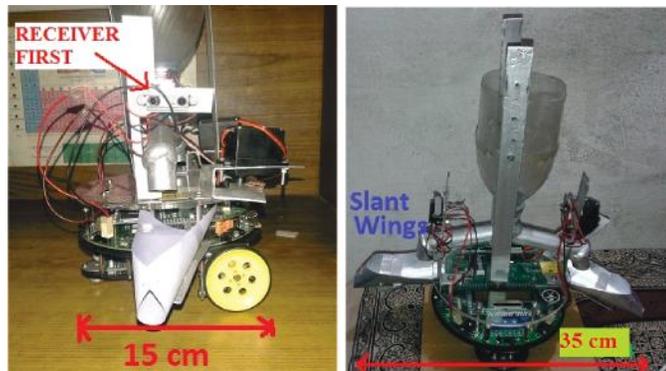


Figure 2. Receiver and slant wings.

### 2. HARDWARE REQUIREMENTS

Figure 2 represent the receiver and slant wings respectively. To create this mechanical arrangement a standard Atmega 2560 AVR based FIREBIRD V<sup>[4]</sup> robot with LCD, etc., and properly calibrated White Line sensor’s LED brightness have been used. Besides a fertilizer container, a Y-shaped hollow pipe mechanism

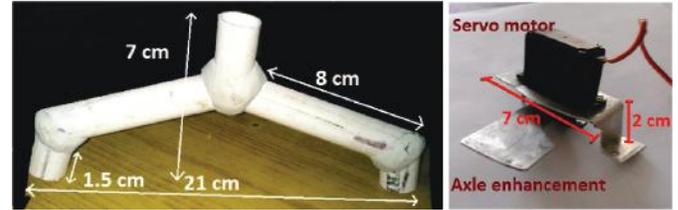


Figure 3. Material used.

to carry the fertilizer, 2 SHARP sensors (GP2D12), 2 mini servo motors (fig. 3), metals strips to hold the bottle (container), cylindrical mouth opening (outlet) are required.

For the prototype, materials required are 0.75 inch electrical conduit pipes to create the Y-outlet, 24 cm vertical metal strips with one side (L-ended) to hold the bottle in the vertical position by means of screws, Z-shaped rectangular slotted metal sheet holder to hold the servo firmly in its place, sharp’s holding metal strips to create a trapezium opening in order to enable the Y-shaped outlet to come out without obstruction, nut & bolts, etc.

### 3. SOFTWARE REQUIREMENTS

- Atmel Studio 6 used to write the program and generate the .hex file.
- NEX Robotics’s AVR Bootloader software for PC which is used to write the .hex file to the robot by means of USB serial communication via serial communication<sup>[5]</sup>.
- NEX Robotics “Bootloader” code programmed into the AVR microcontroller previously.

### 4. DESIGN ANALYSIS

A common bottle holding containment unit, which feeds both the outlet sides slants has been chosen. It contains one common storing unit, in case if all the plants occur on one side of the robot only. In case of two separate holders, one might get depleted entirely as the pellets are given in limited amount. There is a small CD sector cut out mounted on the axle of servo under the final opening of the inverted Y-shaped tube, which blocks the outlet when it is under the mouth of the opening. When servo is rotated by a specific amount, then the opening is without bounds, and pellets drop into the slant and thus into the plant.

- (a) To design the dispenser mechanism, servo motors have been preferred because of the following

advantages:

- (b) Need of the rotation by an angle between  $90^{\circ}$  and  $180^{\circ}$ , which can be easily controlled using the servo motors.
- (c) It requires only one control pin as compared to the five pins needed for the stepper motors. It has a very low power requirement.
- (d) The FIREBIRD V <sup>[6]</sup> kit has 3 easy-to-use servo connectors onboard.

The stepper motor was not chosen because:

- It is required to rotate the robot by a fixed constant angle. Hence, the ability of a stepper motor, to control the angle of rotation of axle dynamically in small step values, is not needed.
- A servo requires only 3 pins- Vcc, Gnd and a control pin, as compared to a total of 5 pins required by the stepper motors.

Similarly the DC motors were not chosen because:

- (a). Using a DC motor, the angle of rotation of axle cannot be controlled.
- (b). It has a higher power requirement.
- (c). It will have to clear out C1&C2 external motor interfacing ports, which requires the sacrifice of other functions performed by Firebird kit, like interrupt switch used for loading hex codes through bootloader.

## 5. ALGORITHMIC ANALYSIS

In this algorithm a logic has been devised such that the bot is completely autonomous <sup>[7]</sup> in its tasks. The bot is only fed with the sequence in which the plant varieties (tuples) are to be fertilized, and then the bot autonomously derives the shortest path acquirable to fertilize all the plants of the same category by manipulating the order in which plants are fertilized, thus consuming minimum time. For this the greenhouse is transposed to a hypothetical 2D axis plane assigning coordinates to all plants.

The plant numbers are in a 2D “Plant [ ][ ]” array, where columns represent tuples, and rows represent the plants in a tuple. A lookup table concept is used to access the coordinates assigned to each plant. Then the distance of all the plants in a tuple from current position is calculated. The least distance plant is chosen. In case of a tie when equi-distant the plant farthest from next tuple is chosen first. So that the shortest path between 2 tuple is achieved.

After selecting the nearest plant, its targets (the possible positions on the path of the bot, standing where the bot can fertilize the plant) are found. These targets are then processed and the one at least distance from the current position is chosen. In case of equi-distant targets, the distance of these targets is seen from the next nearest plant, and so on and so forth

for all plants in the tuple. If the tie still exists, the target which has least cumulative distance from all the plants of the next tuple is chosen.

Once the final target is chosen then the bot plots a way autonomously to reach the target from its current position. This is done by first matching the current y-axis position with that of target. In case they are not the same, the bot travels to the nearest node (intersection of two paths), which is also nearer to the selected target. The bot traverses to the final selected node. For this, the current y-coordinate is matched with that of the target. After ordinate matching, the current position abscissa is matched with the target’s x-position.

After reaching the desired target near the selected plant, the bot fertilizes the plant by initially deciding as to on which side of the bot the plant lies. Then the respective servo is switched on for a specific fixed amount of time (maintained by timer 3-overflow interrupt) to drop desired quantity of fertilizer. Then this entire process is repeated to serve all the plants in the greenhouse.

The bot acts as a pseudo multi tasking processor even though it can process only one task at a time, because of the “FLAG” variable implemented in the logic. The FLAG is assigned 0 value at the commencement of each physical task (motion to next immediate destination, fertilizing the plant, etc) and the bot is then assigned a state such that it recommences it’s processing for the next task to be performed after completion of this task. Thus the THINKING state of the robot coincides with the actual physical tasks, whose end is denoted by the updation of FLAG variable to value-1. Thus the precious processing time during the motion to the next target is utilized to calculate its entire path, which servo is to be switched on, and which plant/target is to be selected next.

The SHARP sensors used to detect the plant are switched on only just 5cm before reaching the plant, thus extending battery life and reducing power consumption, and switched off after plant is fertilized. The sharp sensors have a capability to stop the bot as soon as the plant is detected, even though the desired distance was not covered by the position encoders. Also they have the capability to move the bot another further 5 cm beyond the position encoder’s value, to find the plant in case of any manual mis-positioning of the plant. If still the plant is not detected, then the plant is skipped off, to avoid any time loss and loss of fertilizer pellets.

Thus the system developed is efficient in every sphere, may it be swiftness, or power consumption or efficient use of resources.

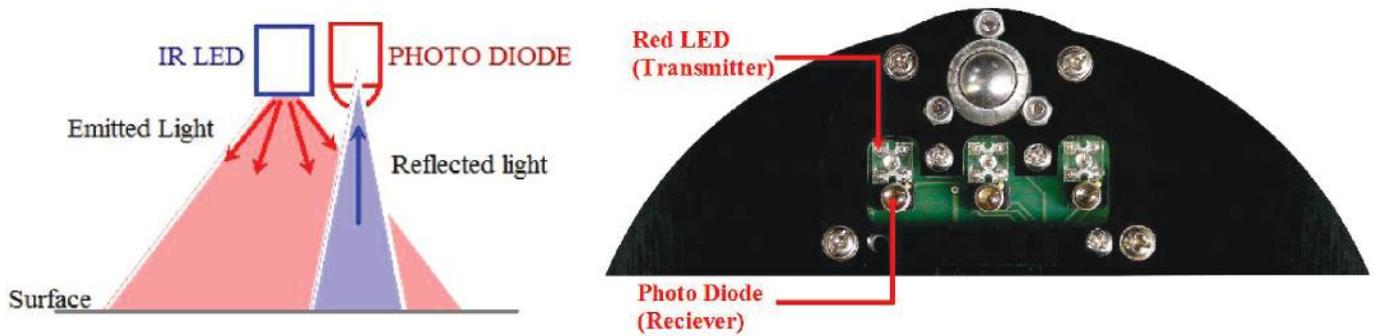


Figure 4. White line sensor.

**5.1 Environment Sensing**

The functioning of environment sensing technique used by FIREBIRD V robot is as follows:

- (a) White Line Sensor: used to detect the white line on the floor. It consists of highly directional photo transistor for line sensing and bright light led for illumination. When the robot is not on the white line, the amount of light reflected is less, hence less leakage current flows to the photo transistor and output voltage will be 2 to 3.3 volt. When the sensor is on the white line more light gets reflected, resulting in the fall of output voltage (2 to 0.1 volt) (Fig. 4)
- (b) Sharp IR Range Sensor: Used for accurate distance

measurement up to 80 cm. It consists of IR LED and linear CCD array. When light hits the obstacle and reflects back to the linear CCD array, the angle of the reflected light varies depending on the distance from the obstacle. This angle is measured by using CCD array to estimate the distance from the obstacles. (Fig.5)

- (c) IR Proximity Sensor: Used to detect proximity of an obstacle in the short range (about 10 cm). These sensors sense the presence of the obstacles in the blind spot region of sharp IR range sensor. In the absence of obstacle, there is no reflected light hence no leakage current will flow through the photodiode and output voltage will be approx. 3.3 volt. As the obstacle comes closer more light get reflected, resulting in the increase of leakage current hence output voltage will fall.
- (d) Position Encoder: They provide position & velocity feedback to the robot. It consists of slotted disc which rotates between optical transmitter and receiver. When the slotted disc moves in between the optical encoders, we get square wave signals whose pulse count indicates the position, and frequency indicates the velocity.

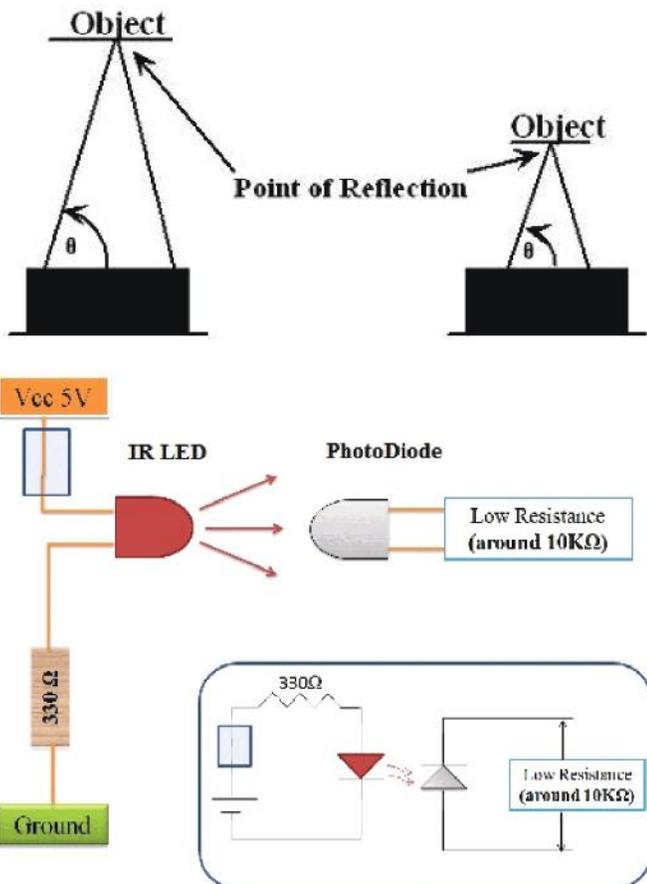


Figure 5. Sharp IR range sensors.

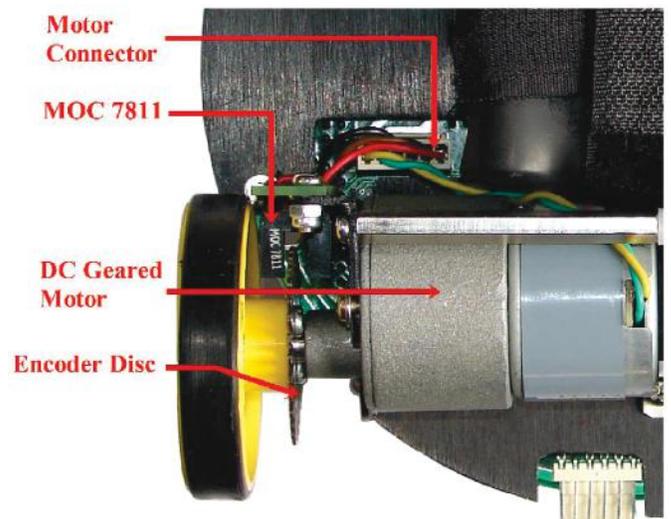


Figure 6. Position encoder.

## 5.2 Navigation Scheme

To demonstrate the prototype an arena has been developed wherein different plants are emulated and the path for movement of the bot is marked by black lines. So the robot initially works on “Black Line follower” technique to reach a particular segment (out of the 6 grids). A broad rectangular black node (3cm\*3cm), signals the bot to plan for a possible course change. By measuring the distance traversed by the robot (feed from position encoder), the bot determines its location autonomously, on basis of which it determines the next nearest target plant. The robot later, uses ‘White Line follower’ technique to reach the target plant from the black grid line, following the White stripe.

- White Line Sensor: Feed from this sensor, maintains the bot on the white strip.
- Sharp IR Range Sensor & IR Proximity Sensor: Halts the robot near the plant so that the pellet dispensing mechanism lies exactly overhead the plant.
- Position Encoder: To enable the robot to determine its location dynamically.

## 5.3 Challenges

- The amount of fertilizer (pellet units) dropped in the plant was controlled by placing a counter mechanism below the final dropping pipe that closed the dispenser outlet. The mechanism was designed using an IR sensor and a receiver counting the no of pellets by use of pulses generated at the receiver end
- Proper calibration of the White Line Sensors posed a serious challenge which was overcome by changing the RED led potentiometer’s brightness levels.
- The proper height alignment of the opening/closing metal sheet lid and the vertical section of the Y-shaped pipe was necessary in order to prevent dropping of any pellets at undesired moments of time during motion even in case of a “jerk”.
- The code provides the provision through which the bot moves an extra 5cm distance in case it does not encounter the plant till the position encoder’s stipulated distance. Thus care is taken that the extra distance moved by the bot is recorded and compensated in the next movement of the robot to avoid distance mismatches.
- The parallel processing of the bot by the use of interrupts, PWM using timer, “flag” variable to plan the next move and calculations while moving on the arena posed a tough logical challenge for the algorithm.
- The selection of the shortest and minimum time consuming path for the given tuple to be fertilized

was solved by a very intricate and complex logic algorithm, but it offered a very high end advantage of shortest path traversal, increasing the efficiency of the system.

## 6. CONCLUSIONS

This paper examines the benefits of modern-day agriculture—a task made necessary by the fact that an increasing share of the population has little connection to farms or rural areas—and thus little opportunity to understand the nature of farming, especially the modern advances that are both helping to better feed the world’s people and better protect the environment. Recently, the development of robotic systems in agriculture has experienced an increased interest, which has led many experts to explore the possibilities to develop more rational and adaptable vehicles based on a behavioral approach. A combined application of new sensor systems, communication technologies, positioning systems (GPS) have enabled to develop a prototype to demonstrate the fertilizing automation in a model greenhouse successfully.

## निष्कर्ष

इस पत्र में विशेष रूप से आधुनिक खेती को लाभप्रद कैसे बनाया जाये, पर चर्चा की गयी है। बढ़ती जनसंख्या, प्रकृति, खेतों एवं ग्रामीण क्षेत्रों की हिस्सेदारी कम समय में समझने के लिये तथा अधिक संबंध कैसे बनाया जाये, पर जोर दिया गया है। आधुनिक कृषि कार्य को बढ़ावा देना है जिससे कि दुनियां के लोगों को खिलाने और पर्यावरण की रक्षा करने के लिए मदद कर सकता है। हाल ही में कृषि के क्षेत्र के लिये विकसित रोबोट प्रणालियों में लोगो कि रुचि में वृद्धि देखी गयी है। विकास के एक व्यवहार दृष्टिकोण पर आधारित अधिक तर्कसंगत और अनुकूलनीय वाहनों की संभावनाओं का पता लगाने के लिए कई विशेषज्ञों के नेतृत्व में एक संगठन बनाया गया है, जिसमें की अनुभव किया है, नया सेंसर प्रणाली, संचार प्रौद्योगिकी, पोजीशनिंग सिस्टम (जीपीएस) एक संयुक्त एक ग्रीनहाउस मॉडल में निशेचन स्वचालन प्रदर्शित करने के लिए एक प्रोटोटाइप विकसित करने के लिए सफलतापूर्वक सक्षम है।

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## विनिर्माण क्षेत्र में सूचना प्रौद्योगिकी का उपयोग Role of Information Technology in Manufacturing Sector

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### सारांश

इस पत्र का मुख्य उद्देश्य वांछित स्तर और लाभप्रदता के स्तर और उत्पादकता सुराग की श्रेष्ठता को बढ़ा सकते हैं जो विनिर्माण क्षेत्र में आईटी के महत्व को दिखाने के लिए है इसके अलावा, सूचना प्रौद्योगिकी (आईटी) और विनिर्माण क्षेत्र के संयोजन से प्राप्त वैभव सुविधाओं आज के युग का सबसे अच्छा प्रतिद्वंद्वी है। मुख्य ध्यान केंद्रित सूचना प्रौद्योगिकी के बिना विनिर्माण क्षेत्र में समस्या पर है और इसे शुरू करने के बाद, भारी बदलाव किया जाना गया है। कई बार किसी भी पड़ाव बिना असंगत जोरदार काम को करने के लिए बहुत कठिन काम हो गया है। कारण सूचना प्रौद्योगिकी के लिए वर्तमान घटना में आते परिवर्तन, नए निर्माण के लिए आकांक्षा उत्पादन क्षमता को बढ़ाने के लिए। बुद्धिमान सूचना प्रोसेसिंग विनिर्माण शासन के साथ *recombines* तो यह भारी बदलाव देता है। सूचना प्रौद्योगिकी शुरू करने के बाद विनिर्माण क्षेत्रों के वर्तमान परिदृश्य तेजी से प्रदर्शन में एक आवश्यक तंत्र के रूप में और भविष्य की बेहतरी के साथ ही विनिर्माण उद्योगों पर सामाजिक पहलुओं के लिए देखा जाता है। विनिर्माण क्षेत्रों में, कंप्यूटर एकीकृत विनिर्माण (यूके), कम्प्यूटर संख्यात्मक नियंत्रण (सीएनसी), वितरित संख्यात्मक नियंत्रण प्रणाली के नवीनतम रुझानों हैं और इसके द्वारा यह समग्र विनिर्माण वृद्धि में सुधार करने के लिए उद्योगों में लचीली विनिर्माण प्रणाली (एफएमएस) प्रदान करता है।

### ABSTRACT

The main purpose of this paper is to show the importance of IT in manufacturing sector which can increase the level and superiority of productivity leads to the desired level and profitability. Moreover, the splendor features obtained from combination of Information Technology (IT) and Manufacturing Sector is the best paragon of today's era. The main focus is on the problem in manufacturing sector without Information Technology and after introducing IT, the tremendous changes has to be done. At times become very tedious job to perform strenuous work inconsistently without any halt. The changes come into present phenomenon due to the Information Technology, aspiration for new creation to increase production efficiency. If the intelligent information processing *recombines* with manufacturing regime it gives tremendous changes. Present Scenario of manufacturing sectors after introducing Information technology is increasingly seen as an essential mechanism in performance and for the betterment of future as well as the social aspects on the manufacturing industries. In manufacturing sectors, computer integrated manufacturing, computer numerical control, distributed numerical control system are the latest trends of IT and hereby it provides flexible manufacturing system (FMS) in industries to improve the overall manufacturing growth.

**Keywords:** Computer aided design, computer integrated manufacturing, computer numerical control, direct numerical control, distributed numerical control, flexible manufacturing system

### 1. INTRODUCTION

Manufacturing sector is the huge sector in all over the world in which all Engineering field are combine, mechatronics, information technology, computer science, mechanical, electrical and automobiles engineering.

Manufacturing engineering is a particular class of engineering systems, manufacturing processes and interrelated actions within a manufacturing enterprise.

Manufacturing process is a combination of new technologies and procedure which is used to define how products are to be manufactured with high accuracy. A foundation of manufacturing process is the fundamental reservoir for the combination of all the tools and equipment and activities aids in the searching of substitute production line scenarios; improve the efficiency of assembly lines with the aspire of reduced lead time period for

manufactured goods launch, lesser the product time and reduced work in progress inventories as well as allow quick response to product or product changes. Introduction of Information technology and its system in other sector create anxiety of the business arena in the field of manufacturing. Advancements of the information and Communication technologies and increased competition resolute manufacturing enterprises to change their manner to trail that business.

As consequence, new paradigms for manufacturing engineering systems have emerged. The main aim of this article is to show the importance of IT sector in various zone of manufacturing, research work, development concepts to improve the design, remove the weaknesses and got the preliminary results of an inter-disciplinary for the development, performance modeling and execution of an intellectual self-healing, self adaptable and self-improving manufacturing engineering system. Main manufacturing paradigms are shortly presented, emphasizing their main strengths and weaknesses. The planned classification structural design towards a wise manufacturing engineering system is introduced, to solve fundamental main challenges and open issues.

The right manufacturing system can help your compact to achieve the production goals, maintain high superiority standards and keep costs low and profits high.

There are mainly four types of manufacturing systems, which differentiate according to the working importance and limitations of the manufacturing systems. Flexible manufacturing system is the most advanced description of manufacturing system in which IT is initially introduces.

- a. *Custom Manufacturing System*- Custom manufacturing systems is the one of the oldest and most commonly used forms of product manufacturing. In this system, a single worker can produce one item at a time by hand or by machine it takes time and error rate is increases but if the machines are used instead of worker, they are frequently well specialized, and capable of producing only a single line of merchandise. This system offers the lowest level of accuracy and efficiency and highest cost per unit, and only due to this reason the levels of manufacture is very low.
- b. *Intermittent Manufacturing System*- Intermittent manufacturing systems, is already shows the meaning by name which is able to producing two or more objects at the same time. These objects must be identical, or may be very similar, and cannot be customized for individual customer. This type of system is best for limited production runs, or for companies looking to manufacture a low amount of goods.

- c. *Continuous Manufacturing System*- Continuous manufacturing systems is used for mass production of products. In this system, the product moves from one station to another station along an assembly line, with different workers performing various construction tasks along the way. This type of system promotes the companies to meet high manufacture (production) goals, and results in a lower per-unit cost. To create an assembly line the large amount of equipment are required as well as high level labor to manage the system, is often associated with large capital investments.
- d. *Flexible Manufacturing System*- Flexible manufacturing systems represent one of the most extensively used modern production systems and advanced techniques. In this type of system, companies spend many variety of machinery that can be rapidly and smoothly reconfigured for large number of production. Flexible manufacturing system includes the advance features as well eliminating the need of labors, automatic vehicles, or incorporates robots to improve the accuracy and maintain the reliability and accuracy for the production process; this system requires a high degree of capital investment.

## 2 LITERATURE REVIEW

Pulkit<sup>[1]</sup> had show the importance of IT in manufacturing sector whether it concentrate on the customer goods ,machine tools, equipment, performing operation, higher accuracy and production quality rate, and increase profit margins by introduction IT, CIM is one the most common and important application of IT of the ambitious target in many such organizations. Through it all, the enterprise must fulfill the five R's- produce the right product, with the right quality, in the right quantity, at the right price, and at the right time- and it must do more than satisfy its customers.

Cheng<sup>[5]</sup>, *et al.* had explained about computer integrated manufacturing (CIM) definition, concepts, and flexible and integration importance and wide role of CIM in manufacturing sector. The knowledge how to solve the Industries problems by using CIM methodology; it is a very fruitful research area. Also define the flexible manufacturing system (FMS), it reduces manufacturing system, increase the reliability of the system by showing the model for FMS planning, function and resource management.

Lorin<sup>[3]</sup>, *et al.* had explained the value of Information Technology, by using IT reduces the huge load in organization like file work, accountant work, delivery report, capital investment all are computer based. It reduces the time, cost effective, reduces the error rate and increases the accuracy, computer-based scheduling and routing enable transport vehicles to be used more

efficiently, decreases the need to expand fleets.

### 3. PROBLEMS FACING MANUFACTURING SECTOR

The manufacturing industry faces various problems in previous time when Computer technology was not launched, even in recent time somewhere numerous challenges are present in today.

The following are the main problem:

- *Globalization*- Globalization means global connection between the industries and companies which allowed manufacturers to increase the market values. Industries can move their production anywhere in the world and connect with the best dealer also search of materials, dealing import export in minimum time through internet, but without computer integrated manufacturing (CIM) it create huge problem expertise, and low labor costs. Foreign country firms have benefited from this facilities and arrangement because they are easily able to purchase materials and tool and labors at minimum prices.
- *Employability* – Information technology itself a vast branch of engineering and introduce various trends and technical software which increases the need of qualify engineers. Work ethic, accuracy and reliability are basic requirements, but they're lacking in a great many applicants. It noticed that without information technology a manufacturing plant or industry is not growing speedily, in modern manufacturing sector recent trends has to be introducing to increase the employment rate and economic rate.
- *Industry image* – As in 21<sup>st</sup> century there is a boom of information technology, advanced techniques are introduces day by day, the image of many people have of manufacturing is one of labor in a dark, often filthy and potentially hazardous (unsafe) environment. Today, the companies reduce the unskilled and non-technical workers and in favor of that they introduce high technical computerized machines and highly educated employees. With time the old trends and working style is changes in manufacturing companies.
- *Training to unskilled labors* – In addition the problem concerned is attraction of unskilled labor with new computer based machines, the manufacturing industries has also been suffering with this so they provide training to the employees theoretical and practically as well. Getting employees to enroll in, and complete, job skill training has proven difficult.

### 4. INTEGRATION OF INFORMATION TECHNOLOGY

Manufacturing sector is itself a very important aspect in national economic welfare and Information Technology (IT) is gradually played a vital mechanism in manufacturing performance. Extensive coordination of manufacturing with computerization has been introducing so many advanced techniques; it makes the work easier and systematic which increases the economy as well as efficiency.

The following chart shows the role of IT in manufacturing systems, the organization trends of any industry or factor, customer dealership, virtual organization, globalization, all activities are totally depends on Information trends by using connectivity, micro autonomy. Media support is also play an important role to promote the recent trends as well as the demand of the customer. After the trends the organizational needs and the design factor, in need the customer satisfaction, collaboration and coordination of the trends, tool integration avoidance of problem they are interrelated with the new capabilities of the IT, automation, intelligent information processing, digitalization, sensors etc. Finally the manufacturing operations and Computerized based design are based on IT collaboration and management.

Combination of design and operation give the final result, i.e., intelligent searching, negotiation, diagnosis and learning program and finally the merge output is software agents.

There are a various processes or systems given by IT sector and maximum processes are control by IT which is the strength of the manufacturing system. Modernization in the manufacturing sector is generally means production innovation, but can also consist of new processes, tools or equipment. New green technologies is also introduce that eliminate desecrate (waste) during production. Thus benefits or profit of introducing IT and its trends may include greater ability, accuracy to respond according to customer requirement, less waste and downtime, improve product design, increased product quality, and improved relationships with suppliers and consumers.

### 5. FUTURE ASPECTS

The concept of the Information Technology is usually applied in the manufacturing sector due to the demand and circumstance of discrete product manufacturing so to improve the quality of the system. Successful consumption of IT for manufacturing requires the management of various diverse groups, and negotiations over system designs. The advance technology introduce by information technology for the future of manufacturing sector will have to achieve necessary automated functions such as processing, material handling, assembly, and inspection. Information Technology is the engineering that has given a feature to manufacturing industries

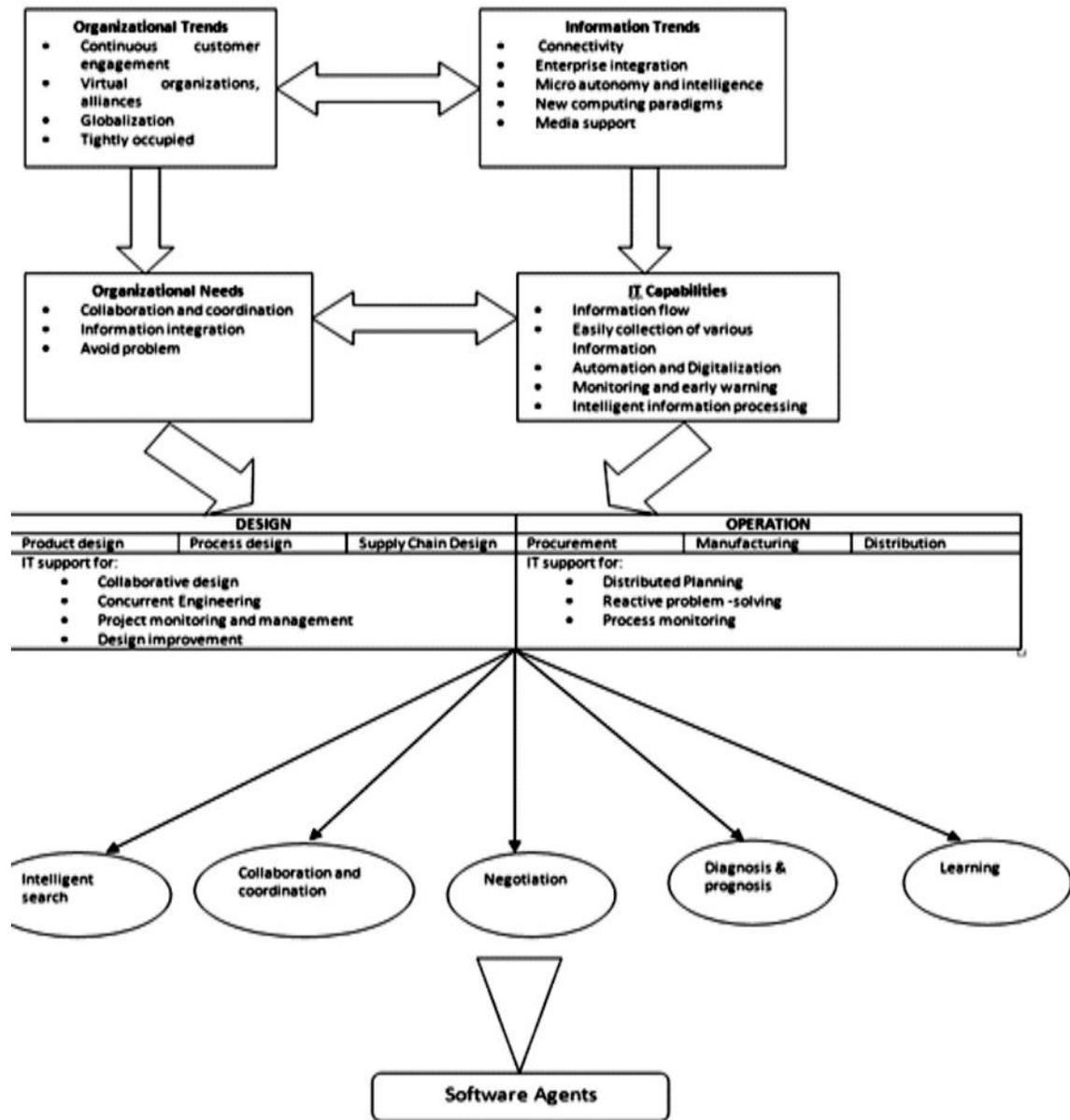


Figure 1. The flow chart shows the integration of IT with Manufacturing System.

in India on global level. Today, the country has developed enormous involvement with various other countries on the basis of its amazing IT services. It is definitely a reason of pride that India is known for outsourcing IT services and promotes the other sectors in the world. With the power of information technology, the country has not only extremely gained in its status and acknowledgment in the world but also has improved its overall economy. Naturally, this promises a long and prosperous future of Information technology in India.

## 6. SOCIAL IMPACT

There will be a social significance of introducing IT trends in the manufacturing sector. The manufacturing sector covers the huge rate of employment and affects

the social life. Reduced number of employees in future manufacturing factories and there is no direct participation in the production or operation processes. The natural impact is on the unskilled labor that will not be needed to run the production machines and only perform the manual tasks.

It will not possible that all companies/factories/industries immediately switch to the IT trends in overnight. The set-up and learning process will take time, with some industries implementation of the new technologies likes- CIM and CAPP/CAD/CAM are more slowly than others. The advanced manufacturing sector will be introduced gradually, and effects on the labor force will be evolutionary rather than revolutionary.

There are some social and economic factors, which encourage the improvement of such sectors.

These include:

- To increase the economic rate as well as the production growth.
- Requirement to increase the machine utilization
- The high cost of in-process stock
- The need to get maximum production in minimum time.
- The desire to fulfill the customer demand in limited time period.
- Find the optimum result and reduce the error rate.
- The need to use raw materials and energy as efficiently as possible.

## 7. CONCLUSION

IT provides so many features to manufacturing sectors such as CIM, which itself contains so many processes which can improve quality control and production rate. Computer numerical control (CNC), Direct numerical control (DNC) and Distributed Numerical Control increases the accuracy, precision and speed rate during the manufacturing process. IT is comprehensively used in the manufacturing industries to reduce the production and designing cost of product, supply chain management and the manufacturing process itself. IT can diminish the strength of worker needed to manufacture the products, improve the overall quality and permit manufacturers to take action quickly and more efficiently to their customers. Further with the advancement of IT in the field of manufacturing design Flexible Manufacturing System (FMS) are most commonly used now a days to develop the manufacturing system, it is basically related to the production work, use of robots for improving the work quality. Manufacturing sector get advancement by using IT functions.

In short, we can mention the merits of IT in manufacturing sector as:-

- Improved Engineering Productivity.
- Reduce time and error rate.
- Increase the accuracy of design.
- It increases the efficiency of the machine.
- Less human effort.
- Provides better functional analysis to reduce prototype testing.
- FMS enables manufacturers to machine a wide variety of work pieces on few machines with low staffing levels and high degree of reliability.
- Lowers work in procedure inventories.
- Reduce scrap rate.

## निष्कर्ष

यह ऐसी ही गुणवत्ता नियंत्रण और उत्पादन दर में सुधार कर सकते हैं, जो इतने सारे प्रक्रियाओं जिसमें यूके, के

रूप में विनिर्माण क्षेत्रों के लिए इतने सारे सुविधाएँ प्रदान करता है। कम्प्यूटर संख्यात्मक नियंत्रण (सीएनसी), प्रत्यक्ष संख्यात्मक नियंत्रण (DNC) और वितरित न्यूमेरिकल नियंत्रण निर्माण प्रक्रिया के दौरान सटीकता, गति और सटीक दर बढ़ जाती है। आईटी व्यापक उत्पादन और उत्पाद की डिजाइन लागत, आपूर्ति श्रृंखला प्रबंधन और निर्माण की प्रक्रिया ही कम करने के लिए विनिर्माण उद्योगों में प्रयोग किया जाता है। आईटी, उत्पादों का निर्माण करने के लिए आवश्यक कार्यकर्ता की ताकत कम हो जाना जल्दी से और अधिक कुशलता से अपने ग्राहकों के लिए कार्रवाई करने के लिए समग्र गुणवत्ता और परमिट निर्माताओं सुधार कर सकते हैं। इसके अलावा निर्माण डिजाइन लचीले विनिर्माण प्रणाली (एफएमएस) के क्षेत्र में आईटी के विकास के साथ सबसे अधिक उत्पादन प्रणाली विकसित करने के लिए एक दिन अब इस्तेमाल कर रहे हैं, यह मूल रूप से उत्पादन कार्य से संबंधित है, काम की गुणवत्ता में सुधार लाने के लिए रोबोट का उपयोग करें। विनिर्माण क्षेत्र में आईटी कार्यो का उपयोग करके उन्नति प्राप्त

- संक्षेप में, हम के रूप में क्षेत्र के निर्माण में आईटी की खूबियों का उल्लेख कर सकते हैं: –
- इंजीनियरिंग उत्पादकता में सुधार।
- समय और त्रुटि दर कम करें।
- डिजाइन की शुद्धता बढ़ाने के।
- यह मशीन की क्षमता बढ़ जाती है।
- कम मानव प्रयास।
- प्रोटोटाइप के परीक्षण को कम करने के लिए बेहतर कार्यात्मक विश्लेषण प्रदान करता है।
- एफएमएस मशीन को कम स्टाफ के स्तर और विश्वसनीयता के उच्च स्तर के साथ कुछ मशीनों पर काम टुकड़े की एक विस्तृत विविधता निर्माताओं सक्षम बनाता है।
- प्रक्रिया माल में काम कम करती है।
- स्कैप दर कम करें।

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## विकलांग व्यक्तियों के लिए स्वतंत्रता की बहाली में सूचना और संचार प्रौद्योगिकी की भूमिका Role of Information and Communication Technology in Restoration of Independence for Persons with Disabilities

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### सारांश

सूचना प्रौद्योगिकी स्वयं की देखभाल में स्वतंत्रता के लिए आवश्यक अनुकूली उपकरणों और तकनीकों को उपलब्ध कराने के आज के जीवन के हर पहलू में एक बहुत महत्वपूर्ण भूमिका निभाता है। ओपन लर्निंग और दूर-शिक्षा के साथ-साथ नई संचार प्रौद्योगिकियों अब कारणों की एक किस्म के लिए, पारंपरिक का सामना करने वाली चेहरा विश्वविद्यालयों में अध्ययन नहीं कर सकते हैं, उन सभी के लिए अतिरिक्त शिक्षा के अवसर की पेशकश की एक लंबे समय के लिए किया गया है। सूचना प्रौद्योगिकी विकलांगों के लिए रोजगार और सशक्तिकरण के लिए बहुत तेजी से विकसित कर रहा है जो एक क्षेत्र है। सही सब सुलभ चैनलों के माध्यम से जानकारी प्राप्त करने के लिए के रूप में वास्तव में विकलांग (PWDs) सभी नागरिकों के साथ सभी व्यक्तियों के मान्यता प्राप्त मौलिक अधिकारों में से एक है। विज्ञान और प्रौद्योगिकी के युग में, ताजा जानकारी एक घातीय दर से उत्पन्न किया जा रहा है और यह जानकारी विस्फोट का सामना करना बेहद मुश्किल हो गया है। एक लोक निर्माण विभाग ने अपने जीवन के हर पहलू में पूर्ण भागीदारी और समानता का आनंद चाहिए कि आदेश में यह जानकारी उसे करने के लिए सुलभ रूप में सूचित किया जाना चाहिए कि जरूरी है। सूचना प्रौद्योगिकी पहले से ही विकलांग छात्रों की शिक्षा के लिए कई योगदान दिया है। वे जोरदार प्रशिक्षण के माध्यम से बहुत ही कठिन मार्ग से गुजरना जाने के लिए और लक्ष्य इसभी के लिए पुनर्वास प्राप्त किया जा रहा है अगर sincerest प्रयास करना है। एक किफायती मूल्य पर गुणवत्ता पुनर्वास सेवाएं भारत में घंटा आज की जरूरत हैं। आधुनिक इंजीनियरिंग के नए अनुप्रयोगों के लिए सभी आर्थिक रूप से और प्रभावी ढंग से देश के आदर्श वाक्य पुनर्वास को प्राप्त करने में एक लंबा रास्ता तय कर सकते हैं। हम उसे/हमारे समाज के उसके स्वयं के लिए पर्याप्त है, आत्म-निर्भर और आत्म-कमाऊ सदस्य बनाने के लिए सक्षम नहीं हैं, तो एक व्यक्ति का पुनर्वास पूरा नहीं होगा।

### ABSTRACT

Information technology plays a very significant role in every aspect of today's life providing adaptive equipments and techniques needed for independence in self-care. Open learning and tele-education as well as the new communication technologies have for a long time now offered additional educational opportunities to all those who, for a variety of reasons, cannot study in traditional face-to-face Universities. Information Technology is an area which is developing very fast for the employment and empowerment for the disabled. Right to obtain information through all accessible channels is one of the recognized fundamental rights of all Persons with Disabilities (PWDs) as indeed of all citizens. In the age of science and technology, the fresh information is being generated at an exponential rate and it has become extremely difficult to face the information explosion. In order that a PWD should enjoy full participation and equality in every aspect of his life, it is imperative that information should be communicated in the form accessible to him. Information Technology has already made many contributions to the education of the students with disabilities. They have to go through very difficult path, undergo through vigorous training and make sincerest effort if the goal 'Rehabilitation for All' is to be attained. Quality rehabilitation services at an affordable price are the need of the hour in India today. Innovative applications of the modern engineering can go a long way in achieving the country's motto-rehabilitation for all-economically and effectively. The rehabilitation of an individual will not be complete if we are not able to make him/her self- sufficient, self-dependent and self-earning member of our society.

**Keywords:** Information technology, disabled, tele-education, persons with disabilities

## 1. INTRODUCTION

India is a country of diversity. On one hand, we have brilliant scientists, doctors, engineers, educationists and a professional education system that is comparable with the rest of the countries in the world. On the other hand, we are also challenged with the predicament of acute poverty, illiteracy, malnutrition, sickness, infant mortality and disability. India is on the verge of processing one of the strongest information and the telecommunication links like the satellite, ISDN, telephone lines, wireless loops and information technology like videoconferencing/ teleconferencing/ audio-conferencing that are now available in India provide an answer to the challenge faced by the Indian disability rehabilitation system today.

India is a country with highly skilled people but does not provide adequate opportunities for vocational education and training particularly for PWDs. If adequate opportunities for vocational education and training is provided, he or she can be made self-earning, respectable and useful citizens who will enjoy the human rights like all the other people. They have to go through very difficult path, undergo through vigorous training and make sincerest effort if the goal "Rehabilitation for All" is to be attained. Quality rehabilitation services at an affordable price are the need of the hour in India today. Innovative applications of the modern engineering can go a long way in achieving the country's motto-rehabilitation for all-economically and effectively.

The rehabilitation of an individual will not be complete if we are not able to make him/her self-sufficient, self-dependent and self-earning member of our society. We have to use modern tools, information technology and other hi-tech methods for imparting training.

Information Technology is an area which is developing very fast for the employment and empowerment for the disabled. It is hoped that in the 21<sup>st</sup> century many web sites may be launched on the Internet by leading agencies for the benefit of the disabled in India. Since the country is moving towards rapid development in IT sector, it is hoped that the disabled will have a great future in the new millennium.

### 1.1 Technological Advancements

Technological aids certainly include computers, but it could also refer to a number of other types of device which enable individuals with disabilities to function more independently. Computers are an important type of technological aid because they open up so many exciting possibilities for writing, speaking, finding information, or controlling an individual's environment, though computers are not the only avenues to solving problems through technology. Many assistive technology projects are available in advanced

countries and are mainly engaged in manufacturing of technology-based devices for PWDs. Sophisticated technological interfaces in the form of special keypads, touch screens; wireless sensors are all available with their resource directory. Most of these devices are not affordable to Indian masses. Hence our main aim should be to produce quality rehabilitation aids through internal sources so that Indian mass can use it with in an affordable price. Goel<sup>1</sup> has prepared a comprehensive compendium of large number of aids and appliances for the vocational rehabilitation of PWDs. The main goal of this project is to coordinate, compile and develop a proper database of the aids and appliances for the education, training & rehabilitation (ETR) of PWDs, especially in the Indian context. The scientific and technological developments in the field of disability rehabilitation are scattered and no effort has so far been made to consolidate this voluminous information. Every possible care has been taken to compile and consolidate these developments.

It is to be noted that people are not handicapped by their disabilities but by obstacles or barriers in their living environment. In order to meet a compromise between affordable prices for an essential utility in any part of the country, we have to find means of designing and developing the existing technologies according to the requirement of our society. Skilled volunteer engineers, design technicians and health workers should integrate to make assistive aids so that greater independence could be achieved for any PWD. There is lot of technological advancement in our country.

### 1.2 Information Oriented Education

The future of the mankind is each individual's responsibility. Today the very existence of mankind is at threat and it is very difficult to safeguard the dignity of just a society call for concerned effort to be initiated at a national level to orient parents, teachers, educationists, administrators, politicians and other functionaries at all levels to make information oriented education an integral part of the ongoing educational process. Information oriented education is most important to make people 'information conscious' which will lead to achieve rapid economic development and technological progress and thus create a special order founded o the values of freedom, social justice and equal opportunity. Almost all possible in whatever area, will be more of the existence of information systems. They will expected to be informed, they will be generally aware of how the system work or could work, and will not tolerate failure to provide accurate and timely information due to poor or insensitive system design. Effective information system is absolutely essential for successful planning, decision making and carrying out any meaningful research and studies.

While education in all its forms is a vital component for the development of large human population into a resource, it is mostly the higher education which contributes to the QOL. In India there has been a spectacular expansion in the higher education system. In India the common man has not reached the stage when he can say that he is able to appreciate the importance and usefulness of information technology. When the stage is reached, the QOL of common man will be better than what it is today. In India, we started late in developing the information technology and made a slow progress but it suddenly made a phenomenal growth and today we are using it profusely in railways, airlines, banks, industries, in weather forecasting and cyclone warning and in several other sectors. There is a considerable scope of using this technology in teaching and for the eradication of illiteracy in the country. Literacy is an essential aspect of human dignity and a window of apprehension and comprehension. The country has already entered the 21<sup>st</sup> century with maximum number of literates in the world. No economic measures can restore the dignity of the person, if he is illiterate. With the growth of distance learning, self-paced learning, individualized learning and the need to continue to learn throughout one's lifetime as career pattern change, the roles of teacher and information personnel merge toward the common goal of knowledge transmission. A new partnership is developing between the information specialist, the computer and the teacher. Each has distinctive qualities to offer, but the combination of all three can provide a formidable force in the learning process. Now a days, it has become almost rhetorical to speak of the 'information society', the 'information age' or the 'information revolution' when referring to the impact of ICTs on the development of human societies during the later half of twentieth century. Technological innovations have led to change in the ways we acquire, transmit and use information, and thence to behavioural changes in individuals. Future changes will be marked by complex interaction among basic technologies, new communication media and new distribution concepts. These will affect the ways people are educated, perform their jobs, and carry out day-to-day activities. The ever-increasing impact of ICTs on overall socio-economic development with the convergence of computer and telecommunication technologies has led many countries since the beginning of 1990s to formulate national plans and initiatives aimed particularly at exploring the newest possibilities – particularly the 'information superhighway' – for the purpose of education. Education empowers a person to face the challenges of life and thus it liberates him. Lack of education is a colossal deprivation and is a major deterrent of 'QOL' in India<sup>2</sup>. Meadow<sup>3</sup>, a professor

and leading Information Scientist of Drexel University said, "We have, in history, largely been a profession that responded rather than led. However, information science will, in the future, adopt a broader definition of itself, attract more adherents from other sciences and emerge as a mature and respected science". How accurate was his observation and certainly the last 35 years (i.e., 1979-2014) were the years of unending excitement – this science has already entered the high-tech era and emerged to 'Information Technology', a very challenging and exciting discipline transforming our responsibilities for communicating and our capacity for collecting, processing, disseminating and accessing information, consequently bringing about far-reaching changes in economic, political, social and cultural spheres of life in the whole world. Information Technologies are the world leaders today in every area of human activity.

Information Technology is an area which is developing very fast for the employment and empowerment for the disabled. Necessary technical expertise can be sought from IITs, DST, DRDO, NASSCOM, NISTADS, and other IT companies. Computers have taken every conceivable field of operation today. Regular schools in metropolitan cities have begun introducing children to computers from as early an age as seven years. Children will require more expensive special equipment and software in order to keep up with the present trend. Special schools as well as other organizations working for them have very little choice but to go for it.

### 1.3 Computer Revolution for Persons with Intellectual Disability

Computers are prevailing in all the important areas of academic activity. As computers are introduced into all important fields, it has entered into the education field also. Computer as an aid for teaching has been gaining momentum throughout the world. If teachers do not become computer literate over the next 10 years, they may be left behind in the field<sup>4</sup>. Teachers should consider the use of microcomputer as management tools. Teachers can take advantage of the tremendous storage and retrieval capacities of computers to plan individualized education programmes and monitor their students' progress. CAI has several advantages that can be applied to the instructional needs of many learners with intellectual disability. Computer programmes are available that can:

- Generate instructional objectives
- Produce records of progress and report cards
- Generate quarterly and semester reports
- Administer, score and interpret test performances
- Record and analyze classroom observations
- Manage weekly and monthly meeting schedules

- Store student health, discipline and academic records.
- Store information about community resources.
- Enhance student interaction and motivation.
- Provide immediate feedback.
- Provide needed reinforcement.
- Allow self-paced instruction.
- Free the teacher to work with other students while some students work on the computer.

Recent developments in the field of micro-technology have led to an awareness that microcomputer controlled systems may prove a useful teaching medium with mentally retarded individuals. Microcomputers can be a great asset in teaching reading skills, written expression skills, arithmetic skills, communication skills, problem solving skills, etc. It is felt by many professionals that the mentally retarded as a group inherently had poor problem solving skills but with the advance of CAI the retarded students can solve problems previously not thought possible. The retarded students can learn problem solving skills with the help of logo. Since the children as young as 3 and 4 years old have had great success with logo, so most moderately and many severely retarded students might benefit from interaction with this software.

Computer programmes designed in graphics with music are especially useful for children with mental retardation because music as a therapy works wonders. Patterns and pictures can be flashed on the screen to develop the skills of recognizing the pictures. Children with mental retardation have eye-hand coordination problems. The computer can overcome many of these problems if the child is allowed to play and explore a range of shapes, patterns and colours to produce beautiful pictures. Whenever a student makes a mistake the computer automatically beeps and displays error message and asks him/her to do it again. In education, technological inputs are making profound impact and Mani<sup>5</sup> gives the following role of ICT is to:

- Improve the efficiency of the teachers,
- Reduce the cost of education,
- Improve the quality of education,
- Decrease the duration in the realization of educational objectives,
- Bring more number of children under the umbrella of education,
- Develop the scientific temper in the learner, etc.

The purpose behind the use of technology is to use existing knowledge to serve humanity to solve some practical problems. In the field of special education, it carries special significance. We are committed to Universalization of Primary Education in India. We cannot achieve this goal if we exclude the education of handicapped population. Our traditional methods of

instruction may not be able to meet the new demands coming forth as a result of phenomenal advancement in all disciplines of knowledge including special education. We should beam more through an instructional strategy which guarantees the output and has a technological base. We hope that the future will be characterized by technological advances and improved conditions for the mentally retarded. There is much to believe that influences such as advocacy groups, interest groups, and social attitudes will continue to shape the quantity and quality of programmes and services for those who are mentally retarded. As the Action Plan for the National Policy on Education (NPE – 1986) has suggested: The use of technology in special education should receive attention. It involves modification, adjustment and adaptation of the equipment and material in the learning resource centre. Educational technology for mentally retarded children is a nationwide movement, which cannot and should not only be the responsibility of one Department of Ministry. It is the duty of most of the ministries at the national and state levels to pool their resources to make special education a success. Today we cannot remain passive observers under any circumstances but must become active participants in the problems and needs of the mentally retarded persons.

Today, computers affect all of us in our professional and personal lives. They are changing our lives today just as the telephone, automobile and aeroplane changed our lives at various points of time. One has to be computer literate to be successful in the modern world. Computers have had a tremendous impact on the world around us. The information revolution brought out by computer technology during the last forty years has changed the world more than all the earlier, nineteen centuries did.

#### **1.4 Access to Information for Person with Visual Impairment**

A person receives about 80% information through his sense of sight. Loss of sight is a severe handicap. In education, it affects the majority of activities associated with learning both in and out of the classroom. A Person with Visual Impairment (PVI) has to rely on the enhanced use of auditory and tactile modes of communication to ensure that the widest possible curriculum is available, but many learning problems still remain.

Right to obtain information through all accessible channels is one of the recognized fundamental rights of all blind persons as indeed of all citizens. In the age of science and technology, the fresh information is being generated at an exponential rate and it has become extremely difficult to face the information explosion. In order that a PVI should enjoy full participation and equality in every aspect of his life, it

is imperative that information should be communicated in the form accessible to him. Information Technology has already made many contributions to the education of the students with visual impairment.

Information can be accessible to them in tactile form through Braille printing, embossed literature, Braille teaching aid, three-dimensional 'touch and tell', exhibits, tactile image generator, optacon, etc. The partially-sighted can have access to information in visual form through low vision and magnification aids, closed circuit television, large print material, etc. Auditory form is the most important means to have access to information through talking books, talking computers, talking word processors, stereo cassette recorders, wireless, T.V. for blind, Kurzweil Reading Machine, etc. Voice Indexing Device will allow random access to the pages of a talking book. Modern electronic devices like Braille on magnetic cassette, Microbraille, Digicassette, Sony Tape recorder, Braillex Viewscan Text System, etc. have been developed to provide effective communication media to the visually impaired. Developments in Information Technology like online computerized Databanks, British aids database, technical aids information systems, online rehabilitation database, etc. have given a boost to visually impaired. A systematic speech output for the blind has been developed whereby a microcomputer can speak to its operator avoiding the need to translate printed information into Braille. These devices are fascinating, futuristic and extremely useful but prohibitive in cost at least for the blind individuals in this country.

### 1.5 Tele-education

Information technology plays a very significant role in every aspect of today's life providing adaptive equipments and techniques needed for independence in self-care. Open learning and tele-education as well as the new communication technologies have for a long time now offered additional educational opportunities to all those who, for a variety of reasons, cannot study in traditional face-to-face Universities. Tele-education, open and flexible learning have firmly established themselves in the different education scenes worldwide as a viable alternative for the disabled and the chronically ill. This paper deals with the advantages of tele-education for disabled and use of advanced communication facilities like Internet for tele-education. Internet technologies--the largest network communication technology in the world--used in the area of vocational and technical education to persons with disabilities are a relatively new phenomenon. Today, about 61600 internet resources (websites, web pages, online journals, etc.) are available as internet resources about vocational and technical education to persons with disabilities. The information technology

has the potentials of providing higher order learning requirements, desirable teaching/learning attributes, and availability of resources and extending the usability of resources for teaching/learning attainments through multi-learning web (MLW). The MLW is having five modes-print, audio, video, multimedia and internet. electronic libraries, also called digital libraries, comprise of interactive videocassettes, interactive CD-ROMs, electronic journals and magazines, hypertexts and graphics. E-books are much more powerful than traditional books as they are available twenty four hours a day, seven days a week from any location in the world. Conferencing technologies are increasingly used now a days to enable effective conversation between a group of people either in a closed room or from remotely located places. As the technology explores, the information flows from world around and makes a global village in which world information is a common knowledge to everyone. Tele-education is not only helpful to PWDs but it is also helpful to the society in general. With improving internet facilities, bandwidth and modern devices such as voice to text-messaging, e-books, telecommunication devices, more and more persons with different types of disabilities will be attracted to tele-education. Although many projects are underway in different parts of the world to improve the standards of tele-education and help the general and technical education to the disabled population, Indian scientists should come forward to take a lead in this field and help the large population of PWDs in this great nation. These efforts would be extremely valuable to people with devastating neuro-motor handicaps since it can offer new augmentative communication technology to those who are paralyzed or have severe movement deficits.

Information technology is a term used for computers, communications, internet, multimedia and cyberspace. Computers have invaded almost every part of human life. There is an urgent need to revamp the total education system in view of the growing revolution in information technology. The whole world is going towards paperless system in almost every walk of life. Information technology has the solution to break barriers of time, space and to fulfill the dreams of life long education. His excellency, Dr. A.P.J. Abdul Kalam, the 10<sup>th</sup> President of India, while delivering convocation address of the North Orissa university on 15<sup>th</sup> May 2003 said that Information and Communication Technology is one of our core competencies. The information technology and communication technology have already converged leading to the information and communication technology. This area can be used to promote education in remote areas and also to create national wealth. Within next 20 years, India is going to transform technologically with new emerging economic and technical situations<sup>6</sup>.

## 2. INTERNET RESOURCES ABOUT PERSONS WITH DISABILITIES

Internet technologies—the largest network communication technology in the world—used in the area of vocational and technical education to persons with disabilities are a relatively new phenomenon. The internet technology is an empowering tool for persons with disabilities; it gives them immediate access to information that historically has been unavailable to them. The internet is also a great boon for teachers and parents who are struggling to find information and support for their special needs. Today, about 61600 internet resources (websites, web pages, online journals, etc.) are available as internet resources about vocational and technical education to persons with disabilities.

- National Rehabilitation Information Center (NARIC): NARIC disseminates research on all aspects of disability. NARIC has five searchable databases that contain articles, books, organizations, and internet resources. Over 50000 documents are included in the databases.
- The Council for Exceptional Children (CEC): CEC is an international professional organization devoted to improving educational outcomes for students with disabilities and gifted students. CEC provides research for professional, as well as professional development opportunities. CEC is also involved in advocacy activities.
- Sights Network: This computer network provides bulletin boards and database information for blind and visually impaired individuals and those working with them. The information covers vocational and rehabilitation resources, assistive technology, public policy, educational information for parents, teachers, and students, and more.
- Closing the Gap: Closing the Gap provides information about technology for special educators. This organization also maintains a searchable database and printable resource of assistive technology products.
- Computer Assessment and Training Programs for Individuals with Disabilities: This list contains information on programs and organizations that provide computer-oriented assessment and training for people with disabilities, either children or adults. Organizations may also do assessments of a person's computer skills and recommend adaptations.

Today, what we used to see as distinct technologies—telephones, television, radio, and cable—are converging. The key component now is information, which can be represented in digital form.

New technology has the capability of 'speaking' for people with speech disabilities and 'hearing' for people who are deaf. It can bring information and education into homes and workplaces for people who

have mobility limitations. It can provide added cues and reminders for people with memory or cognitive loss. Overall, it can help support a web of communication that makes it easier for people with disabilities to stay integrated in society. For individuals with limitations in hearing, seeing, moving, speaking or cognition, the explosion of telecommunications offers opportunities as never before.

## 3. TELEWORK FOR PERSONS WITH DISABILITIES

Telework, often referred to as telecommuting, occurs where paid workers work away from their normal place of work, usually from home. Such workers can telework all their work time, or on an occasional or ad-hoc basis. Most telework takes place a day or two per week. Telework relies primarily or to a large extent on the use of Information Technology (mainly personal computers or terminals linked up to a mainframe, telephone, fax machine). There is a link between the tele-worker and the employer/contractor, which is used for communication.

Telework can save millions while helping to balance busy lifestyles, while reducing job related stress. Telework organizations take full advantage of new technologies and new ways of working to focus on the work performed rather than the location where it is performed. As the information revolution reshapes our corporate and personal lives, moving us closer to a global society, telework also represents a major step towards working anywhere, anytime.

Most PWDs derive tremendous satisfaction from their professional activities. It often happens that the continuous work rhythm imposed on everyone in the office can cause problems for someone who has treatment to carry out now and then or who suffers from sudden bouts of tiredness. Moreover, the work place does not always respect the need for privacy. There are other drawbacks that vary with the nature of the disability: rearrangement of the premises to make room for wheelchairs, an object suddenly placed in a corridor, blocking the passage, a meeting in an inaccessible place, the vastness of the premises and the distances to be traveled in the normal course of work are important concerns for PWDs.

The limits that disability imposes on daily life add to the constraints of the traditional pattern of work. The labour market is sometimes quite unreceptive to PWDs and particularly so where old people are concerned. Telework can partly help to overcome the obstacles that the disabled often encounter in ordinary work situations.

Work occupies an important place in the life of PWDs, and it becomes all the more necessary in that disability or a disability imposes certain restrictions

in other domains such as leisure or social life.

Telework can help the elderly and the disabled to feel less isolated. In most cases, access to Information and Communication Technologies (ICTs) is an additional means of communication and a way of breaking their isolation. The risk of isolation is often brought up in connection with telework. It is generally associated with a lower level of interaction with work colleagues and the absence of social contacts. Nevertheless, ICTs create a feeling of belonging to a work community, a company or more globally, the “working world”.

By abolishing physical distance, Information and Communication Technologies (ICTs) enable access to new services from any place at all, provided one has access to a telecommunications network and the necessary equipment. Traditional obstacles bound up with the reduced mobility of disabled or elderly people and with the difficulty in using public transport can be overcome with the help of ICTs.

The psycho-social profile of the teleworker plays a vital role in the conditions for implementing telework. The major hurdle in the education for disabled population is their inability to move freely. But this hurdle can be overcome with the use of advanced access technology and tele-education in this age of information technology. Tele-education, open and flexible learning have firmly established themselves in the different education scenes worldwide as a viable alternative for the disabled and the chronically ill. Tele-education, using information technologies, is a computer-based approach to instruction, which opens up vocational options for people who, for a variety of reasons, are unable to attend conventional training centers for technical education.

#### **4. THE EMERGING TECHNOLOGIES**

Modern age is an age of technology. The technologies like computer networking, simulation laboratories, digital libraries, hypermedia and CD ROM libraries are the new emerging technologies in education. Expert systems, shared databases, world-wide-web (WWW), simulation software packages and virtual reality are some of information technologies that can be used to assist constructive teaching/learning environment. The integration of various applications of IT to enhance the usability of education technology has given rise to an entirely new kind of teaching/learning environment called multi-learning web. The advent of Local Area Networks (LAN), Wide Area Networks (WANS) has provided an opportunity for the academic communities for effective information resource sharing.

In addition to this, emerging technology is helping the PWDs to gain not only the physical independence but also the prerequisite skills to become an important part of the society and economy system of the country.

Computer assisted and computer guided aids are very useful to children with special needs. One should be aware of the use, maintenance, and benefits of these aids. Teachers can use these aids to make better performance. He/she can also adopt some instructional modifications like, clear articulation, emphasis on visual, tactile, auditory and speech inputs. He/she can use bold print [Large Print] books, talking calculators, speech synthesizer software, computer software, etc. that are accessible to the PWDs.

#### **5. GLOBAL VILLAGE**

The educational institutions have no longer been considered as the only information sources. As the technology explores, the information flows from world around and makes a global village in which world information is a common knowledge to everyone. In fact the information superhighways are a means for global interconnectivity. The main requirement to realize a global village is the construction of National Information Infrastructure (NII) and a Global Information Infrastructure (GII) having a common platform to deal with information transmission, and its utilization in various areas.

The impact of new information technology and the changes that are taking place in the community of PWDs due to liberalization, privatization and globalization is being felt by the various thinkers in education, namely, policy makers, curriculum planners, administrators, teachers and students. In order to gear up the educational technology, its method of management has to be proactive and prepare the thinkers for handling new tasks and responsibilities efficiently and effectively.

In an information-based economy, knowledge is power. Technological and manufacturing advances are also driving down the cost of computers and software, bringing sophisticated technologies within the reach of more households in India.

Today thousands of families are interested in making technology a part of their lives. A definite perception has taken place toward the computer being seen as a versatile and essential tool for working and learning. It is clear indication that investment in IT is a key factor to the economic success of the country and if India wants to remain in the race for economic supremacy, it needs to accelerate the deployment of IT in the management of educational technologies.

#### **5.1 Empowerment**

Disability is an issue that concerns all of us; it can affect anybody, of any background, in any country, at any time. In India, disability has so far been perceived as a problem and not a priority. Disability is not a charity issue, but it is a rights issue. People

with disabilities want to be treated like other citizens, with rights. They want to be treated equally and to participate as equal citizens in their communities. There have been major shifts in the perception of disabled people's rights, from charity to social development, from treatment to prevention, from dependency to empowerment, from humanitarian concern to human rights. Self-awareness and self-confidence are two key essentials of empowerment. These have to be coupled with a realistic acceptance of the disability and a belief in oneself. It follows that for an individual to become empowered, the person needs to acquire knowledge, develop skills, and be motivated. To be empowered means "our inner being-our unique self-is vested with power and inner strength. When we feel empowered, we can meet challenges with confidence. Once we are empowered we have personal power and control over our lives. We have positive self-images that are affirmed and sustained."

## 6. CONCLUDING REMARKS

It is hoped that in the 21<sup>st</sup> century many web sites may be launched on the Internet by leading agencies for the benefit of the disabled in India. Since the country is moving towards rapid development in IT sector, it is hoped that the disabled will have a great future in the new millennium. We are living in democratic India. Democracy means transparency and transparency stands for right to information. With rapid industrialization, India is heading towards information revolution. IT is an agent of transformation of every aspect of human life. While education is creating a learning society, IT is making it knowledge-based. A new awareness is on the increase, so is its application in our social and economic life. It is fast penetrating into our rural areas. It is becoming increasingly important that millions of people with disabilities and rehabilitation practitioners do their own thinking to develop information-based rehabilitation and to use IT for formulating better plans and services. Tele-education is not only helpful to PWDs but it is also helpful to the society in general. With improving internet facilities, bandwidth and modern devices such as voice to text-messaging, e-books, telecommunication devices, more and more persons with different types of disabilities will be attracted to tele-education. Although many projects are underway in different parts of the world to improve the standards of tele-education and help the general and technical education to the disabled population, Indian scientists should come forward to take a lead in this field and help the large population of PWDs in this great nation. In this great noble and humanitarian task, we hope to continue our crusade against disability and look forward to a bright future for the disabled population of India. During the Decade

of Disabled (1983-92), Asia & Pacific Decade of Disabled (1993-2002), Biwako Millennium (2003-2012); both Government and non-Government Agencies have initiated suitable measures so as to enable PWDs to enjoy their rights of receiving information.

## निष्कर्ष

यह आशा की जाती है कि 21<sup>वीं</sup> सदी में भारत में विकलांगों के लाभ के लिए अग्रणी एजेन्सियों के द्वारा इंटरनेट पर कई वेब साइटों को शुरू किया जा सकता है। चूंकि सूचना प्रौद्योगिकी के क्षेत्र में देखा तेजी के साथ विकास की ओर बढ़ रहा है, यह आशा व्यक्त की जाती है कि नई सहस्राब्दी में विकलांगों के लिए विशाल भविष्य होगा। हम लोकतांत्रिक भारत में रह रहे हैं। लोकतंत्र का मतलब पारदर्शिता होता है और सूचना अधिकार के लिए पारदर्शिता खड़ी है। भारत तेजी से औद्योगीकरण के साथ सूचना शक्ति की ओर बढ़ रहा है। सूचना प्रौद्योगिकी मानवीय जीवन के हर पहलू के परिवर्तन का एजेंट है। शिक्षा एक शिक्षित समाज को बना रही है जबकि सूचना प्रौद्योगिकी इसे ज्ञान आधारित बना रही है। एक नई जागरूकता के अनुप्रयोगों ने हमारे समाजिक और आर्थिक जीवन में वृद्धि की है। ये तेजी के साथ हमारे ग्रामीण क्षेत्रों में प्रवेश कर रहे हैं। यह तेजी के साथ महत्वपूर्ण होता जा रहा है कि लाखों लोग विकलांग और पुर्न प्रतिष्ठा वाले पेशेवर के साथ अपनी निजी सोच को जानकारी आधारित पुर्नसुधार 'बहाली' विकसित करने के लिए और बेहतर योजनाओं एवं सेवाओं को तैयार करने के लिए इसका इस्तेमाल कर रहे हैं। टेली-शिक्षा न केवल लोक निर्माण विभाग के लिए उपयोगी है बल्कि समाज के लिए भी सामान्य रूप से उपयोगी है। इंटरनेट की सुविधाओं में सुधार, बैंडविड्थ और पाठ संदेशों के रूप में आधुनिक उपकरण, ई-किताबें, दूरसंचार उपकरणों के साथ विभिन्न प्रकार की विकलांगता वाले अधिक से अधिक लोगों को टेली शिक्षा की ओर आकर्षित किया जाएगा। यद्यपि टेली-शिक्षा के स्तर में सुधार और विकलांग आबादी को सामान्य और तकनीकी शिक्षा में मदद करने के लिए दुनिया भर के विभिन्न हिस्सों में कई परियोजनाएं चल रही हैं, इस महान राष्ट्र में भारतीय वैज्ञानिकों को इस क्षेत्र का नेतृत्व करने के लिए और लोक निर्माण विभाग की बड़ी आबादी की मदद के लिए आगे आना चाहिए। इस महान आदर्श और मानवीय कार्य में, हमने विकलांगता के खिलाफ एक मुहिम चला रखी है और भारतीय विकलांग आबादी के लिए एक उज्ज्वल भविष्य की उम्मीद जगाई है। विकलांग दशक 1983-92, एशिया और पश्चात विकलांग दशक 1993-2002, बिवाको मिलेनियम 2012-2013 के दौरान सरकारी और गैर सरकारी दोनों ही एजेन्सियों ने जानकारी प्राप्त करने के अपने अधिकार का आनन्द लेने के लिए लोक निर्माण विभाग को सक्षम में उपयुक्त उपाय किये हैं।

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## भारत में उच्च शिक्षा संस्थानों द्वारा वेब 2.0 को अपनाया जाना Adoption of Web 2.0 by the Institutions of Higher Education in India

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### सारांश

यह अध्ययन भारत में उच्च शिक्षा संस्थानों द्वारा वेब 2.0 टूल्स को अपनाए जाने पर चर्चा करने के संबंध में है। यह पत्र विभिन्न उच्च शिक्षा संस्थानों, यथा आईआईटी, आईआईएम और एम्स, में वेब 2.0 टूल्स के प्रसार को मापने का प्रयास करता है। संस्थाओं के वेबसाइटों का अलग-अलग सर्वेक्षण किया गया और उनके वेबसाइटों पर उपलब्ध वेब 2.0 टूल का अध्ययन किया गया। देश के कुल 36 उच्च शिक्षा संस्थानों पर विचार किया जा रहा और वे 62 वेब 2.0 टूल्स का प्रयोग करते हैं। अध्ययन में पाया गया कि अध्ययन के अंतर्गत शामिल कुल जनसंख्या में आईआईटी की संख्या 44.4 प्रतिशत, आईआईएम की संख्या 36.11 प्रतिशत, और एम्स की संख्या 19.44 प्रतिशत है।

### ABSTRACT

This study is to discuss the adoption of Web 2.0 tools by Institutions of Higher Education (IHE) in India. This paper attempts to measure the dissemination of Web 2.0 tools in various IHE that is, IITs, IIMs, and AIIMS. The websites of Institutions were surveyed individually and the web 2.0 tools available on their websites was studied. A total 36 institutions of higher education of the country are being considered and they use 62 Web 2.0 tools. The study found that 44.44 per cent of the total population under study consists of IITs, 36.11 per cent of IIMs, and 19.44 per cent of AIIMS.

**Keywords:** Web 2.0, www, internet, institutions of higher education, IITs, IIMs, AIIMS, India.

### 1. INTRODUCTION

The World Wide Web (WWW) was born on August 6, 1991, when the first web page was launched on the Internet by Sir Tim Berners-Lee (Fig.1). Sir Tim Berners-Lee said that “the Web is more a social creation than a technical one. I designed it for a social effect to help people work together and not as technical toy”<sup>1</sup>. The growth of the Internet has had a revolutionary effect on society. It changes the obstacle of the distance from the communication process. Web is a practical interface to a compound network of computers and data. In Asia alone, there are about 1076.7 millions of Internet users which are the largest number of Internet users (44.8%). The growth of world total internet users in 2011-2012 is 566.4% (Table.1).

The information age, the Internet is an ocean of information and is used in every walk of life these days. It provides information on the fields of business science, education, government and non-governmental organizations, etc. It is one of the facilities through which the information can be stored, retrieved, arranged, and transmitted back to the users quickly, in a timely

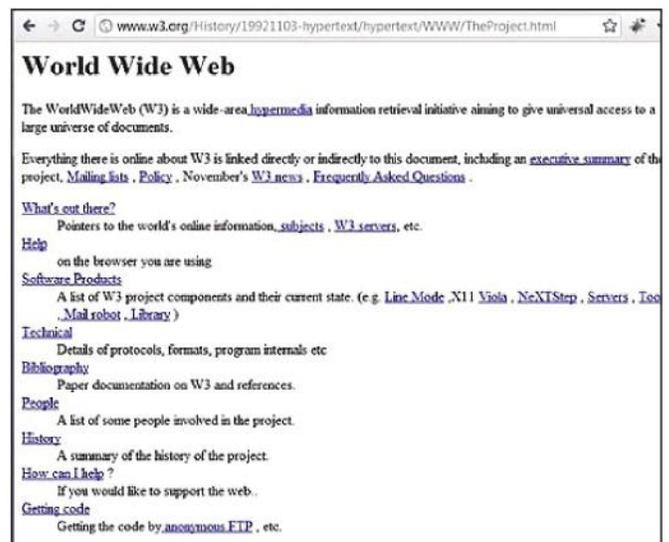


Figure 1. Sir Tim Berners-Lee's website is a page of links to share data and news.

fashion, and accurately<sup>2</sup>. Internet can create both synchronous communication, including chat rooms and instant messages, occurs in real-time. It can happen in single location through employing office application

**Table 1. World internet usage and population statistics June 30, 2012<sup>6</sup>.**

World Regions	Population (2012 Est.)	Internet Users Dec.,31,2000	Internet Users Latest data	Penetration (% Population)	Growth 2000-2012	Users % of Table
Africa	1,073,380,925	4,514,400	167,335,676	15.60%	3606.70%	7.00%
Asia	3,922,066,987	114,304,000	1,076,681,059	27.50%	841.90%	44.80%
Europe	816,372,817	105,096,093	518,512,109	63.50%	393.40%	21.50%
Middle East	223,608,203	3,284,800	90,000,455	40.20%	2639.90%	3.70%
North America	348,280,154	108,096,800	273,785,413	78.60%	153.30%	11.40%
Latin America/ Caribbean	592,994,842	18,068,919	254,915,884	43.00%	1310.80%	10.60%
Oceania/ Australia	35,815,913	7,620,480	24,279,579	67.80%	218.60%	1.00%
World Total	7,012,519, 841	360,985,492	2,405,510,175	34.30%	566.40%	100.00%

or in multiple locations with using conference calls, webinars, multiparty text chat, Google text, Microsoft SharePoint, Windows Live SkyDrive, Videoconferencing. On the other hand, asynchronous communication such as emails, blogs, discussion forum, and team survey allows people to respond to communications<sup>3</sup>. Fast and easier access to the Internet through computers and the handheld mobile devices, and the interactive characteristics of recently developed Web 2.0 tools have allowed users to collaborate in virtual societies. Web 2.0 is a shared web development platform that refers to the accumulative changes in the ways software developers and users succeed profits from the web<sup>4</sup>. In current years, Web 2.0 technologies have become most popular among the younger generation to make communication effective and interactive<sup>5</sup>.

In the late 1990s, user profiles became a central characteristic of social networking sites (Fig. 2), allowing users to compile lists of "friends" and search for other users with similar interests. New social networking methods were developed in 1990s and many sites began to develop more advanced features for users to find and manage friends<sup>7</sup>. This newer generation of social networking sites began to grow with SixDegrees.com in 1997, followed by Makeoutclub in 2000, Friendster in 2002 and became part of the Internet mainstream. MySpace and LinkedIn a year later, and finally Bebo, and Facebook launched in 2004, has since become the largest social networking site in the world. Information system of social networking is that support interactions on a social network.

Hossain and Aydin<sup>8</sup> identified, "social networking applications such as blogs, discussion forums, podcasts, and wikis are the successful implementations of the new generation of web 2.0 technologies. These provide web 2.0 based applications, programs, and services including web hosting, text-audio-video sharing, communication, social interaction, and many more. Web 2.0-based applications such as Facebook, LinkedIn, MySpace, Twitter, and YouTube enable users to share



**Figure 2. Social media.**

ideas, opinions, and interests within their individual networks over the internet in convenient ways. The free, open, collaborative, and interoperable features of Web 2.0 technologies allow users to create many virtual communities at home and abroad free of charge". Macaskill and Owen<sup>9</sup> have defined Web 2.0 tools as a "web-based platform which allows users to gain access, contribute, describe, harvest, tag, annotate and bookmark web mediated content in various formats, such as text, video, audio, pictures and graphs".

Anderson<sup>10</sup> stated that "there are a number of webbased services and applications that demonstrate the foundations of the Web 2.0 concept, and they are already being used to a certain extent in education and research. These are not really technologies as such, but services or user processes built using the building blocks of the technologies and open standards that underpin the Internet and the web. These include blogs, wikis, and multi-media sharing services, content syndication, podcasting and content tagging services".

O'Reilly<sup>11</sup> defines "the web 2.0 is the network as platform, spanning all connected devices; Web 2.0

applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the page metaphor of Web 1.0 to deliver rich user experiences".

## 2. INSTITUTIONS OF HIGHER EDUCATION

India higher education system is the third largest in the world, next to the United States and China. The main governing body at the tertiary level is the University Grants Commission, which enforces its standards, advises the government, and helps coordinate between the centre and the state.

Some institutions of India, such as the Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), All India Institutes of Medical Sciences (AIIMS), National Institute of Technology (NITs), International Institute of Information Technology (IIIT-H), Aligarh Muslim University (AMU), Banaras Hindu University (BHU) University of Mumbai and Jawaharlal Nehru University have been globally acclaimed for their standard of education. The IITs enroll about 8000 students annually and the alumni have contributed to both the growth of the private sector and the public sectors of India. However, India still lacks internationally prestigious universities such as Harvard, Cambridge, and Oxford<sup>12</sup>.

## 3. REVIEW OF LITERATURE

Literature plays a very significant role in research activities, as it forms the very first step of a research pursuit. In this study an attempt has been made to cover few works which have been undertaken in India and abroad.

The purpose of the study conducted by, Isfandyari-Moghaddam and Hosseini-Shoar<sup>13</sup> was to identify factors affecting the adoption of Web 2.0 tools by librarians of academic libraries located in Hamedan, Iran. The study found that totally, ten broad factors affecting the adoption of Web 2.0 tools by the librarians were identified. The most effective factors are job conditions, changeability, skills, competitiveness, and saving time.

In James Baxter<sup>14</sup> paper, one of the principal findings that it indicates the importance of reviewing social and cultural factors in organizations when introducing Web 2.0 technologies in the work place. As far as technical issues with the intention of impact on the implementation of web 2.0 tools in organizations, this

issue also explores subject matters such as the dilemma of whether a top-down or a bottom-up approach is more effective towards engaging staff in the adoption of web 2.0 tools at work.

Ahmad, Hussain and Aqil<sup>15</sup> study focused on usage of web 2.0 tools by Saudi's Private and Public Saudi Universities. The study only considers those web 2.0 tools which are linked on websites of universities. This is the first kind of study which revealed use and awareness of web 2.0 tools such as Facebook, Twitter, YouTube, RSS feed, Flickr, LinkedIn, Tumblr and Google+ within Saudi Universities.

According to London<sup>16</sup> found that web 2.0 functionality differs from traditional, primarily face-to-face modes of work and learning. Web 2.0 technologies could be promote generative learning processes in which team members were open to new ideas, explore new ways of interacting, and apply their learning.

Margam and Noushad<sup>17</sup> attempted to revealed that study websites are lagging behind in exploiting the full potential of the multimedia features, particularly, audio and video features as well as instructional tools, currency, and Web/Library 2.0 features. The consequences of the study focused that many of the study IIM library websites in India was ranked above average mainly providing general information of the library and their services. The study website with the highest score is for IIM-Lucknow with 65.92 per cent (89 out of 135) and the least scored study website belongs to IIM-Bangalore with 42.96 per cent (58/135). These findings open the door to librarians to explore the possibilities of communication, promotion, text responses, and catalogue access via mobile technology with the help of library websites.

Lwoga<sup>18</sup> carried out a study on the extent to which learning and web 2.0 technologies are utilized to support learning and teaching in Africa's higher learning institutions, with a specific focus on Tanzania's public universities. The study also found that these universities faced a number of challenges in their adoption and use of Web 2.0, such as:

1. the poor technological infrastructure,
2. awareness and attitudes towards e-learning,
3. the lack of local expertise in curriculum development for e-learning, and,
4. the lack of ICT technical support to support e-learning initiatives.

Garoufallou and Charitopoulou<sup>19</sup> found that although most of the students have heard of the term web 2.0 and its tools, further knowledge of the subject is limited. This lack of knowledge was apparent in the poor ways that students exploited web 2.0 features. The questionnaire, which was divided into two sections, examined the knowledge and use of web 2.0 tools by students, and further explored the use of

web 2.0 tools in the educational process. The results of this study provided insightful information to the Greek LIS community in order to better understand students' behaviour, with a view to encouraging the incorporation of new elements into the curriculum with regard to Web 2.0.

Han and Liu<sup>20</sup> were to explore the status and construction pattern of web 2.0 technologies hired in top Chinese university libraries. The major finding of the study were more than 2/3rd the 38 top Chinese university libraries apply one or more kinds of web 2.0 tools through the elementary functions of their web sites. Among six types of tools, Catalog 2.0 and RSS are the most common, while IM, Blog, SNS and Wiki are less frequent.

Chaurasia<sup>21</sup> has conducted a study under title “comparative study in adoption of web 2.0 technologies between western and Arab universities”. The main findings of the study were: the status of web 2.0 applications usage in education sectors is inadequate in Arab world, as compared to western universities.

Sriram, Anbu K. and Kataria<sup>22</sup> study was to provide an insight into the implementation of selected of the innovative Web 2.0 applications at Jaypee University of Information Technology (JUIT) with the aim of exploring the expectations of the users and their awareness and usage of such applications

In Grosseck<sup>23</sup> article, the main finding of the study was: the latest generation of web 2.0 technologies (blogs, wikis, RSS etc.) are quickly becoming ubiquitous, offering much unique and powerful information, sharing and collaboration features. The study also found that all the experts from the educational field (teachers, tutors, trainers, administrators, or those responsible for policies) focused the web 2.0 technologies have efficient and promising both for the educational process and for self-development.

**4. SCOPE OF THE STUDY**

This study discusses the adoption of web 2.0 by the institutions of higher education in India. This paper attempts to measure the dissemination of web 2.0 tools in selected institutions of IHE that is, IITs, IIMs and AIIMS. This study only goes for analysis of Facebook and Twitter because these both tools are significantly more popular among all of web 2.0 tools.

**5. METHODS**

These tools are measured on the basis of their usage in selected institutions of higher education in India. Web 2.0 has already available the IITs, IIMs and AIIMS websites of the home pages. This study consisted of four phases

- a. Browsed all IITs, IIMs and AIIMS websites and linked web 2.0 tools 'profile on them on February

and March, 2014.

- b. Count occurrences.
- c. Analyze the results, and
- d. Discussion & Suggestion.

In this study total 36 institution of higher education of the country are being analyzed and they use 62 web 2.0 tools. The study only considers those web 2.0 tools which are linked to websites of Institutions.

**6. RESULTS AND DISCUSSION**

The data collected from all linked web 2.0 profile following on Indian institutions websites. For further analysis, the authors visited Facebook and Twitter profiles of Indian institutions organized data in excel programs as tabulated form and gathered findings.

The Table 2 shows that 44.44% of the total population under study consists of IITs, 36.11% IIMs, 19.44% of AIIMS.

**Table 2. Size of the sample**

Institutions of Higher Education	No. of institutions	% age
Indian Institute of Technologies (IITs)	16	44.44
Indian Institute of Management (IIMs)	13	36.11
All India Institutes of Medical Sciences (AIIMS)	07	19.44
Total	36	100.00

The study was conducted to understand the awareness regarding Web 2.0 tools such as Facebook, Twitter, Google+, Blogs, LinkedIn, YouTube, RSS feed, Wiki and ilive in the institutions of higher education in India. Results indicate that Facebook 16 (44.44 %), Twitter 12(33.33%), Google+ 9(25%) web 2.0 tools are most popular among them as indicated in Table 3.

Table 4 reveals that Web 2.0 tools IITs (4), IIMs (9) and AIIMS (3) are using Facebook followed by Twitter same order as IITs(4) as well as IIMs(8),

**Table 3. Web 2.0 tools used by the institutions of higher education in India**

Web 2.0 Tools	No. Web 2.0 Tools	% Web 2.0 Tools
Facebook	16	44.44
Twitter	12	33.33
Google+	9	25.00
Blogs	8	22.22
LinkedIn	6	16.67
YouTube	5	13.89
RSS feed	3	8.33
Wiki	2	5.56
ilive	1	2.78

(n=36)

**Table 4. Web 2.0 tools used by the institutions of higher education**

Web 2.0 application	IITs	IIMs	AIIMS	Total	%age
Facebook	4	9	3	16	25.81
Twitter	4	8	0	12	19.35
Google+	4	5	0	9	12.90
Blog	2	5	1	8	14.52
LinkedIn	2	4	0	6	9.68
YouTube	2	3	0	5	8.06
RSS feed	2	1	0	3	4.84
Wikipedia	1	1	0	2	3.23
ilive	0	1	0	1	1.61
Total	21	37	4	62	100.00

while IITs(2), IIMs (5), and AIIMS (1) are used as Web 2.0 tools as Blogs. This table further reveals that only one IITs is using Web 2.0 tools.

Table 5 shows that 2 out of 16 IITs have linked on their facebook profile websites as well as 2 have given back link of their institutions of higher education facebook profiles. This table further reveals that only 2 IITs have formed standard user names on facebook, while 2 out of 4 IITs have mentioned their Facebook joining date on their profiles. IITGandhinagar is the first facebook joined members of IITs.

Table 5 also shows that IIT Madras has the maximum numbers of "likes" on Facebook. The India Institute of Technology Gandhinagar and India Institute of Technology Bombay have "likes" on Facebook in chronological order.

Table 6 shows that 8 out of 13 IIMs have linked on their facebook profiles, while one have given back links of their institute on Facebook profiles. The table 6 further reveals that IIM Lucknow has the majority of "liked" on Facebook, followed by IIM Calcutta, IIM Kozhikode, IIM Ranchi, IIM Kashipur, IIM Tiruchirappalli and IIM Udaipur.

Table 7 shows that 3 out of 7 AIIMS have linked on their facebook profile. This table further reveals that only 2 AIIMS shaped standard user name on facebook account. AIIMS New Delhi is the oldest institutions of higher education in India but has not adopted any web 2.0 tools, that is, Facebook, LinkedIn, Twitter etc. Table 7 also shows that AIIMS Raipur has the maximum numbers of "likes" on Facebook. The AIIMS Bhopal and AIIMS Patna have "likes" on Facebook in chronological order.

## 7. CONCLUSION AND RECOMMENDATIONS

This study discusses the adoption of web 2.0 by the institutions of higher education in India. In this paper found that maximum numbers of web 2.0 tools

**Table 5. Indian Institute of technology's liked on facebook**

IITs	Facebook liked	User Name (FB)	Facebook's link on Web	Facebook Joined/Found
IITKGP	NA	NA	NA	NA
IITB	172	Central Library, IITB	√	05-01-13
IITM	17,867	www.facebook.com/ReachIITM	No	NA
IITK	NA	NA	NA	NA
IITD	NA	NA	NA	NA
IITG	NA	NA	NA	NA
IITR	0	http://www.iitr.ac.in/	No	NA
IITH	NA	NA	NA	NA
IITP	NA	NA	NA	NA
IITGN	1464	www.facebook.com/pages/IIT-Gandhinagar/139092996158047	√	03-11-11
IITBBS	NA	NA	NA	NA
IITRPR	NA	NA	NA	NA
IITJ	NA	NA	NA	NA
IITI	NA	NA	NA	NA
IIT Mandi	NA	NA	NA	NA
IIT BHU	NA	NA	NA	NA

NA=Not Available

**Table 6. Indian institute of managements liked on facebook**

IIMs	Facebook liked	User Name (FB)	Facebook's link on Web	Facebook Joined/ Found
IIM-C	8839	www.facebook.com/iimcalcutta	√	Founded 01-11-1961
IIM-A	994	www.facebook.com/VikramSarabhaiLibrary	√	2010
IIM-B	NA	NA	NA	NA
IIM-L	11739	www.facebook.com/IIMLucknow?fref=ts	√	Founded 1984
IIM-K	6288	www.facebook.com/pages/IIM-Kozhikode/101851176539713?ref=hl	NA	Founded 1997
IIM-I	NA	NA	NA	NA
IIM-S	2245	https://www.facebook.com/IIM.Shillong	√	Founded 2008
IIM-Rohtak	NA	NA	NA	NA
IIM-R	7096	www.facebook.com/pages/Indian-Institute-of-Management-Ranchi/136020619772680?ref=ts	√	NA
IIM-Raipur	NA	NA	NA	NA
IIM-T	1460	https://www.facebook.com/IIMTiruchirappalli	√	Founded 04-01-2011
IIM-U	1459	https://www.facebook.com/IIMUdaipur	√	06/20/2011
IIM-Kashipur	2708	www.facebook.com/IndianInstituteOfManagementKashipur	√	Founded 2011

NA=Not Available

**Table 7. All India institute of medical sciences liked on facebook**

AIIMS	Facebook liked	User Name (FB)	Facebook's link on Web	Facebook Joined/Found
AIIMS New Delhi	NA	NA	NA	NA
AIIMS Bhopal	916	www.facebook.com/bhopalaiims	√	Founded 18-09-2012
AIIMS Bhubaneswar	NA	NA	NA	NA
AIIMS Jodhpur	NA	NA	NA	NA
AIIMS Patna	386	www.facebook.com/groups/410241208997671	No	No
AIIMS Raipur	1502	www.kfu.edu.sa/en/Deans/Library/Pages/Home1.aspx	√	Founded 24-9- 2012
AIIMS Rishikesh	NA	NA	NA	NA

NA=Not Available

used by IIMs, IITs and AIIMS of the total population of the study. It is found that facebook are the most used by IIMs after that Twitter, Google+, Blogs, LinkedIn and YouTube.

Based on the analysis it becomes clear that the IIM Lucknow, IIM Madras and AIIMS Raipur have available maximum numbers of liked on facebook profiles. AIIMS New Delhi is the oldest institutions of higher education in India in the field of medical sciences but has not adopted any web 2.0 tools, that is, Facebook, LinkedIn, and Twitter etc. This is the

drawback of the institution. It is recommended that the institutions of higher education in India should implement entire web 2.0 tools for the usages of state-of-the-art by users. It is hoped that study IHE shall be attend to this lacuna and rapidly develop more interactive and up-to-date dynamic content, Web 2.0 and Web 3.0-based features, instant messaging (IM) reference services, virtual library tours, floor maps, online library calendar, FAQs, bulletin boards, discussion forums, Listserve, web counter, effective searching features, etc.

## निष्कर्ष

यह अध्ययन भारत में उच्च शिक्षा संस्थानों द्वारा वेब 2.0 टूल्स को अपनाए जाने पर चर्चा करने के संबंध में है। इस पत्र में पाया गया कि अध्ययन में शामिल कुल जनसंख्या में अधिकतम संख्या में वेब 2.0 टूल्स आईआईटी, आईआईएम और एम्स में उपयोग किया जाता है। यह पाया गया है कि विभिन्न आईआईएम द्वारा फेसबुक का सर्वाधिक उपयोग किया जाता है, जिसके बाद ट्विटर, गूगल, ब्लॉग्स, लिंकडइन और यूट्यूब का नम्बर आता है।

विश्लेषण पर यह स्पष्ट हो गया कि आईआईएम लखनऊ, आईआईएम मद्रास और एम्स रायपुर फेसबुक प्रोफाइलों में अधिकतम संख्या में 'लाइक' रखते हैं। एम्स, नई दिल्ली आयुर्विज्ञान के क्षेत्र में भारत का सबसे पुराना उच्च शिक्षा संस्थान है, लेकिन इसने किसी भी वेब 2.0 टूल्स, जैसे फेसबुक, लिंकडइन, और ट्विटर इत्यादि को नहीं अपनाया है। यह इस संस्था की खामी है। यह सिफारिश की जाती है कि भारत में उच्च शिक्षा संस्थानों को, प्रयोक्ताओं द्वारा अत्याधुनिक प्रौद्योगिकी का उपयोग किए जाने के लिए, सम्पूर्ण वेब 2.0 टूल्स को लागू करना चाहिए। ऐसी आशा की जाती है कि उच्च शिक्षा संस्थान इस कमी की ओर ध्यान देंगे तथा और अधिक अन्वयक्रियात्मक और अद्यतन बहुआयामी अंतर्वस्तु, वेब 2.0 और वेब 3.0 आधारित विशेषताओं, तत्क्षण संदेश (आईएम) संदर्भ सेवाओं, आभासी पुस्तकालय भ्रमण, फ्लोर मानचित्रों, ऑनलाइन पुस्तकालय कैलन्डरों, अक्सर पूछे जाने वाले प्रश्नों, समाचार बोर्डों, चर्चा मंचों, लिस्टसर्व, वेब काउंटर, प्रभावी खोज विशेषताओं, इत्यादि को तेजी से विकसित करेंगे।

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## भारत में कोयला खानन उद्योग में सूचना प्रौद्योगिकी के अनुप्रयोग Application of Information Technology in Coal Mining Industry in India

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### सारांश

अनुकूल सुरक्षा मानदंडों के अभाव में सैकड़ों खान श्रमिक भारतवर्ष में अपनी जान गवा देते हैं। सूचना प्रौद्योगिकी का विस्तार काफी तेजी से हो रहा है, जैसा कि दिन-प्रतिदिन इसके नये-नये अनुप्रयोग देखने को मिलते हैं। परंतु दुर्भाग्यवश सूचना प्रौद्योगिकी का उपयोग खनन क्षेत्र में तुलनात्मक रूप से कम है। खनन क्षेत्र को भी उन्नत सूचना प्रौद्योगिकी के प्रयोग से वंचित नहीं रखा जाना चाहिए।

### Abstract

Hundreds of miners lost their lives in the coal mines in India due to lack of proper safety measures. Information Technology advancement is moving rapidly as every day we come across new IT applications but unfortunately the uptake of IT tools in mining sector is comparatively slow. The advancement of IT tools in mining sector should not be left out.

**Keyword:** Modules, network sensors, web-based information

### 1. INTRODUCTION

It has been noticed that India is lacking in the effective use of Information Technology tools in the Coal Mining Industry in India. The coal mining industry has to improve upon its production and safety by computerized online monitoring, implementation of wireless communication system in underground mines and using IT-based systems for achieving the production targets. In this paper, light has been thrown on the scope of IT applications in Coal Mining Industry in India.

### 2. IT APPLICATION IN COAL MINES

The management needs a complete history of daily targets and achievements, output per man shift, etc. for the effective mine management. Using the sensors and computers Mine Manager can be pro-active in time measurement. Seeing the web-reports generated by the system, it is easy to demarcate the grey areas and the priority can be set for the allocation of resources for improvement in the production and productivity.

Information technology is an effective tool in personnel management. The employees' data can be maintained at mine level, preventing delay in dealing with personnel records. Each individual data can be

maintained for improving the discipline and increase in productivity.

It is seen that almost every year sow disasters happen in coal mines causing major accidents including death of miners and heavy losses of property. The computerized online monitoring of pump operation and water-level using sensors is essential for the detection of faults. Using the computerized relational database management system (RDBMS), the safety related data could be easily searched wherever required. The analysis of data can identify areas of weaknesses in the mine safety system and the data can be used in the decision-making process.

Using the wireless communication system in coal mines, machine breakdown time is saved, and help in passing communication from underground to surface for the rescue operations can be taken up.

The computerized online sensor based environmental monitoring system can be deployed in Indian coal mines which will provide online visual representation of trend of all monitored parameters and to give a warning alarm when it reaches the threshold limit. The Mine Manager can take advantage of this for taking an appropriate action. This would also help in early detection of fire, proper ventilation planning, etc.

Information Technology tools is very effective in the post-disaster management. The RDBMS can provide the information about accident-prone areas, probable remedies, emergency response plan, first-aid list, rescue trained personnel with complete address. By using this tool, the mobilization of resources can be effectively managed to rescue the trapped miners without any further delay. As it is seen that during any mishap, there is misplacement of statute books, but if the reports are made available in the web-enabled database, the information can be searched easily. It is helpful in providing assistance and benefits to affected

people. The computerized attendance monitoring system can be used during the emergency period.

The statutory requirements data can be made online for retrieving the required information as and when required.

### 3. COAL MINES DISASTERS – DHANBAD DISTRICT, INDIA

It has been seen from the Table 1 that the main cause of accidents during last 5 years (2008-2012) is mainly due to fall of person into height/into depth. Rope haulage, dumpers, conveyors, etc.

**Table 1. Causes of accidents in coal mines of Central Zone, Dhanbad, India (Source : DGMS, Dhanbad)**

Year	Name of Mine	Date of Accident	Owner	Brief Cause	Place of Accident
2009	MOONIDIH PROJECT	13-May-09	Bharat Coking Coal Ltd.	Conveyors	> 10m of longwall face
2010	BHELATAND AMALGAMATED	01-Oct-10	Tata Iron & Steel Co. Ltd.	Conveyors	Conveyor roadways
2010	MOONIDIH PROJECT	24-Sep-10	Bharat Coking Coal Ltd.	Cutting Machines	< 10m of development face
2011	CHAPAPUR	20-Oct-11	Eastern Coalfields Ltd.	Drilling Machines	< 10m of face
2011	AKASHKINARI	15-Nov-11	Bharat Coking Coal Ltd.	Drilling Machines	Other belowground places
2010	SIJUA	31-Dec-10	Tata Iron & Steel Co. Ltd.	Drowning in Water	< 10m of face
2011	GOVINDPUR PROJECT	16-Jan-11	Central Coalfields Ltd.	Drowning in Water	Unclassified
2012	DHORI KHAS	28-Aug-12	Central Coalfields Ltd.	Drowning in Water	< 10m of development face
2008	LOHAPATTI	31-Mar-08	Bharat Coking Coal Ltd.	Dumpers	Other transportation roads
2008	MURAI DIH	21-Nov-08	Bharat Coking Coal Ltd.	Dumpers	Workshop powerhouse engine room etc.
2008	SENDRA BANSJORA	14-Dec-08	Bharat Coking Coal Ltd.	Dumpers	Unclassified
2009	SOUTH TISRA OCP	15-Jan-09	Bharat Coking Coal Ltd.	Dumpers	Unclassified
2009	KUMARDHUBI	18-Mar-09	Eastern Coalfields Ltd.	Dumpers	Unclassified
2009	KUSUNDA	23-May-09	Bharat Coking Coal Ltd.	Dumpers	Waste/overburden hard rock
2009	NEW AKSHKINAREE	09-Jul-09	Bharat Coking Coal Ltd.	Dumpers	Transportation road/sites
2010	SELECTED DHORI QRY.NO.1 (KALYANI PROJ.)	28-Jan-10	Central Coalfields Ltd.	Dumpers	Aerial ropeways
2010	MURAI DIH	17-Feb-10	Bharat Coking Coal Ltd.	Dumpers	Haul roads
2010	KARGALI OCP	08-Mar-10	Central Coalfields Ltd.	Dumpers	Railway lines belonging to mines
2010	KARO I	02-Apr-10	Central Coalfields Ltd.	Dumpers	Coal/ore benches
2010	BHOWRA (NORTH)	06-Sep-10	Bharat Coking Coal Ltd.	Dumpers	Waste/overburden hard rock
2010	GONDUDI H	15-Dec-10	Bharat Coking Coal Ltd.	Dumpers	Other transportation roads
2010	MUDIDI H	21-Dec-10	Bharat Coking Coal Ltd.	Dumpers	Haul roads
2010	AMALGAMATED KESHALPUR-WEST MUDIDI H	25-Dec-10	Bharat Coking Coal Ltd.	Dumpers	Top of the quarry
2010	CHASNALLA	27-Dec-10	Indian Iron & Steel Company Ltd.	Dumpers	Waste dump
2011	GOPINATHPUR	21-Feb-11	Eastern Coalfields Ltd.	Dumpers	Haul roads
2011	SHATABDI OCP	10-Apr-11	Bharat Coking Coal Ltd.	Dumpers	Other transportation roads

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2011	SAWANG	03-Dec-11	Central Coalfields Ltd.	Dumpers	Other places (specify)
2012	AMALGAMATED KESHALPUR-WEST MUDIDIH	28-Jan-12	Bharat Coking Coal Ltd.	Dumpers	Top of the quarry
2012	KUJAMA	02-Feb-12	Bharat Coking Coal Ltd.	Dumpers	Other transportation roads
2012	JEENAGORA	25-Mar-12	Bharat Coking Coal Ltd.	Dumpers	Other transportation roads
2012	AMALGAMATED KESHALPUR-WEST MUDIDIH	28-Apr-12	Bharat Coking Coal Ltd.	Dumpers	Haul roads
2012	MUDIDIH	17-Jun-12	Bharat Coking Coal Ltd.	Dumpers	Unclassified
2008	TETULMARI	14-Jan-08	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Unclassified
2008	LOYABAD	17-Jan-08	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Unclassified
2008	MANDAMAN	18-Feb-08	Eastern Coalfields Ltd.	Fall of Objects incl. Rolling Objects	Rope haulage roadways
2008	BLOCK II OCP	26-Feb-08	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Workshop powerhouse engine room etc.
2008	KHOODIA U/G	11-Jun-08	Eastern Coalfields Ltd.	Fall of Objects incl. Rolling Objects	> 10m and within working district
2008	NORTH TISRA U/G	19-Jul-08	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Haul roads
2008	BADJNA	08-Aug-08	Eastern Coalfields Ltd.	Fall of Objects incl. Rolling Objects	< 10m of face
2008	NOONODIH JITPUR	12-Sep-08	Indian Iron & Steel Company Ltd.	Fall of Objects incl. Rolling Objects	> 10m of longwall face
2008	JEENAGORA	06-Nov-08	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Unclassified
2009	MOONIDIH PROJECT	09-May-09	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	> 10m of longwall face
2009	DHANSAR	11-Jul-09	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	< 10m of development face
2009	TETULMARI	17-Sep-09	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Coal/ore benches
2010	10/12 PITS KACHHI BALIHARI	22-May-10	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Workshop powerhouse engine room etc.
2010	BAGDIGI	09-Jul-10	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Other belowground places
2010	AMALGAMATED KESHALPUR-WEST MUDIDIH	11-Aug-10	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Other belowground places
2010	JAMADOBA	04-Sep-10	Tata Iron & Steel Co. Ltd.	Fall of Objects incl. Rolling Objects	< 10m of face
2010	SENDRA BANSJORA	23-Nov-10	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	> 10m and within working district
2010	NOONODIH JITPUR	26-Nov-10	Indian Iron & Steel Company Ltd.	Fall of Objects incl. Rolling Objects	Other belowground places
2010	MOONIDIH PROJECT	14-Dec-10	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	> 10m but < 30m
2010	NOONODIH JITPUR	18-Dec-10	Indian Iron & Steel Company Ltd.	Fall of Objects incl. Rolling Objects	Other belowground places
2010	SUDAMDIH INCLINE	22-Dec-10	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	Unclassified
2011	KUYA	17-Feb-11	Bharat Coking Coal Ltd.	Fall of Objects incl. Rolling Objects	> 10m and within working district

It is seen from the above Table 2 that the main place of accidents are : rope haulage roadways, coal/ ore benches, > 10m and within working district, >10m of longwall face, and < 10m of face, etc.

**Table 2. Place of accidents in coal mines of Central Zone, Dhabad, India (Source : DGMS, Dhanbad)**

Year	Name of Mine	Date of Accident	Owner	Place of Accident	Killed	S/Inj.
2008	JAMADOBA	04-Apr-08	Tata Iron & Steel Co. Ltd.	< 10m of development face	0	2
2008	BURRAGARH	10-Jun-08	Bharat Coking Coal Ltd.	< 10m of development face	1	0
2008	MANDAMAN	26-Oct-08	Eastern Coalfields Ltd.	< 10m of development face	0	1
2008	MANDAMAN	04-Nov-08	Eastern Coalfields Ltd.	< 10m of development face	1	0
2008	MURULIDIH 20/21 PITS	24-Nov-08	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2009	JAMADOBA	24-Feb-09	Tata Iron & Steel Co. Ltd.	< 10m of development face	1	0
2009	MANDAMAN	03-Apr-09	Eastern Coalfields Ltd.	< 10m of development face	0	1
2009	DIGWADIH	10-Apr-09	Tata Iron & Steel Co. Ltd.	< 10m of development face	1	0
2009	SIJUA	06-May-09	Tata Iron & Steel Co. Ltd.	< 10m of development face	1	0
2009	DHANSAR	11-Jul-09	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2009	MANDAMAN	21-Jul-09	Eastern Coalfields Ltd.	< 10m of development face	0	1
2009	P.B.PROJECT,1&2 PIT	19-Sep-09	Bharat Coking Coal Ltd.	< 10m of development face	1	0
2010	BASANTIMATA	12-Feb-10	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2010	BASANTIMATA	25-Jun-10	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2010	MOONIDIH PROJECT	24-Sep-10	Bharat Coking Coal Ltd.	< 10m of development face	1	0
2010	MOONIDIH PROJECT	07-Dec-10	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2010	BADJNA	25-Dec-10	Eastern Coalfields Ltd.	< 10m of development face	0	1
2011	ALKUSA	10-Jan-11	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2011	BAGDIGI	18-Mar-11	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2011	KHARKHAREE	18-May-11	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2011	BLOCK-IV/KOORIDIH	09-Jul-11	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2011	POOTKEE	25-Oct-11	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2011	SAWANG	03-Nov-11	Central Coalfields Ltd.	< 10m of development face	0	1
2011	MOONIDIH PROJECT	12-Nov-11	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2011	HARIAJAM	26-Dec-11	Eastern Coalfields Ltd.	< 10m of development face	0	1
2012	NORTH TISRA U/G	19-Jan-12	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2012	ANGARPATHRA	29-Jan-12	Bharat Coking Coal Ltd.	< 10m of development face	0	2
2012	MURULIDIH 20/21 PITS	27-Apr-12	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2012	SIMLABAHAL	20-May-12	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2012	PARBATPUR COLLIERY	29-Jun-12	M/S Electrosteel Castings Limited	< 10m of development face	0	1
2012	DHORI KHAS	28-Aug-12	Central Coalfields Ltd.	< 10m of development face	2	0
2012	SIJUA	06-Oct-12	Tata Iron & Steel Co. Ltd.	< 10m of development face	0	1
2012	PARBATPUR COLLIERY	31-Oct-12	M/S Electrosteel Castings Limited	< 10m of development face	1	1
2012	MOONIDIH PROJECT	13-Dec-12	Bharat Coking Coal Ltd.	< 10m of development face	0	1
2008	POOTKEE	29-Feb-08	Bharat Coking Coal Ltd.	< 10m of face	0	1
2008	BASTACOLA	16-Jun-08	Bharat Coking Coal Ltd.	< 10m of face	0	1
2008	WEST MUDIDIH	12-Jul-08	Bharat Coking Coal Ltd.	< 10m of face	1	0
2008	BASTACOLA	03-Aug-08	Bharat Coking Coal Ltd.	< 10m of face	0	1
2008	BADJNA	08-Aug-08	Eastern Coalfields Ltd.	< 10m of face	0	1
2008	MURULIDIH 20/21 PITS	23-Sep-08	Bharat Coking Coal Ltd.	< 10m of face	0	1
2010	JAMADOBA	04-Sep-10	Tata Iron & Steel Co. Ltd.	< 10m of face	1	0

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2010	SIJUA	31-Dec-10	Tata Iron & Steel Co. Ltd.	< 10m of face	1	0
2011	GOVINDPUR PROJECT	11-Jan-11	Central Coalfields Ltd.	< 10m of face	0	1
2011	MURULIDIH 20/21 PITS	31-May-11	Bharat Coking Coal Ltd.	< 10m of face	0	1
2011	PATHARDIH	24-Jul-11	Bharat Coking Coal Ltd.	< 10m of face	2	1
2011	CHAPAPUR	20-Oct-11	Eastern Coalfields Ltd.	< 10m of face	0	1
2012	SIJUA	20-Mar-12	Tata Iron & Steel Co. Ltd.	< 10m of face	0	1
2012	BASTACOLA	28-Mar-12	Bharat Coking Coal Ltd.	< 10m of face	0	1
2012	MANDAMAN	16-Apr-12	Eastern Coalfields Ltd.	< 10m of face	0	1
2012	BASTACOLA	01-Dec-12	Bharat Coking Coal Ltd.	< 10m of face	0	1
2008	CHAPAPUR	24-Jan-08	Eastern Coalfields Ltd.	> 10m and within working district	0	1
2008	LODNA	05-May-08	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2008	KHARKHAREE	06-Jun-08	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2008	KHOODIA U/G	11-Jun-08	Eastern Coalfields Ltd.	> 10m and within working district	0	1
2008	KHARKHAREE	28-Jun-08	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2008	BASTACOLA	25-Sep-08	Bharat Coking Coal Ltd.	> 10m and within working district	1	0
2008	10/12 PITS KACHHI BALIHARI	13-Dec-08	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2009	KHARKHAREE	06-Jan-09	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2009	SIMLABAHAL	02-Feb-09	Bharat Coking Coal Ltd.	> 10m and within working district	1	1
2009	SHAMPUR B	15-Feb-09	Eastern Coalfields Ltd.	> 10m and within working district	0	1
2009	BASTACOLA	12-Mar-09	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2009	LAKHIMATA	24-Mar-09	Eastern Coalfields Ltd.	> 10m and within working district	0	1
2009	BANSDEOPUR	05-May-09	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2009	MOONIDIH PROJECT	15-Jun-09	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2010	MANDAMAN	02-Mar-10	Eastern Coalfields Ltd.	> 10m and within working district	0	1
2010	ALKUSA	30-Jun-10	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2010	HURRILADIH	18-Jul-10	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2010	SENDRA BANSJORA	23-Nov-10	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2010	MOONIDIH PROJECT	02-Dec-10	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2011	KUYA	17-Feb-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2011	KUMARDHUBI	26-Feb-11	Eastern Coalfields Ltd.	> 10m and within working district	1	1
2011	SIMLABAHAL	17-Mar-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	5
2011	SIMLABAHAL	01-Apr-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2011	KUYA	09-Jul-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2011	KHARKHAREE	04-Aug-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2011	HURRILADIH	18-Aug-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2011	KUYA	28-Sep-11	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2012	BADJNA	10-Apr-12	Eastern Coalfields Ltd.	> 10m and within working district	0	1
2012	MURULIDIH 20/21 PITS	09-Jun-12	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2012	SIMLABAHAL	07-Nov-12	Bharat Coking Coal Ltd.	> 10m and within working district	0	1
2008	SIMLABAHAL	25-Nov-08	Bharat Coking Coal Ltd.	> 10m but < 30m	0	1
2009	SUDAMDIH INCLINE	08-Aug-09	Bharat Coking Coal Ltd.	> 10m but < 30m	0	1
2010	MOONIDIH PROJECT	14-Dec-10	Bharat Coking Coal Ltd.	> 10m but < 30m	0	1
2012	BASANTIMATA	05-Jan-12	Bharat Coking Coal Ltd.	> 10m but < 30m	0	1
2008	MOONIDIH PROJECT	15-Jun-08	Bharat Coking Coal Ltd.	> 10m of longwall face	0	1
2008	NOONODIH JITPUR	12-Sep-08	Indian Iron & Steel Company Ltd.	> 10m of longwall face	0	1

It is clearly seen from the above Table 3 that the ratio of persons killed is quite high in Bharat Coking Coal Limited (BCCL), as compare to other

owners. A proper safety measures needs to be adopted to overcome the problem.

**Table 3. Ownerwise distribution of persons killed in Central Zone, Dhanbad, India (Source : DGMS, Dhanbad)**

Year	Name of Mine	Date of Accident	Owner	District	Killed	S/Inj.
2008	ALKUSA	08-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	TETULMARI	14-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BLOCK II OCP	14-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	KUSUNDA	16-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MOONIDIH PROJECT	16-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	LOYABAD	17-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	AMALGAMATED KESHALPUR-WEST MUDIDIH	21-Jan-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BLOCK II OCP	26-Feb-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	POOTKEE	29-Feb-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	SENDRA BANSJORA	04-Mar-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	POOTKEE	12-Mar-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BLOCK II OCP	12-Mar-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	PHULARITAND	25-Mar-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MURULIDIH 20/21 PITS	31-Mar-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	LOHAPATTI	31-Mar-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BARAREE	07-Apr-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	LODNA	05-May-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	LODNA	08-May-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MURULIDIH 20/21 PITS	12-May-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BLOCK II OCP	22-May-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	KHARKHAREE	06-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BURRAGARH	10-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	BASANTIMATA	13-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MOONIDIH PROJECT	15-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BASTACOLA	16-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	LOYABAD	27-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	KHARKHAREE	28-Jun-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	WEST MUDIDIH	12-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	BASTACOLA	16-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	JAMUNIA OCP	16-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	SIMLABAHAL	17-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	LODNA	18-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	NORTH TISRA U/G	19-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	KUSTORE	31-Jul-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BASTACOLA	03-Aug-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	KUSTORE	04-Aug-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BASANTIMATA	25-Aug-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	BASANTIMATA	28-Aug-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	SIMLABAHAL	14-Sep-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MURULIDIH 20/21 PITS	23-Sep-08	Bharat Coking Coal Ltd.	Dhanbad	0	1

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2008	BASTACOLA	25-Sep-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	AMALGAMATED KESHALPUR-WEST MUDIDIH	03-Oct-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	MURULIDIH 20/21 PITS	07-Oct-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	AMALGAMATED KESHALPUR-WEST MUDIDIH	19-Oct-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	TETULMARI	04-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MOONIDIH PROJECT	05-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	JEENAGORA	06-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	SOUTH GOVINDPUR	15-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MADHUBAND	17-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	ALKUSA	18-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	LODNA	19-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	MURAIIDIH	21-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	1	0
2008	10/12 PITS KACHHI BALIHARI	23-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	MURULIDIH 20/21 PITS	24-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	SIMLABAHAL	25-Nov-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	TETULMARI	04-Dec-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	10/12 PITS KACHHI BALIHARI	13-Dec-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	SENDRA BANSJORA	14-Dec-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2008	JEENAGORA	31-Dec-08	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	JOGIDIH	03-Jan-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	LODNA	05-Jan-09	Bharat Coking Coal Ltd.	Dhanbad	3	0
2009	KHARKHAREE	06-Jan-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	SOUTH TISRA OCP	15-Jan-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	BHAGABAND	20-Jan-09	Bharat Coking Coal Ltd.	Dhanbad	1	0
2009	SIMLABAHAL	02-Feb-09	Bharat Coking Coal Ltd.	Dhanbad	1	1
2009	BLOCK-IV/KOORIDIH	03-Feb-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	PATHARDIH	07-Feb-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	BHOWRA NORTH(PARISHABAD OCP)	07-Feb-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	PATHARDIH	13-Feb-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	SENDRA BANSJORA	18-Feb-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	P.B.PROJECT,1&2 PIT	03-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	JEENAGORA	05-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	AMALGAMATED KESHALPUR-WEST MUDIDIH	10-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	BASTACOLA	12-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	BASTACOLA	17-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	1	0
2009	SIMLABAHAL	20-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	AMALGAMATED KESHALPUR-WEST MUDIDIH	24-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	MURAIIDIH	24-Mar-09	Bharat Coking Coal Ltd.	Dhanbad	0	1
2009	TETULMARI	03-Apr-09	Bharat Coking Coal Ltd.	Dhanbad	0	1

**4. WHAT MAKES THE COAL MINES UNSAFE ?**

There are various things which make coal mines unsafe, e.g., mine ventilation, roof fall, coal dust, and methane explosion, etc. The important issue is the oxygen low-level content and inappropriate concentration of noxious gases. If the management comes to know the situation in real-time, it can take the appropriate steps to avoid the same.

**5. METHODOLOGY**

The wireless sensor network can be integrated with an external network., i.e., intranet/internet. This network should have several nodes placed at various locations of the mine. Each node needs to be fabricated with temperature sensors and gas sensors which can measure the temperature concentrations of oxygen, carbon-monooxide, methane, etc. The whole network needs to be set in a suitable topology.

The application maintains a database of all the accidents that happened in the past and can generate the reports on different aspects so that management can analyse the different points, causes, reasons, etc of accidents and can use the safety measures accordingly. This application uses appropriate software and database.

**5.1 Software and Database**

For developing any application, we first have to think upon it which platform we will be using. So many options are available., i.e., Java, php,.Net, etc. We decided to choose Java as it is platform-independent. Further we have to select which database we should work upon. There are many databases available, i.e, Oracle, SQL Server, DB2 and many more. We used My SQL for data storage as it is a open source software.

**5.2 Forms**

The Application consists of different forms. Each forms has been discussed as follows:

- (i) Add Form–This form is used to add the new details in the database. It consists of the following fields:
  - a) Year
  - b) Mine Name
  - c) Accident date
  - d) Accident time
  - e) Owner
  - f) Zone
  - g) Cause
  - h) Accident place
  - i) Killed
  - j) Seriously injured
  - k) Suggestions
- (ii) Edit/Delete Data – The data can be edited/deleted

**Data By Zone**

Year	Name of Mine	Accident Date & Time	Owner	Zone	Cause	Accident Place	Killed	Injured	Suggestions
2008	ALKUSA	2008-01-08 & 19:30:00	Bharat Coking Coal Ltd.	Dhanbad	Fall of Persons on the Same Level	Unclassified	0	1	
2009	JOGIDIH	2009-01-08 & 19:09:00	Bharat Coking Coal Ltd.	Dhanbad	Unclassified	Other belowground places	0	1	
2010	RAMKANALI	2010-01-10 & 12:10:00	Bharat Coking Coal Ltd.	Dhanbad	Other Electrical Accidents	Unclassified	0	1	

**Edit Data**

Year	Name of Mine	Owner	Zone	Cause	Accident Place	
2008	ALKUSA	Bharat Coking Coal Ltd.	Dhanbad	Fall of Persons on the Same Level	Unclassified	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
2009	JOGIDIH	Bharat Coking Coal Ltd.	Dhanbad	Unclassified	Other belowground places	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
2010	RAMKANALI	Bharat Coking Coal Ltd.	Dhanbad	Other Electrical Accidents	Unclassified	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

**Select Cause**

Select Cause:

**Select Date**

Start Date:   
End Date:

in case some mistakes have been made in adding data while using the add form.

### 5.3 Reports

The Reports can be generated and analysed using different aspects like date-wise, zone-wise, mine-name wise and cause-wise. We have different forms for generating all the reports. If report has to be seen date wise then one has to select the start date and end date and click on the show button and it will show the whole data as per the date one has provided. Similarly, one can generate the report zone-wise by selecting zone; mine-name wise by selecting mine name, cause wise by selecting causes, etc.

### 6. CONCLUSION

By using the IT-based application in coal mining industry in India, it will help the officials to easily access and integrate the critical information for deciphering the tactical decision and to provide the long-term information that senior managers requires for taking the strategic decisions. It will also be beneficial in getting information on the latest development in the coal mining industry across the globe. By this they can adopt technology by modifying that suits to their conditions. By using the web-based RDBMS the safety aspects of miners can be taken care effectively.

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### निष्कर्ष

भारतवर्ष में कोयला खनन उद्योग में सूचना प्रौद्योगिक आधारित अनुप्रयोगों के उपयोग से कर्मियों को सही निर्णय लेने में आसानी हो जाती है। साथ ही वरिष्ठ प्रबन्धकों को सामरिक निर्णय के लिए सूचनाएँ उपलब्ध हो जाती हैं। इससे विश्व में कोयला खनन उद्योग में हो रहे अद्यतन विकास की सूचना प्राप्त करने में भी सहायता मिलती है। इसके द्वारा उन प्रौद्योगिकियों को अपने यहाँ अपनी परिस्थितियों के अनुरूप उपयोग में ला सकते हैं। वेब आधारित आर डी बी एम एस के उपयोग से खनन प्रक्रिया की सुरक्षा का ध्यान रखा जा सकता है।

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# सूचना और सॉफ्ट तकनीक का जल संसाधन परियोजनाओं पद्धतियों की समीक्षा

## Review of Information and Soft Computing Technique Approaches in Water Resources Projects

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### सारांश

कम्प्यूटेशनल तकनीकों के उपयोग के युग में, जल संसाधन परियोजनाओं की बहुमुखी संवादात्मक प्रक्रियाओं को साफ्ट कम्प्यूटिंग से निर्मित नवीनतम सूचना और डेटा कम्प्यूटेशनल तकनीकों का उपयोग करते हुए विश्लेषण किया जा सकता है। सूचना और सॉफ्ट कम्प्यूटिंग तकनीक पद्धतिया: फजी, ए एन एन, वेवलेट, एस वी एम, आर एस, जी आई एस तकनीक व्यापक रूप से जल संसाधनों से जुड़े विभिन्न क्षेत्रों में उपयोग होती हैं। आभासी मॉडलिंग (वीएम) की सूचना और सॉफ्ट कम्प्यूटिंग तकनीक विधियों ने गैर रेखीय जल संसाधन घटकों के अनुसंधान और अभ्यास में और उपलब्ध डेटासेट में छुपी हुई सक्रियता और शोर की बड़ी मात्रा के प्रबंधन में अच्छा कार्य किया है। इस आलेख में लेखकों ने जल संसाधनों के विभिन्न क्षेत्रों में उपयोग की जानी वाली विभिन्न सूचना और कम्प्यूटेशनल तकनीकों पर चर्चा की गई है। जल संसाधन परियोजनाओं को विश्लेषण करने के लिए प्राप्त डाटा और सूचना आधारित साफ्ट कम्प्यूटिंग को जोड़ना ही एक विधि हो सकती है।

### ABSTRACT

In the era of the use of computational techniques, multifaceted interacting processes of WRP can be analyzed using the latest information and data computational techniques, which mainly comprises of soft computing. Among the broader applications of ISCT approaches; Fuzzy, ANN, Wavelet, SVM, RS, GIS are widely used in different fields of water resources. The Information & Soft Computing Techniques (ISCT) methods of virtual modelling (VM) have shown promise in research & practice of non-linear water resources components and in management large amounts of dynamicity and noise concealed in available datasets. In this paper the authors have discussed the different information & computational techniques used in the various fields of water resources. Observed data (physical data) coupled with information based soft computing can be the method of choice for analysis of water resources projects in totality.

**Keywords:** Information and soft computing techniques, fuzzy, ANN, wavelet, SVM

## 1. INTRODUCTION

Water Resources, a broad sense of social responsibilities, is the most challenging area of research & management around the world. Successful water management involves concerns from multifaceted interacting processes with most inviting competing claims. To accommodate the competing claims better planning, implementation, monitoring and evaluation of Water Resources Projects (WRP) is required. In view of the recent advances in water management only a holistic and trans-disciplinary approach can prove to be useful. WRP has to deal with social, environmental, technical, legal, economics and policy aspects; the outcomes of which help sustain both the water resources as well its dependants. To ensure more effective, efficient and transparent results, comprehensive knowledge of all the basic components of water resources is required. Water resources

projects can be divided five broad categories; named hydrology, Hydraulics, Geomorphology, Management & Socioeconomics.

Advances in geospatial technologies (GPS, RS and GIS) have enabled quick and precise data acquisition and accurate and in depth investigation of the components of water resources project. Recent years; Information & Soft Computing Techniques (ISCT) approaches have seen a significant rise in water resources research sector. Despite the flexibility and usefulness of physical methods in research of water resources processes, they have some drawbacks with extremely non-stationary & random responses. The efficient performance of ISCT approaches such as data-driven models has been reported over a wide range of water resources components; hydrology (e.g., precipitation, stream-flow, rainfall-runoff, sediment load, water quality,

groundwater level & contamination, etc.), hydraulics (e.g., water level, velocity & turbulence, scour depth, discharge coefficient, sediment transport), water resource management (flood forecasting, risk assessment, conflict resolution, transboundary issues)

Fuzzy techniques offer an approach to incorporate & integrate information in a water resources research when statistical information is not available. Due to its great flexibility in coping with less available data, fuzzy logic theory has found numerous successful applications in water resources projects. Dynamical behaviors of fuzzy systems in reservoir operations have proven better alternative to other conventional techniques. A novel approach based on neural network and fuzzy logic has been successfully applied in the area of hydraulic research also.

Artificial Neural Network (ANN) is an influential processing tool which has been used in water resources research. Processing time series components of WRP with ANN requires some sort of preprocessing stage for data reduction such as Wavelet Transform (WT) in order to gain advantages in training time & also to pass up redundancy in input data and to obtain a model with better generalization ability. This is the reason why integration of WANN found with better results in different aspects in water resources. Support Vector Machine (SVM) which can achieve a nonlinear mapping from an original input space into a high dimensional feature space with less prior assumptions about the input data & to maximize the classification margin, therefore possessing better generalization ability.

## 2. HYDROLOGY AND ISCT

Rainfall and Runoff are an issue of enormous concern among hydrologists, as it is used to quantify surface & groundwater flows. Both rainfall and runoff are highly non-linear & stochastic hydrological processes, spatially as well as temporally. Consequently, the process mapping method (ANN, SVM, GA) coupled with data characteristic separating techniques (Wavelet) can be integrated successfully through fuzzy logic theory for above mentioned hydrological processes. Hourly, Daily & Monthly stream flow was reproduced using ISCT approaches. The multi-layer feed forward neural network (MFNN) is one of the most important ANN architecture used for stream flow forecasting. ANN-fuzzy model shows better prediction accuracy and generalization capability in comparison to the ANN models. Artificial neural network was found to be a suitable predictive tool for average monsoon rainfall over India. Scaling structure of temporal rainfall using wavelet was examined by Venugopal. Introduction of new wavelet theory along with ANN, SVM & Fuzzy improved the rainfall prediction pattern.

ANN has been also implemented to get synthetic rainfall series & rainfall erosivity indices. Unlike the conventional rainfall-runoff model, the ANN seeks to learn patterns and not to replicate in detail the physical processes involved in transforming input into output. Integration of wavelet decomposition to ANN improved the efficiency of rainfall-runoff models. Relationship between discharge and sediment using Fuzzy, SVM & GA was also mentioned in available literatures.

Along with surface hydrology, groundwater hydrology was equally important as well as complex water resources components. Study found that the WANN model was substantially more accurate than the best ANN model for ground water level forecasting. Wavelet added additional components in the analysis of groundwater datasets. The sensitivity analysis of ground water showed that ANN-Fuzzy models were sensitive to the number of fuzzy sets, nature of the rule weights, shape of the fuzzy sets, and validation techniques used during the learning processes. Integration of GIS and ANN-Fuzzy systems permitted sensitivity analysis of the models and facilitated the exhibit of outcome in a spatial context. The contaminant concentrations in groundwater predicted from a numerical model using fuzzy probabilistic approach.

## 3. HYDRAULICS AND ISCT

Uses of ISCT approach in the field of hydraulic are relatively newer than hydrology. Prediction of hydraulic characteristics such as mean velocity, turbulence, water-level etc. is very important when measurements are unavailable or inadequate.

The neural structure is competent of generating a comprehensive multipoint time record with the same structural characteristics and basic statistics as those of the original instantaneous velocity field. An artificial neural network, based on fuzzy, that is capable of learning the basic nonlinear dynamics of a turbulent velocity field. Comparison results indicated that the ANN-Fuzzy model performed better than the ANNs and regression models in mean velocity estimation. To extract coherent vortices, the turbulence series was successfully decomposed using Wavelet. The successful predictions of turbulence using neural networks encourage producing more data for analysis.

Scour depth near bridge pier using ISCT approaches has several examples. It shows that the neural networks and ANN-Fuzzy approaches predict scour depth much more accurately than the existing methods. Along with scour depth; measuring water level with the help of ISCT approaches are found very frequent in literature. ANN-Fuzzy hybrid approach was used to construct a water level forecasting system during flood periods. ANN model was used to estimate the water level during an irrigation period along the main drainage canal in

the Chiyoda drainage basin. A different solution was also presented to the expert system, using SVM to forecast the daily dam water level.

An ANN-Fuzzy model was developed to determine the discharge coefficient of the trapezoidal labyrinth side weirs & it was found better than ANN model. The ANN-Fuzzy model reduced the root mean square errors and mean absolute errors with respect to the non linear regression by 27%. ISCT approaches were applied in the area of sediment transport as well as suspended sediment concentration. The results indicate that the ANN model gives inferior results in relative to the Fuzzy & ANN-Fuzzy models. The reason behind this may be the fact that the Fuzzy & ANN-Fuzzy model are more flexible than the ANN model considered with more options of incorporating the fuzzy nature of the real-world system. Fuzzy logic and artificial neural networks was also used in past for estimation sediment transport rate. The channel morphology & the gravel bed river topography was examined with the help of wavelet in conjunction with GIS. Degree of complexity can be also evaluated using wavelet reconstruction.

#### 4. WATER MANAGEMENT AND ISCT

A fuzzy approach was applied frequently within the context of water resource management under uncertainty. The approach allows various sources of uncertainty and is intended to provide a flexible form of group decision support. The use of fuzzy logic in the field of flood forecasting by several researchers and it shows the significant results. ANN model was applied for real-time flood forecasting of the Tiber River in Rome.

In water management, conflicts of interests are inevitable due to the variation in demands and the number of stakeholders involved. Fuzzy cognitive maps can be used for identification of issue in water resources conflict resolution. In many respects, water resources allocation problems have fuzzy characteristics owing to uncertainty and imprecision not only as numerical data but also as linguistic data, in addition to the political nature of resource allocation. The application of fuzzy logic and game theory in water resources allocation is found in case of Turkey, Syria, and Iraq and the same has been used in water resource allocation among different stakeholders. Along with allocation, the coalition possibilities can also be studied using fuzzy. Fuzzy synthetic evaluation technique was applied to predict transboundary river basins at risk which addresses the issue of water conflict and cooperation within a methodologically more rigorous predictive framework.

#### 5. CONCLUSION

1. The use of ISCT has been wide spread in hydrology, gaining interest in hydraulics as well. This review suggests a more integrated and comprehensive approach of ISCT in hydraulics.
2. Fuzzy logic and Game Theory has been widely used in water management, be it among various demands of stakeholders or riparians. It can be proposed to incorporate different methods of ISCT for water resource management. Wavelet can be to reduce uncertainty of data and ANN & SVM can be used for functional mapping of the water resource components.
3. The application of ISCT approaches in the socioeconomic aspects of water resources is very scarce. As the need of socioeconomic studies is deemed important in developing as well as developed countries, it is proposed to use ISCT approaches to study the socioeconomic aspects of water resources.

#### निष्कर्ष

- 1 सूचना और सॉफ्ट कम्प्यूटिंग तकनीक का उपयोग व्यापक रूप में हाइड्रोलोजी (जलविज्ञान) में हो रहा है और जलविज्ञानशास्त्र में बढ़ता जा रहा है। यह समीक्षा सूचना और सॉफ्ट कम्प्यूटिंग तकनीक की एकीकृत और समग्र पद्धति की हाइड्रोलिक्स में उपयोग की सलाह देता है।
2. फजी लॉजिक और गेम थ्योरी को व्यापक रूप से जल प्रबंधन में इस्तेमाल किया गया है, और यह हितकारकों विभिन्न मांगों में शामिल हैं। इन्हें जल संसाधन प्रबंधन के लिए सूचना और सॉफ्ट कम्प्यूटिंग तकनीक के विभिन्न तरीकों में प्रस्तावित किया है। वेवलेट डेटा की अनिश्चितता को कम करता है और ए एन एन और एस वी एम को जल संसाधन घटकों के कार्यात्मक मानचित्रण के लिए इस्तेमाल किया जा सकता है।
3. सूचना और सॉफ्ट कम्प्यूटिंग तकनीकों की उपयोगिता जल संसाधनों के सामाजिक-आर्थिक पहलुओं में बहुत दुर्लभ है। क्योंकि सामाजिक-आर्थिक अध्ययन की जरूरत को विकासपील एवं विकसित देशों में महत्वपूर्ण समझा जाता है इसलिए सूचना और सॉफ्ट कम्प्यूटिंग तकनीक पद्धतियों को जल संसाधनों के सामाजिक-आर्थिक पहलुओं का अध्ययन करने में उपयोग करने का प्रस्ताव है।

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## उपग्रह संचार प्राद्यौगिकी द्वारा जल प्रबंधन व्यवस्था Satellite Communication Technology for Water Management Systems

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### सारांश

विश्व में उपलब्ध उपग्रह संचार अनुसंधानों ने विज्ञान और प्राद्यौगिकी तथा समाज के समग्र विकास में अभूतपूर्व योगदान दिया है। ज्योस्पेसियल डाटा (GRATI और NSDI) के कुछ अनुप्रयोग जल प्रबंधन, उच्च शिक्षा सुधार, दूर संचार, भूगोल (डिजिटल मानचित्र), रक्षा, कृषिक्रान्ति, टेलीमिटी, भूमंडलीय अध्ययन उल्लेखनीय हैं। पेयजल स्रोतों की निकटता, पहुँच, उपयोग और सतत् उपलब्धता को विश्व की अनेक चुनौतियां प्रभावित कर रहीं हैं। संयुक्त राष्ट्र के एक आंकलन के अनुसार 2025 तक शुद्ध पेयजल की मांग आज की तुलना में 60 प्रतिशत अधिक और 2050 तक विश्व की जनसंख्या 7 अरब से 9 अरब हो जायेगी। भारत 24 प्रतिशत भौगोलिक क्षेत्र और 4 प्रतिशत जलस्रोतों से विश्व की 17.5 प्रतिशत जनसंख्या का जल प्रबंधन करता है। विश्व का सर्वाधिक 10,000 से 12,000 मि.मी वार्षिक जलसिंचन वाले अरुणाचल प्रदेश के बाबजूद भारत के प्रत्येक नागरिक को शुद्ध पेयजल उपलब्ध नहीं है। सरकारी अभिकरणों को उपग्रह संचार प्राद्यौगिकी के उपयोग से जल प्रबंधन व्यवस्था का यथाभूत ज्ञान तत्काल प्राप्त होता रहता है, परिणामस्वरूप जलस्रोतों और संस्थानों की जलगुणवत्ता और मात्रा की उपलब्धता में सुधार के साथ जल बिलों में कमी और जनस्वास्थ्य सुरक्षा नियंत्रण करने में सहयोग मिल जाता है। इस शोधपत्र में उपग्रह संचार प्राद्यौगिकी द्वारा जल प्रबंधन व्यवस्थाओं का दूरस्थ मॉनीटरिंग प्रणालियों के प्रयोग का विवरण और लाभ वर्णित किया गया है। इसके अंतर्गत जल प्रबंधन में प्रयुक्त मॉनीटरिंग प्रणालियों के 6 चरण हैं—जलस्रोत, जलप्रवाह, जलखपत, जलसंग्रह, जलगुणवत्ता और जलवायु निरीक्षण। जल निरीक्षण व्यवस्था में जल अभिकरणों को उपलब्ध कराये गये उपग्रह संचार आधारित टर्मिनलों द्वारा चरम समय चेतावनी तत्काल मिलती रहती है, जिससे दूरस्थ स्थानों की आपात स्थिति का आंकलन कर उपयुक्त सुधार कर लिया जाता है। इन प्रणालियों द्वारा प्राप्त डाटा अभिकरणों को उचित ज्ञान और नए यंत्र व साधन उपलब्ध कराने का अवसर देता है, जो जल प्रबंधन की जलस्रोतों से लेकर जल संग्रह तक की समस्त समस्याओं के समाधान में उपयोगी होता है।

### ABSTRACT

Today world is facing a number of challenges affecting the availability, accessibility, use and sustainability of its fresh water resources. According to UN estimates by 2025, the demand for fresh water resources will rise by nearly 60% more than is currently available. By 2050 the global population is forecast to reach 9 billion an increase from 7 billion in 2014. By using satellite communication technology in Water Management Systems government agencies gain real time knowledge of water resources, their quality and quantity while improving availability, reducing costs and improving public safety. The paper discusses some of the satellite communication technologies and the benefits of implementing remote monitoring processes in the 8 stages of water management. Water monitoring systems, which include sensors and satellite based communication terminals, offer water agencies the ability to receive time-critical alerts immediately and improve emergency response. Information collected with these systems also provides agencies the tools and knowledge to implement everything from water source monitoring systems to water conservation, fault detection and water metering initiatives.

**Keywords:** Satellite communication technology, water management systems, water monitoring

### 1. INTRODUCTION

According to a recent United Nations report, stresses on water supplies aggravated by climate change are likely to cause more conflicts, and water should be considered as vital to national security as

defence. The report points out that 145 countries share watersheds with neighbours and there are more than 300 trans-boundary aquifers from which groundwater can be extracted. Yet, we still do not fully understand how much water is available and how it is distributed,

which is a requirement for planning how to deal with changes in climate and, particularly, in rainfall. This knowledge gap is due to limitations in the relevant science and technology, the vastly insufficient number of sensors deployed around the world, especially in developing countries, and data denial by many governments due to security concerns.

Matteo Luccio has stated that under NASA water related satellite missions different sensors and techniques have been employed to measure water on earth distributed in oceans, seas and lakes, atmospheric moisture, deep underground aquifers, snow, ice sheets and sea ice. Satellite based communication technologies available to-day has benefited in overall development of S&T and growth of society. Some of the new applications of Geospatial Data (GRATI & NSDI) are in smart water management, higher education reforms (curriculum development), geography (digital cartography & maps), student's spatial cognition and in defense, agriculture revolution, telemetry, geo-sphere etc. Although water purification technologies and water reuse systems have provided solution to a large urban population in many countries.

Smart water management has become a key policy issue for the 21<sup>st</sup> century, as a growing number of factors are impacting the delivery of already scarce fresh water to millions of people. Economic growth, seasonal climatic conditions and rising population are all affecting availability of water resources. Moreover, a number of effects linked to climate change, such as lengthy droughts and extreme weather events, are worsening the situation. ICT can be a strategic enabler for smart water management policies and surveys upcoming ICT standards that will enable smart water initiatives.

## 2. STATUS OF WATER MANAGEMENT

Pressure on the world water resources has been growing at an inexorable pace. The global survey has revealed that unsustainable consumption, urban population, catastrophic effects of climate change such as droughts and flooding continue to diminish and degrade the world's water resources. The consequence of global warming on the world's glaciers further threatens the future supply of water in many countries. In India glaciers of the Himalayas and the Tibetan plateau accounting 70 percent of water flowing in the Ganges are retreating at a rate of 10 to 15 meters a year and ground water tables are also falling at a rate of 0.4 meter a year. The loss of melt water supplied to Ganges would cause water shortage for 500 million people and 37 percent of India's irrigated land according to National Institute of Hydrology, Roorkee, Uttarakhand, India.

Sustained supply of safe and potable water is of paramount importance in promotion of health and well-being of the people. Today world is facing a number of challenges affecting the availability, accessibility, use and sustainability of its fresh water resources. Global studies show a challenging future and a chaotic view, when considering total use and water availability in third millennium. Projections of per capita all purpose water availability will drop from 1000-5000 m<sup>3</sup> per year to-day to less than 1000 m<sup>3</sup> of water per year by 2030 in many developing countries. Globally, fresh water is consumed at a rate that is doubling every 20 years. According to UN estimates by 2025, the demand for fresh water will rise by nearly 60 percent more than is currently available. By 2050 the global population is forecast to reach 9 billion an increase from 7 billion in 2014. Currently more than 1.1 billion people lack access to clean drinking water and 2.6 billion people lack adequate sanitation with 500 million people from India. UN report (2008) states to-day's urban population of 3.2 billion will rise to nearly 5 billion by 2030, when 3 out of 5 people will live in cities. The UN considers this rising trend to be the most significant influence on the welfare and economic security of nations, environmental sustainability and the achievement of human rights around the world.

An integrated approach including water management with satellite technology with all water sectors – R&D, water supply and sanitation demands, agriculture, energy development and environmental management must be acted upon in order to alleviate water shortage. To meet these challenges, the World Water Commission has been created. UN proclaimed the decade 'Water for Life 2005-2015' with goals - greater focus on water related issues, safe drinking water and participation of women.

India occupying 2.4 percent of the total surface of globe with 4 percent of the fresh water resources and highest annual average rain fall of 10,000 to 12,000 mm in Arunachal Pradesh is not able to provide safe drinking water and sanitation systems to our all countrymen. Further the problem of excess salinity, iron, nitrate, fluoride and arsenic in ground water is endemic covering a large population in different states, who are at risk. Government of India under National Water Policy approved in 1987 and National Drinking Water Mission started in 1986 has launched a number of multipurpose projects through different ministries, S&T departments, councils, national institutes and universities to provide safe water for drinking, industries, agriculture, recreation etc. The mission aims at finding low cost treatment for problems of arsenic, iron, fluoride, salinity and brackishness,

bacteriological contaminations, improving the charges of ground water and wetland systems and developing the traditional water retention structures in hill, desert and tribal areas through use of appropriate technology. The approach will help in achieving UN Millennium Development Goal of 2015 set by UN.

Water purification technologies for provision of safe drinking water have been successfully developed. Problems of high salinity and brackishness, arsenic, iron, fluoride and bacteriological contaminations have been solved and treatment plants developed for domestic, community and industry level needs are in use. The use of membrane technologies – reverse osmosis (RO), electro-dialysis (ED), ultra-filtration (UF), micro-filtration (MF) and nano-filtration (NF) and their combinations (like UF-RO, ED-RO, UV disinfection etc.) for aqueous separations have become very popular over the past twenty years. Development of polymeric and ceramic membranes in India have advanced the use of UF, MF, RO and pervaporation applications in water treatment, industrial separation processes and pollution control applications. Recent advances show that improved water quality could be achieved using nano-particles either embedded in membranes or on other structural media. R&D programmes around the world focusing on nano-technology promise breakthroughs in energy efficiency, enhanced membrane performance and even new approaches to trapping and treating contaminants using nano-sponges and new carbon nano-tube filters. The better operational results have been reported by the use of a thin film (20 to 200 microns) of positive charge media on a one-micron or large screen than a MF or UF membrane.

By using satellite communication technologies in water management systems, government agencies will gain real-time knowledge of water quality and quantity of water sources of remote locations in rural, hilly and tribal areas, while reducing cost of water bill of raw and purified water and improving public safety. Satellite for reporting alarms and telemetry, functioning of membranes, bio-filters, meters, pumps and other plant components are being effectively used in many countries.

The author as Programme Director of a major Desalination Project, Member of Research Advisory Committee, National Drinking Water Mission, Expert Member, DST, Government of India and President, Indian Desalination Association has monitored over hundreds of desalination plants and water supply schemes up to 1 mgd installed in the country and visited pioneer industries of water purification in US and Europe. Under the project desalination plants developed by DRDO were installed and operated in remote villages of Rajasthan desert associating RRSC, NRSC, ISRO, Jodhpur for satellite messaging and

BARC, Mumbai for RO plants.

One way to meet these requirements in any country is to gather and analyze water quality and quantity data as it travels from source to consumer and back. Water monitoring data is not only used for regulatory and operational decision making and historical record keeping but also to evaluate the effect of measures of implement to improve total water resource management.

### **3. WATER MANAGEMENT WITH SATELLITE TECHNOLOGY**

This paper discusses 8 stages of water management with satellite technology:

#### *Stage I – Water Source*

Both surface and ground water sources can be monitored with sensors. Monitoring systems with integrated satellite based communication capabilities can cut down the cost associated with gathering and analyzing remote data. River Basin Atlas India (2012) prepared by Central Water Commission of Water Resources Ministry and RRSC (West), NRSC, ISRO, Department of Space, Jodhpur, India under the project Water Resources Information System (WRIS) will be very useful for diverse uses.

#### *Stage II – Water Flow*

Water flow is measured in cubic feet / per second and is calculated using depth and velocity of a stream. Satellite based communication terminals allow flow monitoring data from remote devices like stream gages or agricultural water meters to be downloaded to a central location in near real time, eliminating the delays and data integrity loss associated with manual data collection. In addition to monitoring and sending data from sensors, satellite based communication terminals can be used to remotely control equipments such as pumps, valves, gates or water purification plants. For example in canal management the gates can be remotely operated at low cost using two way satellite communication equipments. If the canal or sub canals is used for delivery of water to customers head gates that direct water into each sub canal can also be controlled remotely to decrease costs and improve customer service.

#### *Stage III – Water Consumption*

Irrigation, industry and thermo electric power generation are major consumers of water. In India about 70 percent water is used by farmers. In farming activities to avoid water waste and conform to conservation mandates, water monitoring systems can ensure that neither too much nor too little water is used. Both weather and soil moisture sensors can be monitored and data sent to a central location for analysis. In

all applications, water recharging the water table can be monitored.

#### *Stage IV – Water Conservation*

In all uses of water in agriculture, industry and all other application water returning to the water table can be monitored for quantity and chemical quality. In India rain water harvesting and conservation in ground water wells have shown remarkable result of recharging the aquifers.

#### *Stage V – Water Treatment and Reuse*

Treatment of sewage water and reuse of water along with wet land developments by using satellite messaging terminals can be monitored. Sea water and brackish water reverse osmosis (SWRO and BWRO) and other desalination major plants producing drinking water can also be monitored at remote locations for water quality/quantity, functioning of valves, membranes, water source, control devices etc.

#### *Stage VI – Water Quality*

Water quality monitoring and waste water monitoring involve examination of the physical, chemical and biological character of water as per laid down water standards for factors posing risk to human and life stock health as well as the environment. Water quality sensors can be installed in water works, water treatments systems, and reservoirs or downstream from a potential contamination source as part of a large water monitoring system. The timeliness and accuracy of water quality data leads to many benefits including reduced costs associated with cleanups and increased public safety.

#### *Stage VII – Water Monitoring*

Weather events have significant impact on water quality and quantity. Satellite based monitoring systems can be used to reliably download all weather station data, monitor for events like floods or overloading of sewer systems and feed data into irrigation and other water management systems.

#### *Stage VIII – Water Metering and Other Applications*

To detect leaks due to breaks in pipelines as well as automatic meter reading satellite messaging terminals are being used effectively to communicate with the satellite constellations. The system downloads and sends water reading from each meter at the same time each day. This alerts water agency and customer to check leakage and above normal consumption.

Weather conditions and events that are monitored include – rainfall intensity and duration, temperature,

solar radiation, wind direction and speed, relative humidity, soil moisture, leaf wetness, snow pack, weather monitoring for mining companies, etc.

## 4. CONCLUSION

Satellite technology is free from political boundaries like atmospheric moisture, rains and groundwater. As the technology improves and water scientists and technologists find out better solution for use of all types of water resources there will be better future opportunities for collaboration rather heightened conflicts among nations. We will see in the developing world a lot of people may use water as a means to collaborate rather than to fight.

## निष्कर्ष

उपग्रह संचार प्राद्यौगिकी वातावरणीय आर्द्रता, वर्षा और भूमिगत जल जैसी राजनैतिक सीमाओं से मुक्त हैं। जैसे जैसे इस प्राद्यौगिकी का विकास होगा, जल वैज्ञानिक और टैक्नालॉजिस्ट्स सभी प्रकार के जलस्रोतों का भविष्य में और अधिक उपयोग की दिशा में नए अवसर प्राप्त कर लेंगे ताकि आपसी समझ और सहयोग से जल विवाद की समस्त समस्याओं का सार्थक समाधान निकाल सकेंगे। हम सभी इस प्राद्यौगिकी विकास के साक्षी बनेंगे जब विश्व के अनेक देशों के लोग जल को आपसी विवादों को निपटाकर परस्पर जोड़ने वाला होगा और “वसुधैव कुटुम्बकम्” को चरितार्थ करेगा।

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## दंत चिकित्सा और रोगी प्रबंधन में नवीनतम उपकरण और तकनीकें Latest Tools and Techniques in Dental Practice and Patient Management

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### सार

यह पत्र दंत चिकित्सा के क्षेत्र में नवीनतम प्रौद्योगिकीय विकासों के संबंध में विस्तृत चर्चा करता है। उपयुक्त उदाहरणों के साथ यह दंत चिकित्सा में नवीनतम प्रवृत्तियों को रेखांकित करता है और बताता है कि किस प्रकार इस प्रौद्योगिकी ने न केवल दंत चिकित्सकों के लिए बल्कि रोगियों के लिए भी कार्य को आसान बना दिया है। यह पत्र व्याख्या करता है कि किस प्रकार उपचार की गुणवत्ता ने समुदाय की मौखिक स्वास्थ्य स्थिति में सुधार किया है क्योंकि पारंपरिक मौखिक स्वास्थ्य देखभाल उपचार प्रक्रिया में प्रगतियों द्वारा प्रतिस्थापित कर दी गई है जो अधिक सटीक और दीर्घ स्थायी परिणामों वाली साबित हो रही हैं।

### ABSTRACT

The paper discusses in detail about the latest technological advancements in the field of Dentistry. With suitable examples it highlights the latest trends in dental practice and how this technology has made tasks easier not only for the dentists but for the patients also. This paper explains how the quality of treatment has improved immensely the oral hygiene status of the community as traditional oral health care been replaced by the advancements in the treatment procedure which are proving more accurate and long lasting results.

**Keywords:** Dentistry, online OPD, dental practices

### 1. INTRODUCTION

The history of man's fight for health begins with what little is known about his earliest existence when he was completely at the mercy of nature with no effective means of combating its hazards. Research in medical and dental technology has resulted in a dramatic acceleration in health knowledge.

Although the speciality of dental Public Health evolved from organised dentistry, the philosophy regarding development and implementation of dental programmes to serve the public is often different between the two. The difference arose because the focus of the dental practitioner is the individual patient and the focus of the dental public health practitioner is the overall community.

The dental public health field has been expanding in scope and complexity with more emphasis being placed on the total dental care delivery system and its impact on oral health status.

The trend in dentistry is utilising technology to make dentistry more comfortable, durable, efficient and natural-looking for the patient as possible. Patients and

their dentists benefit from newer techniques that are less invasive and less painful and more dependable than the traditional ones. Procedures that took multiple trips to the dentist or required multiple teeth care now can be attempted in a single sitting.

There are many new advancements in dentistry that a dentist may choose to offer for an enhanced state of comfort and improved oral health. These dental advances play an important role in the comfort of the patients as well as the dentists, dental specialists, hygienists, and office managers at the practice, allowing them to provide the highest standard of dental care possible.

### 2. MOBILE DENTAL VAN

It is the latest outreach programme for providing the dental health care for unreachable. There are villages and towns where people are uneducated or have little access to dental hospitals. For those needy people who have low socio-economic status, mobile dental clinic is a boon. Here, the patients get complete dental care in their villages/towns at a very nominal cost and

various treatments free of cost even which otherwise may not be afford by poor people. This mobile clinic has all the facilities like dental chair, suction unit, extraction forceps, scalers, and all other necessary instruments and emergency kit for various treatment procedures ranging from fillings, extraction of teeth, scaling/cleaning of teeth, oral health education, fluoride treatments, dental sealants, as well as counseling in the prevention of tobacco. This facility has improved the lives of various young, and old age people. There are facts to prove that school children in these villages and towns where mobile dental facility is available have a much better oral hygiene and dental health awareness as compared to school children who have no exposure to such facility.

### 3. ONLINE OPD

Online OPD is getting importance day by day as hospitals are encouraging a paperless approach. Earlier, patients had to carry their files relating to their case histories and the ongoing treatment details. But nowadays with the advancement in the field of technology we have software for medical fields also. This software helps in the patient data collection and data storage which can be saved and produced by the hospital staff whenever needed. With this software appointments can be given online and patients can be reminded for the subsequent follow-ups. It not only provides accuracy but also authenticity of the records and recall appointments. All the details for the payments and medication prescribed by the clinician can be retrieved whenever necessary. It also eliminates the need for saving record files in the store room and wastage of tons of paper hence contributing to an eco-friendly environment.

### 4. CAD/CAM

Computer Assisted Design/Computer Assisted Manufacture technologies are used in various industries other than dental field to provide highly accurate design of items or materials to be constructed. In the world of dentistry this advance technology allows for the design and fabrication of dentures for completely edentulous and partially edentulous patients for replacing their missing teeth, dental restorations that resemble the appearance and feel of natural teeth. This type of new dental technology can be used for dental bridges, inlays/ onlays, porcelain veneers, implants, orthodontic appliances and crowns, etc.

#### 4.1 Benefits

It allows single sitting procedure which were done in multiple visits before. For instance crowns

and bridges which used to take 2-3 visits now can be done in a single sitting. There are evidences to prove that CAD/CAM restorations are stronger than the traditional cavity filling techniques. These advancements automatically provide a good experience to the patients to the dental offices and a far better satisfactory result to the clinician too.

### 5. USE OF LASERS IN DENTISTRY

Lasers have been used in dentistry since 1994. It is used in removing the carious part within a tooth and also to prepare the surrounding enamel for restoration/filling. Furthermore, it can be used to harden a restoration with its heating effect.

During root canal treatment, it is used to disinfect the roots by removing any periapical pathology or may be a tooth abscess. It also helps in reshaping the gums and aid in removing bacteria from the oral cavity.

It is also used in biopsy, which is removal of a small tissue piece. This can be used for examination of cancerous cells.

### 6. TEETH BLEACHING/TEETH WHITENING

Tooth whitening is very popular dental cosmetic treatment nowadays. More of the younger generation is conscious about their esthetics and smile. Dental bleaching is one such cosmetic treatment which helps in removing the yellowish coloured layer from the surface of the tooth and makes it whiter and shining with the help of bleaching solution. Lasers activate the peroxide bleaching solution applied on the teeth to speed up the whitening process and hence give the better result.

#### 6.1 Benefits

- It reduces the need for anesthesia as it is a relatively painless procedure and the uncomfortable feeling of numbness is eliminated.
- It also minimize bleeding and swelling during soft tissue treatments.

### 7. CONCLUSIONS

The latest technologies in the field of dentistry have improved the quality of dental treatment in comparison to the traditional dental practices. These technologies not only reduced the time and effort of the dentist but have significant impact on the quality of the services rendered. People are becoming more aware and educated by the dental health camps and especially from the facility like mobile dental clinic. Oral hygiene index in the areas where camps are organised on regular basis are proving to be fair.

**निष्कर्ष**

दंत चिकित्सा के क्षेत्र में नवीनतम प्रौद्योगिकियों ने पारंपरिक दंत चिकित्सा पद्धतियों की तुलना में दंतोपचार की गुणवत्ता बढ़ाई है। इन प्रौद्योगिकियों ने न केवल दंत-चिकित्सक के समय और प्रयासों को कम किया है बल्कि दी जाने वाली सेवाओं की गुणवत्ता पर महत्वपूर्ण प्रभाव डाला है। लोग दंत स्वास्थ्य शिविरों द्वारा और विशेषकर मोबाइल दंत क्लिनिक जैसी सुविधाओं के माध्यम से अधिकाधिक जागरूक बन रहे हैं। जिन क्षेत्रों में नियमित आधार पर शिविरों का आयोजन किया जाता है, वहां मौखिक स्वास्थ्य सूचकांक बेहतर साबित हो रहा है।

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## सूचना प्रौद्योगिकी के क्षेत्र में सैन्य प्रणाली के लिए वाह्य ऊर्जा स्रोत Portable Energy Source in the Area of Information Technology for Soldier System

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### सारांश

युद्ध कर चित्रपट भी बदला है। समय के साथ-साथ आर्मी और सुरक्षा के लिए मजबूत सैन्य की भी आवश्यकता बढ़ी है। सूचना प्रौद्योगिकी युद्ध के चित्रपट को भी प्रभावित कर रही है। भविष्य में एक पोर्टेबल शक्ति के स्रोत के रूप में उच्च दक्षता एवं उत्पादकता के साथ रिचार्जबल बैटरी प्रणाली सूचना के प्रभावी संचार के लिए प्रमुख तकनीक की आवश्यकता होगी।

### ABSTRACT

With the progress of civilisation, war landscape has changed from time to time. The requirements of soldier have also changed concomitantly. Information technology (IT) has been influencing the war tactics and practices. New electronic gadgets are coming up in a continuous manner to cater the demands of Defence sector. To run any electronic gadget for communication purpose, it requires electric power. Presently, the soldiers in the field are using batteries for communication purpose; but such batteries have limited life which can adversely affect the efficiency of the war field. Without portable power or battery system, all electronic devices and appliances howsoever hi-tech will become useless burden. In future, the development of rechargeable battery system with extremely high efficiency and reproducibility as a portable power source will be a major technical requirement for effective communication of information.

**Keywords:** Soldier system, portable energy source

### 1. INTRODUCTION

Battle or war, in some form or other, was known even in near prehistoric era and was well documented in the text of Ramayana and Mahabharata. The pattern and form of war changed over the years with the progress of civilization and culture. Obviously the requirements of soldier's need have changed enormously with time.

The first World War took place in 1914. War is a reality but is not a pleasant thing to happen. Year 2014 was the centenary year of 1<sup>st</sup> World War. Although war is generally not required to be celebrated; however, it could recall the history such that we can assess and understand the events and situations of civil as well as the Defence sectors. With further progress of history, 2<sup>nd</sup> World War occurred but it happened for a longer period of time precisely during 1939-1945 and that occurred after 25 years of 1<sup>st</sup> World War. War was

a reality and world community witnessed the grim aspect of war! Thank God, world is yet to witness the 3<sup>rd</sup> World War even 70 years after 2<sup>nd</sup> World War. On the other hand, we find there is proliferation of some other kind of war of competition and cold war diplomacy as understood from the experts' views that direct physical fighting will be slowly losing its importance with the emergence of dominance of intelligence where information and communication technology can play important role. Advanced countries regularly displaying their technological and intellectual might and doing economic transactions with the help of information technology through internet. Understandably, a single click of mouse can erase out the records and documents of vital information and data which can adversely affect the electronic banking system and allied operations; in worst case it can even make economic transaction to a standstill. Thanks to the progress of

computer science and technological innovation which brought forth information technology (IT). In fact, IT has brought about a revolution in science and technology to influence every sphere of life including the Defence life.

Electronic gadgets are the essential force for any communication system where energy source plays key role. Presently, the soldiers in the field are using batteries for communication purpose; but such batteries have limited life which often affects the efficiency of the war field adversely. Thus, the importance of portable energy source has been highlighted here.

## 2. DISCUSSION

In future, the soldiers to be deployed for territorial security purpose, it will be essential that each soldier has to be self-sufficient not only for their mere survival but has to be ready and be equipped with gadgets and logistics to maintain a control over a large adverse and diverse areas of their respective countries. Often, military soldiers face unique operational and environmental challenges in protecting its borders of diverse regions from arid desert to snowy mountain region or for that matter from deep forestry to coastal sea shore. Such diversity calls for appropriate logistic support systems and devices adaptable in different environmental condition.

Desert suffers a geographic isolation which needs constant surveillance through communication systems at distant places across the country from south to north or east to west. Wireless communications, thermal imager, NVDs are the most power-hungry of soldier electronics applications.

With the advancement of technologies in all fronts, there is ever greater threat and vulnerability to detection of deployed soldiers at different geographical locations. This has created increased demand for an individual or a battalion to interact and operate independently through communication systems over longer distances in a complex situation.

Worldwide armed forces are looking for digitisation of the battlefield and a transformation from the fire and maneuver operations towards a more digital and network-centric warfare, the soldier of the future may be increasingly dependent upon mission critical technology to perform its functions. The soldier will have increased reliance on interconnected and interdependent networks that will link sensors, commanders, soldiers and their weapons in real time from strategic planning to tactical execution levels. Reliable computing will become the backbone of these networks for command, control and communications.

Soldiers require increased situational awareness and ability to locate, detect and encounter the enemy. The most critical factor for the supply systems needs

to be operable to enable electronics gadgets to function effectively in continuous mode or at least for a reasonably longer period of time. Soldiers often have to carry huge weight burden caused by body armour, ammunition, batteries, communication devices, equipment, food, gadgets, helmet, intelligent night vision, sensors, weapons, water, and much else in hot, dry and sometimes in mountainous or forestry conditions. Power systems, being the most critical and essential unit add on to the overall weight budget substantially<sup>1-12</sup>.

The soldiers cannot do their jobs if their electronic devices and computers stopped working at the critical moments or in a situation of loss of data. It appears that it is an absolute obligation to provide soldiers with dependable power and energy system that will allow them to function during operation. Equipment often has to work under harsh battlefield condition at any odd time. Anything short of this will adversely impact the ability to carry out the mission. Or worse, affect their morale.

Thus understandably, one of the critical problems in the battlefields is due to the non availability of sufficient electric power to support their needs in an information-rich environment to communicate voice, data, and image transmissions over extended distances of hostile environment. Proper design of electronic devices is essential for any such communication system. But it is worthy to note that for microelectronics circuit design for computation and communications or for sensor systems, it should preferably use lower supply voltages and optimise systems architectures with more parallel processing and more efficient distribution of functions between hardware and software.

These days' engineers are focusing on developing embedded, dedicated computer systems, rather than adapting general-purpose personal computers. Ideally, each sensor or subsystem should have its own processor and wireless transceiver. Also user level programming should be minimized<sup>13,14</sup>. The thumb rule of efficiency is the simplicity and clarity in conception. In fact, human-display interface format must be optimised for maximum situational awareness.

Power is essential requirement to run any electronic gadget but its consumption is a concern; therefore, lower the consumption, better is the power system. Therefore, lower energy consumption by display sub-assemblies can be achieved by long-term R&D program where system level design trade-offs may be introduced early in the display development stage. Reduction in energy consumption that can be achieved by eliminating the analog-to-digital conversion step, and digital format should be investigated, especially for functional enhancements that are planned downstream. Energy efficiency of sensors and displays are improved through development of an optical fiber collector net

to feed data to a central detector processor. Similar architectures might be used to support electronic sensors for optical energy, radio frequency energy, chemical agents, or radioactivity. Multimodal and adaptive communication circuits to achieve the flexibility and energy reductions in radio modern circuits that may be possible in future integrated circuit technology, the engineers will require designs that allow analog radio frequency circuitry to coexist on the same circuit as digital processing optimisation for low power.

Military radios can use communication system architectures that adapt to the environments of battlefield cognitive radio. Illustratively, a radio system that is energy optimized for voice transmission among members of a squad in a rural environment are quite different from one that is emulating a commercial protocol to exploit existing infrastructure in an urban setting. It is highly desirable to have a single portable radio that could be adapted to as low an energy level as possible for various tasks and environments.

Wireless battlefield communications network aimed at adapting commercial cellular and personal communication system networks and technologies to the needs of future soldier systems. Energy-efficient wireless networks should be optimised for specific environments, which will require a wide range of radio interfaces. Terrestrial and satellite-based networks can be part of the overall communications pathway<sup>10-12</sup>.

Radio networks and protocols at the soldier level require peer-to-peer architectures for low latency connectivity and, simultaneously, require hierarchical architectures to meet power concerns and the capability to use COTS (commercial off-the-shelf) technology.

The international (hierarchical) GSM (Global System Mobile) standard now offers low cost, low energy consumption, low latency, and is adaptable for covertness and security. A hybrid wireless network architecture that provides 'virtual' peer-to-peer communication with a hierarchical physical architecture based on GSM should be adapted and optimised for the dismounted soldier.

New wireless battlefield communications network models should be done for optimising energy efficiency advanced fueled systems. As communications come to dominate the energy consumption of systems for the dismounted soldier, the creation of a virtual peer-to-peer architecture becomes increasingly important. Implementation of virtual peer-to-peer architecture requires much more than the straightforward adaptation of commercial technology.

Optimising the distribution of information on the battlefield to eliminate unnecessary wireless traffic requires multidisciplinary thinking by experts in military doctrine, communications, encryption and security.

Energy for radio transmission is expected to dominate power requirements of the future. The complex radio propagation environment is heavily influenced by topography, foliage, precipitation, buildings, and the antenna heights. These influences change significantly at the high frequencies that is to be used to support the increased information flow to and from dismounted soldiers. Research on antenna technology is needed to characterise and quantify interactions of the environment and antennas.

It is worthy to note that commercial industry is already working on energy-efficient mobile communications and data processing, therefore an organization can take substantial advantage of it just by following industry's lead, if necessary depending upon the extent of exigency. It is appropriate to embrace commercial electronics technologies that have the potential for improving energy-efficiency.

A number of strategic research objectives, both Near-term Objective (NTO) as well as Far-term Objective (FTO) identified by professionals. Following Table shows typical summary of information related to communication activities: in Table 1.

It becomes amply clear that there is a great necessity to develop battery system for soldier. Performance of future soldier system (human and /or robot) depends on the energy efficiency of the equipment and need for power continues to grow and the soldiers of the future would have to carry the means to power sensors,

<b>Energy sources and systems</b>
Rechargeable batteries
Fuel cell
Human powered system
<b>Low power electronics design</b>
Design tools for minimizing power consumption
Architectural level design tools
Packaging to minimize interconnections
Optimizing device design
Design methodologies for army system on a chip
<b>Communication computers, displays, and sensors</b>
Thermal equipment architecture
Component and human computer interface
Ultra low power displays and sensors
Multimodal and adaptive communication circuits
Evolution of hardware and software
<b>Network, protocols and operations</b>
Wireless battlefield
Sensor and software for power management
Models for optimizing energy efficiency
Propagation characteristics and antenna design

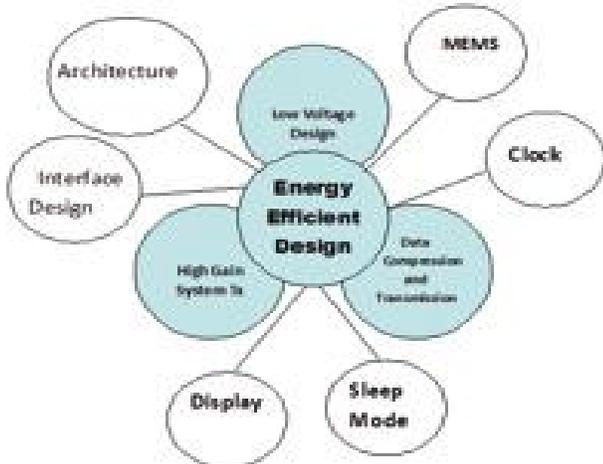


Figure 1. Energy efficient design.

communications, navigation, vision, and even medical or micro-climate changes. Without portable power or battery system, all electronic devices and appliances howsoever hi-tech are useless burden.

### 3. REQUIREMENT FOR SOLUTIONS

Some of the important requirements for the development of portable power system and allied items in relation to modern communication technology are:

- Lithium-ion battery technology is a very important technology for portable energy system.
- Universal charging device are to facilitate configuration and making compatible to all kinds of electronic gadgets
- New material systems such as solid electrolytes, special conductive membranes, anode as well as cathode electrode items probably based on nanotechnology can be utilised to develop battery systems of higher storage capacity with improved stability and safety.
- Photovoltaic solar power systems may be a useful source of power in the operation system. Some of the industries reportedly have developed to cater the need of foldable/ 'flexible' photovoltaic solar power systems for the soldiers.
- Fuel cell may be another option like photovoltaic solar power system. For development of portable fuel cell, it is essential to develop proton conductive temperature resistant membrane technology. The membrane should have good water retention capability as well as withstand and remain functional even at low sub zero temperature for which suitable nanotechnology is a probable way for solution.
- It is essential to evolve low power electronic devices, energy efficient design, new energy equipment voice/data/video compression, architectures, software, algorithm and protocols to mitigate the problem of

energy gap.

Fuel cells are the focus of intense interest because of their potential as instantly 'rechargeable' energy sources that can meet specific energy requirements for high electrical loads and long mission lengths. Like metal/air batteries, fuel cells are air-breathing devices that cannot operate when submerged in water. Future acceptance of fuel cells on the battlefield will be determined to a great extent by logistics, because current prototypes are fueled by the nonstandard logistics fuels like methanol and hydrogen.

Thus, batteries will be an integral part of hybrid and stand-alone energy sources for the foreseeable future. The challenge is to make batteries smaller, lighter, cheaper, more reliable, and more energy-dense without sacrificing safety.

### 4. CONCLUSIONS

Pattern and form of war changed over the years with the progress of civilisation and culture. With the innovation of modern electronic gadgets, the requirements of soldier's need have changed enormously with time. Without portable power or battery system, all electronic devices and appliances howsoever hi-tech will become useless burden. Design of low power electronics items and new effective rechargeable light weight battery as portable power source will be a major challenge to cater the need of future electronic gadgets.

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## विज्ञापनों में सूचना प्रौद्योगिकी का उपयोग : डेसीडॉक के संदर्भ में Application of Information Technology for Advertising : Case Study of DESIDOC

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### सारांश

इस पत्र में किसी भी संगठन के लिए आवश्यक सूचना के प्रसार उपकरण के रूप में विज्ञापनों के बारे में वर्णन किया गया है। यह पत्र विज्ञापन की परिभाषा, जरूरत और उपयोग और उपकरणों के प्रकार पर विचार करता है। यह डेसीडॉक द्वारा अपने उत्पादों, सेवाओं और अन्य क्षेत्रों को बढ़ावा देने के लिए विज्ञापन तथा उसके उपकरणों पर प्रकाश डालता है।

### ABSTRACT

This paper describes about advertisements as essential information dissemination tool for any organisation. It elaborates upon the definition of advertisement, need and uses, and type of advertisements. It highlights the various tools being used by DESIDOC for advertising and promotion of its products, services and other areas.

**Keyword:** Advertising, information technology, case study, tools of advertising

## 1. INTRODUCTION

Advertising is a form of marketing communication used to persuade an audience to take or continue some action, usually with respect to a commercial offering, or political or ideological support<sup>1</sup>. Advertising is the printed, written, verbal representation of a person, product and service sponsored by advertiser for the purpose of influencing the sale, endorsement, use or deliver message. It is an art of sale and a medium whose aim is to publicise the product or service for increasing the demand of the interested customer. Advertising is a process through which the customer's attention is drawn towards the available products and services in relation to their quality and effectiveness. Advertisements are the backbone for the survival of any newspaper or magazine. It is a capital generation or/and promotion process for the survival and growth of any organisation. These advertisements can take medium such as newspapers, television, radio, internet, etc. Each medium is important as each has its specific feature. The choice of audience/readers regarding the selection of media may vary and may depend on specific news, details of news, availability, readability, etc.

## 2. AIMS OF ADVERTISING

For development of any industry advertising is essential. It introduces the development of the industry

to everyone. For national and social development, advertisements play extremely important role. It fulfils the needs and desires of the consumers by leading to them with the information and increase competition which lead to product quality and people's attention. Advertising is done with following aims:

### 2.1 Introduction

No product can gain visibility, recognition, acceptance of its existence without being introduced to consumers. Introduction make a base for initial foundation of any idea, product or subject. It is an important activity of an organisation to duly introduce itself and its products in an appropriate manner to gain acceptance.

### 2.2 Draw Attraction

Main aim of an advertisement is to draw attraction of masses and eventually generate curiosity to utilise the service or products. Without being attracted to a product no customer will think of buying it. This is done by providing the suitable and catchy title (heading), tagline, colour, photographs, expression, context, and a mix of all. They are placed at major and prominent places like railway stations, mobile vehicles, high rise buildings, flyovers, high and low velleys, bridges, etc.

### 2.3 Create Interest

Advertisement should be such which ignite the interest in the mind of customer. For this purpose the qualities and characteristics and users are elaborated in extensive manner.

### 2.4 Faith generation

To generate the faith in the products various product related people such as doctors, actors, sports persons, etc., are engaged in the advertisements. It gives an impression that they are using these products and getting benefits.

### 2.5 Retention in Memory

Advertisements are created in such a way that they get memorised by the people by using catchy taglines and flashy colours, hummable jingles, etc. Repeated telecast or print of the advertisement help in retention in memory of consumers.

### 2.6 Developing Need

The features of products and services are presented in such a way that the customer feels that it is most important for them to buy.

### 2.7 Sale Promotion

The ultimate objective of a business organisation is to generate and increase in its sale and make profits.

### 2.8 Image Building

It is an extremely vital tool for image building of an organisation which shows its long standing, effective marketing, product utilisation, etc to increase brand value. It helps to launch new products of the company and gain easy acceptance in the market.

## 3. TYPES OF ADVERTISEMENTS FOR ELECTRONIC MEDIA

Before advertisement, it is imperative to decide the content, context, scope, budget, etc. The factors like usefulness, popularity, trust, effectiveness of the medium are taken care of. There are different type of advertisements which are:

### 3.1 Display or Decorative Advertisement

They are very important part of newspapers as they are main source of their income. These are published in different sizes, and varied designs. Those advertisements which are published occasionally cost more, because they are not regular and published without preplanning. If they are to be published in specific place then they cost even more. For example, full page advertisement, front page advertisements, etc.

### 3.2 Classified Advertisement

These advertisements are published in daily newspapers at different costs. The cost is decided upon the basis of standing, sale, and popularity of newspaper. They usually cost less than display advertisement. These cover admission notices, situation vacants, lost and found, to let, name change, etc. Generally, all newspapers have specified pages for such advertisements. These have specific headings. Internet also offers classified advertisements such as tenders, expression of interest, etc.

### 3.3 National Advertisements

These type of advertisements are released by government agencies for public welfare informing about the various welfare schemes, activities, etc. For Ex. Dry day, Election related information, Polio immunisation, consumer welfare scheme, etc.

### 3.4 Law-related Advertisements

These advertisements are related to law. Here, public notifications, and information which have relevance with the law are publicised. This also cover notification, probation, bankruptcy, warnings, income tax, etc.

### 3.5 Local Advertisements

These advertisements are covered in the local newspapers from where the newspaper is published. These cover cinema, hotels, restaurants, stores, institutes, etc. Electronic media such as cable television also cover local advertisements.

## 4. CHARACTERISTICS OF ADVERTISEMENTS FOR E-MEDIA

Advertisements should form part of a complete marketing strategy. Online advertisements should coordinate with offline advertisements.

*Visual Attraction*—Advertisements must be visually attractive, colourful and should draw reader's attention. For electronic media the advertisement have to be interactive and animated.

*Target specific*—Advertisements should target specific groups or individual consumers. Advertisements should be adaptable and be able to communicate on a personal level.

*Valuable*—Valuable information should be provided to the consumer, with least delay in uploading.

*Trademarks*—These show the company's good will and long standing in the market and makes competition easy, hence should be displayed prominently.

*Availability*—There is a need to use maximum forums such as social media, mailing lists, frequently visit

sites, youtube, electronic bulletin boards, etc.

*Ordering Process*—The ordering processes should be easy and described in a clear manner. It should have simple and almost the same ordering style what others follow, so that it is convenient and have familiarity with ordering process.

## 5. EFFECTIVENESS OF ADVERTISING

Advertising is not selling. It is a tool for promotion of sale. Advertising depends upon the literacy of the people, time slot chosen by the advertiser, no. of people receiving the message, advertised product technology, exposure to media being used, interest of people in that message (many want to deactivate incoming advertising messages), goodwill of the company, satisfaction of the user, willingness of the user to understand the message, etc.

It is not easy to know the effectiveness of advertising message. The common method is that an area is chosen where earlier advertising is not done and figure of sale is received before advertisement, then change in sale is calculated during the advertisement and then after advertisement. But, one can never be sure if advertising is the only reason for sale. Usually a survey is done to know how many customers have enquired about the product. But will the enquiry be converted in to sale is not sure. For social message advertising, the measurement of effectiveness is even more difficult.

## 6. ABOUT DESIDOC

DESIDOC is committed to be a Centre of Excellence in processing and disseminating S&T information on cutting-edge technologies for Defence R&D in terms of providing quality publications, knowledge management, web-based information services and document supply to the customers through continual improvement of its products, library and reprographic services, publications and quality management system.

### 6.1 Areas of Work

*Library Services (Information Processing and Dissemination)*

- Digital Reference Desk
- DRDO Current Periodicals
- DRDO E-Journals Service
- Forthcoming International Conference on Military Science and Technology (FICMST)
- Info Watch Service (Selective Full-text Article Service)
- Journal Search Service
- New Books
- New Technical Reports
- Newspaper Clippings Service

- Online E-books Service
- Online Public Access Catalogue (OPAC)
- Reference/Document Supply Service
- Strategic Information Service

### *Repositories*

To cater to the need of DRDO R&D community, DESIDOC develops various repositories/databases for dissemination of information. Following repositories have been created:

- Back Volumes of Periodicals (Bibliographic)
- Defence Science Journal Digital Library(Papers published in DSJ) (Full-text)
- DESIDOC Journal of Library and Information Technology Digital Library (Papers published in DJLIT) (Full-text)
- Digital Library of Translated Documents (Full-text)
- Institutional Repository-Gyanstrota (Papers) (Full-text)
- Knowledge Repository (Reports) (Full-text)
- Microfiche Digital (Full-text)
- Newspaper Clippings database (Full-text)
- Union Catalogue of Periodicals of DRDO Libraries (Bibliographic)

### *Publications*

DESIDOC functions as the publication wing of DRDO and brings out a number of publications, covering current developments in Indian Defence R&D. Some of the unclassified publications are:

- *Defence Science Journal*
- *DESIDOC Journal of Library and Information Technology (DJLIT)*
- *DRDO Newsletter*
- *DRDO Samachar (Hindi)*
- *DRDO Science Spectrum*
- *DRDO Technology Spectrum*
- *Technology Focus*
- *Prodyogiki Vishesh (Hindi)*
- DRDO Monographs
- DRDO Conference Proceedings
- *Gyandeep*
- Other Special Publications

### 6.2 Advertising Activities of DESIDOC

DESIDOC has been using various advertising tools using information technology for wider publicity of its products, publications and services. All the publications and services are available in digital format and are disseminated using various information technology tools for wider and timely dissemination. These products and services are being made available as platform independent. DESIDOC is also using federated search facility for wider and quick access of its services through DRDO intranet. Some of the

advertising efforts are:

- *Tenders Information*—Tenders or Expression of Interest is floated through news papers and internet (through website) to purchase products or services.
- *Recruitment*—Advertisements are floated when recruitment is to be done.
- *Information about forthcoming conferences*—Internet is used to announce the forthcoming conference ‘call for papers’ and also the event is covered in various local and national dailies
- *Annual Report*—It is an important tool to publicise an organisation. It is annually brought out by DESIDOC covering the activities and achievements of DESIDOC during last one year.
- *Promotional Material*—Various brochures, fliers and catalogues are brought out covering the details of products and services of DESIDOC and distributed.
- *Sponsorship Programmes*—DESIDOC on behalf on DRDO sponsors various conferences related to its subject area takes part and sponsors conferences whereby promoting DRDO activities.
- *Exhibitions*—DESIDOC on behalf on DRDO exhibits DRDO publications in various book fairs, and Defence exhibitions.
- *Advertisements*—DESIDOC gets its publications advertised in different S&T and defence related journals, conference proceedings, Newsletters, etc.
- *E-book Stores*—The publications are available through various e-book stores like Amazon, etc.
- *Free Subscription*—DESIDOC journals are provided as complimentary subscription to DRDO labs and DRDO monographs to DRDO labs and other defence related institutions and organisations
- *Indexing and Abstracting Services*—The journals details and full-text is provided to various national and international services such as Scopus, LISA, LISTA, EBSCO Abstracts/Full-text, Library Literature and Information Science Index/Full-text, The Informed Librarian Online, DOAJ, OpenJ-Gate, Indian Science Abstracts, Indian Citation Index, Full text Sources Online, WorldCat, Proquest, and OCLC.
- *Conferences and seminars*—DESIDOC organises seminars and conferences on current topics of relevance on regular basis. It conducts and organises

conferences in Hindi also to promote science and generate scientific literature in Hindi for masses.

- *Video magazine*—DESIDOC is bringing out video magazine in hindi and English covering the activities and achievements of DRDO on monthly basis.
- *Newsletter*—DESIDOC publishes monthly newsletter ‘DRDO Newsletter’ highlighting the activities and achievements of DRDO on monthly basis. It is published in Hindi also under the name ‘DRDO Samachar’. Technology Focus is another bimonthly publication covering the products and technologies developed by DRDO.
- *Apps*—It has created apps for wider and dissemination of its services which are tailor made and individual-specific. Apps like RSS feeds and notifications are being used.

## 7. CONCLUSIONS

The purpose of advertising is to provide profit to the producer, educate the consumer, help the retailer, and reduce competition and to build relation between the consumer and producer. Advertising is essential for progress of any organisation and DESIDOC is not an exception to it. It is deeply involved in promoting its products and services in hardcore manner for maximum utilisation of its resources and image building. Continuous efforts and greater visibility are keys for success for any organisation for its survival. A lot has been achieved and a lot is yet to be achieved.

## निष्कर्ष

विज्ञापन का उद्देश्य निर्माता को लाभ उपलब्ध कराना, उपभोक्ता को शिक्षित करना, फुटकर बिक्री में मदद करना, प्रतिस्पर्धा को कम करना और उपभोक्ता और निर्माता के बीच प्रगाढ़ संबंध स्थापित करना है। विज्ञापन किसी भी संगठन की प्रगति के लिए अत्यंत आवश्यक है और डेसीडॉक भी इसका अपवाद नहीं है। डेसीडॉक अपने छवि निर्माण और अपने संसाधनों के अधिकतम उपयोग के लिए विभिन्न तरीकों से अपने उत्पादों और सेवाओं को बढ़ावा देने में गहराई से शामिल है। सतत प्रयास तथा अधिक से अधिक दृश्यता किसी भी संगठन के लिए अपने अस्तित्व को बनाए रखने के लिए सफलता की कुंजी हैं। डेसीडॉक ने गत वर्षों में बहुत कुछ हासिल किया है और अभी बहुत कुछ हासिल किया जाना बाकी है।

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## कार्यशील पूंजी: उत्पादन और व्यापार कंपनी: एक तुलनात्मक अध्ययन Working Capital in Manufacturing Concern V/S Trading Concern: A Comparative Study

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### सारांश

जब हम कार्यशील पूंजी (working capital) के विषय में बात करते हैं तो सबसे पहला विचार यही आता है की कोई भी कंपनी की जीविका की यह आधारभूत जरूरत है! कार्यशील पूंजी मतलब उस पैसे से है जिसकी दैनिक खर्चों के लिए एक कंपनी को जरूरत है इसलिए कार्यशील पूंजी की महत्वता को कुछ शब्दों में लिखना संभव नहीं है क्योंकि यह एक बहुत बड़ा विषय है। प्रस्तुत शोध पत्र में हमारा उद्देश्य एक उत्पादन करने वाली कंपनी और व्यापार करने वाली कंपनी की कार्यशील पूंजी के ढांचे की तुलना करना है इसके कारणों को जानना और इन दोनों कंपनी की रणनीति का ज्ञान पाना है! इन उद्देश्यों को जानने के लिए हमने वर्ष 2009 से वर्ष 2014 की वार्षिक रिपोर्ट को आधार बनाया है क्योंकि हम यह बखूबी जानते हैं की किसी भी उत्पादन कंपनी का मुद्रा रुपांतरण चक्र किसी भी व्यापार करने वाली कंपनी से बड़ा होगा लेकिन यह भी जरूरी नहीं है की व्यापार कंपनी अपनी मुद्रा की उपलब्धता की ज्यादा मात्रा रखें। अनुपात और आलेख की तकनीकों का प्रयोग करके इन प्रश्नों के जवाब को जानने की कोशिश की जाएगी इसके अतिरिक्त हम पिछले 5 वर्षों के मुद्रा रुपांतरण चक्र और उसके उतार-चढ़ाव का भी तुलनात्मक अध्ययन अपने शोध पत्र में करने का प्रयास करेंगे।

### ABSTRACT

While we talk about working capital, one sentence best suits to it that is “Basic need for Survival”. Working Capital means money that is necessary for daily expenditures. So it is not possible to write the extent of importance of working capital in a few words. In our study, the purpose is to differentiate the pattern of working capital of a Trading concern versus the pattern of working capital of a manufacturing concern. The reason behind this question is to get to know the type of strategy adopted by the Selected Organizations for which we are analyzing the pattern of working capital in last 5 years (2009-10 to 2013-14) because we know that the cash conversion cycle of a manufacturing concern is longer as compared to a trading concern, but it is not necessary that a trading concern will keep liquidity at a higher level due to small cycle. The techniques of Ratio along with graphs have been used to find out the answer of this question. As well as we have compared the cash conversion cycles and volatility or variation in the working capital in last 5 years of both concerns.

**Keywords:** Working capital, short term funds, cash conversion cycle, liquidity, volatility, standard deviation, coefficient of variation, ratio, inventory

## 1. INTRODUCTION

Working Capital is the need that a firm has to satisfy to survive its daily operations. Like a person needs money in his pocket to meet his expenses, an Organization also need funds to operate its day to day functions. Without the adequacy of Working Capital, a firm can't run in short term, so the answer of surviving in long term. The term is very clear that how it would survive in long term 'Working Capital' is used in 2 contexts: Gross and Net Working Capital. Gross working capital means the total short term funds (Current assets + Current Liabilities) available to a firm for short term, Net Working Capital means the exact owner's funds available for short term, deducting

Outsider's contributions (current liabilities) from total short term funds.

### 1.1 Selected Companies

For the Purpose of our study, we have selected 2 companies namely BHEL Ltd (as Manufacturing concern) and MMTC Ltd. (as Trading Concern). Their brief profile is as follows:

#### 1.1.1 Manufacturing Company-BHEL Ltd.

Bharat Heavy Electricals Limited (BHEL) owned by Government of India, is a power plant equipment manufacturer. BHEL was established in 1964. BHEL

is India's largest engineering and manufacturing company of its kind. Heavy Electrical (India) Ltd was merged with BHEL in 1974. In 1982, it entered into power equipments, to reduce its dependence on the power sector. It developed the capability to produce a variety of electrical, electronic and mechanical equipments for all sectors, including transmission, transportation, oil and gas and other allied industries. In 1991, it was converted into a public limited company. The company has been earning profits continuously since 1971-72 and paying dividends uninterruptedly since 1976-77.

### 1.1.2 Trading Company-MMTC Ltd.

Metals and Minerals Trading Corporation of India (MMTC), is India's largest public sector trading body. Not only handling the export of primary products such as coal, iron ore, and manufactured agro and industrial products, MMTC also imports important commodities such as ferrous and nonferrous metals for industry, and agricultural fertilisers. MMTC's diverse trade activities cover third country trade, joint ventures and link deals and all modern forms of international trading. The company has a vast international trade network, spanning almost in all countries in Asia, Europe, Africa, Oceania, America and also includes a wholly owned international subsidiary in Singapore, MTPL. It is one of the Miniratnas companies. It is the largest international trading company of India and the first public sector enterprise to be accorded the status of five star export houses by Government of India for long standing contribution to exports.

## 2. OBJECTIVES

- To compare the pattern of the working capital of a manufacturing concern and a trading concern.
- To know where the level of working capital is higher.
- To compare the volatility in working capital of a trading and a manufacturing concern.
- To compare the cash conversion cycle of manufacturing concern and a trading concern.

## 3. METHODOLOGY

The study has been carried out by selecting one manufacturing company namely BHEL Ltd. That is the one of the leading Manufacturing Company in Indian electronic industry and one trading company MMTC Ltd. that is one of the largest company in Indian trading industry.

The data required to complete the study has been collected from the published annual reports of BHEL Ltd. and MMTC Ltd. for last 5 years (2009-10 to 2013-14). The data collected from the published annual reports of the selected company for the 5 year period have been suitably re-arranged, classified and tabulated as per requirements of the study. To analyse the working capital performance of the selected company, the technique of ratio analysis has been used. The ratios which are taken

into consideration are as follows:

### (a) Cash Conversion Cycle of the Companies

It is the time lag between making an expenditure to manufacture a product and ultimately collecting the money from the accounts receivables (by selling the product that we have manufactured). Always a shorter cash conversion cycle is preferred. A longer CCC indicates current or potential problems with cash. So, In short we can define CCC as follows:

'CCC expresses the length of time, in days, that it takes for a company to convert its resource inputs into cash flows'. Financial Dictionary

To calculate CCC, we need following items from the financial statements:

- Revenue or sales and cost of goods sold (COGS) from the income statement;
- Inventory at the beginning and end of the time period;
- AR at the beginning and end of the time period;
- AP at the beginning and end of the time period; and
- The number of days in the period (year = 365 days, quarter = 90).

$$\text{Cash Conversion Cycle} = \text{Days Inventory Outstanding (DIO)} + \text{Days Sales Outstanding (DSO)} - \text{Days Payables Outstanding (DPO)}$$

### (b) Standard Deviation in Working Capital of the Selected Companies

Standard deviation is a statistical measurement that explains historical volatility or fluctuations in terms of number. For example, a volatile stock will have a high standard deviation while the deviation of a stable blue chip stock will be lower. To calculate SD following formula is used:

Performance indicators	Method of measurement
Current Ratio	Current Assets ÷ Current Liabilities
Quick Ratio	Current Assets - Inventories ÷ Current Liabilities
Cash Ratio	Cash and Bank Balance ÷ Current Liabilities
Inventory to Current Assets Ratio	Inventory ÷ Current Assets X 100
Inventory Turnover Ratio	Sales ÷ Avg. Inventory

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{N}}$$

Where, X are the individual values and  $\bar{x}$  is mean of all the values, N is the number of values.

### (c) Coefficient of Variation

The coefficient of variation represents the ratio of the standard deviation to the mean, and it is a useful

statistic for comparing the degree of variation from one data series to another. It gives us the result of volatility in percentage.

$$\text{Coefficient of Variation} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

$$\text{Coefficient of Variation} = \frac{\sigma}{\mu} \times 100$$

**4. ANALYSIS OF DATA**

With the help of above performance indicators, we have computed following results and placed them on a single place to compare the performance of the working capital of both the concerns easily.

Years	DIO	DSO	DPO	CCC-BHEL (days)
2009-10	112.64	195.27	88.58	219.32
2010-11	107.16	202.02	91.21	217.97
2011-12	113.05	171.58	85.76	198.86
2012-13	113.20	201.40	89.25	225.36
2013-14	110.96	257.50	95.14	273.32

(Source: Annual Reports of BHEL Ltd.)

As we can see in terms of numbers that the CCC of a manufacturing concern is longer as compared to a trading concern, because of, many reasons like blockage of money in inventory slower sales and slower generation of cash.

(Rs. in Crore)

Yrs.	WC BHEL	WC MMTC	CR BHEL	CR MMTC	QR BHEL	QR MMTC	CASH RATIO BHEL	CASH RATIO MMTC	ITO BHEL	ITO MMTC	INV. TO C.A BHEL	INV. TO C.A MMTC
2009-10	10366.67	6114.681	1.32	2.139	1.03	1.741	0.30	1.151	4.01	33.60	21.58	18.61
2010-11	12432.49	7173.876	1.32	2.362	1.04	2.237	0.25	1.300	4.30	49.85	21.34	5.27
2011-12	19934.99	879.251	1.68	1.078	1.22	0.994	0.23	0.261	4.09	83.45	27.55	7.80
2012-13	23202.54	783.887	1.82	1.153	1.40	0.977	0.28	0.334	3.97	35.52	23.09	15.30
2013-14	26398.84	781.386	2.02	1.236	1.64	1.140	0.46	0.195	3.76	46.20	18.72	7.73
Mean	18467.106	3146.616	1.632	1.5936	1.266	1.4178	0.304	0.6482	4.026	49.724	22.456	10.942
S.D.	6883.40534	3215.042	0.309386	0.607402	0.258225	0.553767	0.091269	0.531904	0.19578	20.07246	3.252742	5.704189
C.V.	37.2738714	102.1746	18.95751	38.11509	20.3969	39.05818	30.02264	82.0586	4.862903	40.36775	14.48496	52.13114

We have also computed S.D and C.V. to get to know the variance in the working capital.

**4.1 Ratios and Volatility**

Table 1. shows the trend and relationship in current ratios, quick ratios, cash ratios and inventory to current asset ratios as well as SD and CV as volatility measures.

The calculated values have been plotted in to graphs to give them a pictorial form as well as for making the process of analysis easier.

**4.2 Cash Conversion Cycles**

**4.2.1 CCC BHEL**

Years	DIO	DSO	DPO	CCC-MMTC (days)
2009-10	10.94	12.75	30.30	-6.60
2010-11	7.36	10.74	18.50	-0.40
2011-12	4.39	14.79	18.67	0.51
2012-13	10.37	26.43	31.56	5.24
2013-14	8.00	23.85	24.42	7.43

(Source: Annual Reports of MMTC Ltd.)

The calculated values have been plotted in to graphs to represent our results in pictorial form as follows:

Interpretation: The CCC of manufacturing concern takes more time to convert inputs into cash as compared to trading concern, whose CCC is very small.

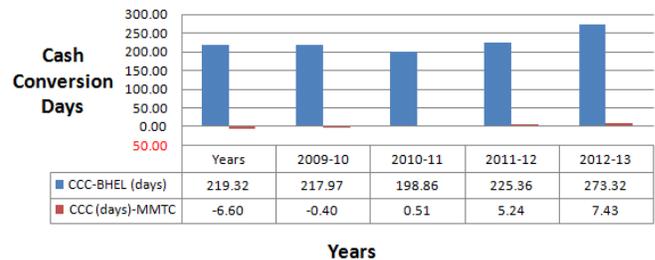


Figure 1. Comparison of cash conversion cycle

**4.3 Comparison of Working Capital**

We can see that there is a huge difference in the working capital of a manufacturing concern and trading concern. The manufacturing concern has to keep its working capital at a higher level.

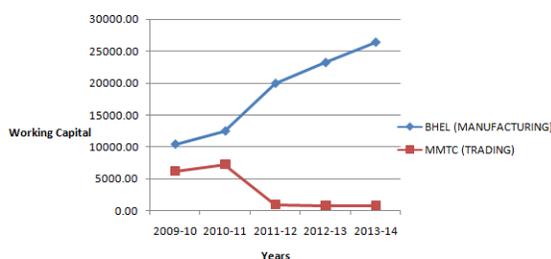


Figure 2. Working capital.

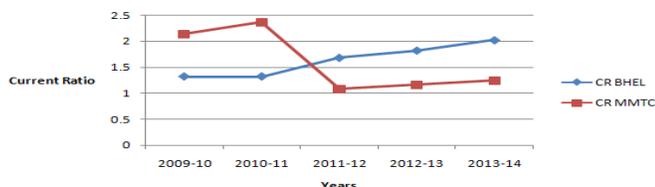


Figure 3. Current ratio.

#### 4.4 Comparison of Current Ratios

The current ratio of MMTC was greater in first two years but after that it got decreased as compared to BHEL, so we can interpret that the CR of manufacturing concern is greater and on increasing trend.

#### 4.5 Comparison of Quick Ratios

The QR of BHEL is also greater as compared to MMTC. So that we can say that BHEL has also maintained its Quick assets at a higher level as compared to MMTC. But MMTC'S QR is showing an increasing trend in future years.

#### 4.6 Comparison of Ratio of Cash to Current Assets

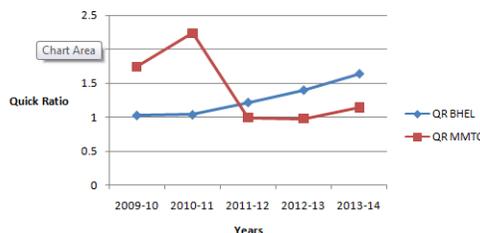


Figure 4. Quick ratio.

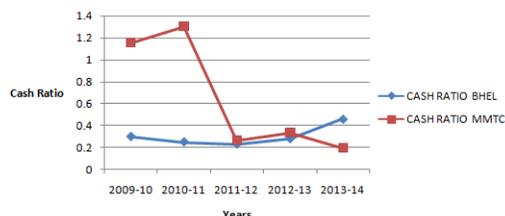


Figure 5. Cash to current assets.

The CR of BHEL has become greater as compared to MMTC in 2013-14 but initially the cash ratio of MMTC was higher. A drastic decrease we can see in CR of MMTC that we can predict in the upcoming years also. But we can see that BHEL is continuously increasing its cash assets or liquidity and we can predict an increasing trend in future also.

#### 4.7 Comparison of Inventory Turnover Ratio

The ITO of MMTC is not stable but on the other hand BHEL'S ITO is smooth and stable so we can interpret that BHEL is selling its inventory on same speed but MMTC'S selling speed of Inventory is on higher trend or we can say MMTC is selling its inventory faster.

#### 4.8 Comparison of Inventory's % of Current Assets

Interpretation: The blockage of Inventory is greater in a Manufacturing concern as compared to trading concern. But we can see that the both concerns are working on the Inventory, because their inventory to current assets ratio is showing decreasing trend.

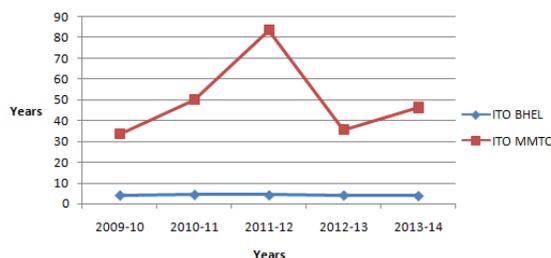


Figure 6. Inventory turnover.

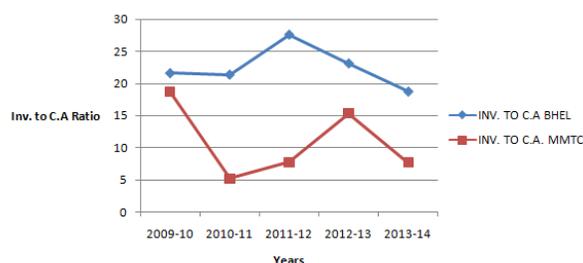


Figure 7. Inventory to current assets (%).

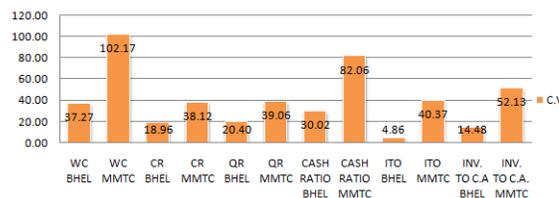


Figure 8. Coefficient of variation.

#### 4.9 Comparison of Coefficient of Variation or Volatility

On the basis of selected parameters we have computed the volatility of those factors in a trading and manufacturing concern. We can interpret that the Working Capital of a Trading concern is more Volatile as compared to a Manufacturing Concern.

#### 5. SUMMARY OF FINDINGS

We have studied the pattern of working capital in a manufacturing concern as well as in a trading concern, both of them are mutually exclusive in terms of their functioning. Following are the results of our study:

- The level of working capital is higher in a manufacturing concern as compared to a trading concern.
- The manufacturing concern has maintained more liquidity as compared to trading concern, as its current and quick ratio is greater, even the cash ratio is has become greater in the current year.
- The speed of turning Inventory into sales, (ITO ratio) of trading concern is faster and fluctuating as compared to manufacturing concern, whose ITO is stable.
- The working capital of trading concern's is more volatile as compared to manufacturing concern.
- The blockage of inventory in a manufacturing concern is more as compared to trading concern.
- The cash conversion of trading concern is faster than manufacturing concern.

#### 6. CONCLUSIONS

On the basis of selected performance parameters we calculated values, like working capital, Liquidity ratios, inventory ratio, and volatility. We can conclude that the working capital of a trading concern is more volatile as compared to a manufacturing concern, but the level of working capital is higher as compared to

a trading concern. Trading concern converts its inputs into cash faster as compared to a manufacturing concern, that's why the cash conversion cycle of a trading concern is smaller as compared to a manufacturing concern. Due to slow conversion the manufacturing concern has to maintain more liquidity as compared to a trading concern.

#### निष्कर्ष

प्रयोग किये गए मापदंडों के आधार पर प्रस्तुत षोध पत्र में हमने पाया की कार्यशील पूंजी तरलता अनुपात (Liquidity Ratio), रहतिया अनुपात (Inventory Ratio) और कार्यशील पूंजी और इसके तत्वों के उतार चढ़ाव का अध्ययन किया गया है! षोध से पता चलता है की किसी भी व्यापार कंपनी की कार्यशील पूंजी में उत्पादन कंपनी की तुलना में ज्यादा उतार चढ़ाव पाया गया है! किन्तु उत्पादन कंपनी में कार्यशील पूंजी की मात्रा व्यापार कंपनी से ज्यादा है! व्यापार कंपनी उत्पादन कंपनी की तुलना में जल्दी पैसे से पैसा बना लेती है! इसी लिए व्यापार कंपनी का मुद्रा रूपांतरण चक्र उत्पादन कंपनी की तुलना में जल्दी समाप्त हो जाता है! षोध के दौरान एक और बात सामने आई की उत्पादन कंपनी की गति धीमी व लम्बी होने के कारण उसे ट्रेडिंग कंपनी की तुलना में पैसे की उपलब्धता ज्यादा मात्रा में रखनी पड़ती है!

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## जलमग्न सेंसरों (एमईएम आधारित वेक्टर हाइड्रोफोन) का डिजाइन और संरचना दृष्टिकोण Design and Fabrication Approach of Underwater Sensors

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### सारांश

वएमईएम (माइक्रो-इलेक्ट्रो-मैकेनिकल-सिस्टम) और एनईएमएस (नैनो-इलेक्ट्रो-मैकेनिकल-सिस्टम) प्रगतिशील क्षेत्र हैं जो ऐसी प्रौद्योगिकियों को उत्पन्न कर रहे हैं जो विद्यमान सेंसरों को सूक्ष्म रूप देने में सक्षम हैं। एमईएम युक्तियां जैसे एमईएम वेक्टर हाइड्रोफोन विशेषकर हल्के वजन के स्वायत्त जलमग्न वाहनों (एयूवी) में प्रयोग के लिए जलमग्न ध्वनिक अनुप्रयोगों में अत्यधिक संभावनाएं रखती हैं। पारंपरिक रूप से, सागरीय ध्वनिक सिग्नल विशिष्ट रूप से सर्वदिशात्मक हाइड्रोफोन का प्रयोग करके, जो ध्वनिक दाब को मापते हैं, प्राप्त किए गए हैं। एमईएम आधारित वेक्टर हाइड्रोफोन दोनों मानदंडों अर्थात् ध्वनिक दाब और आण्विक गति की दिशा प्रदान करने में सक्षम हैं। एमईएम प्रौद्योगिकी का प्रयोग करके वेक्टर हाइड्रोफोन को डिजाइन करना और संरचित करना सेंसर प्रौद्योगिकी के क्षेत्र में भारत में एक नया प्रयास होगा।

### ABSTRACT

Micro electro mechanical systems (MEMSs) and Nano electro mechanical System (NEMS) are advanced fields leading to technologies that are capable of miniaturizing the existing sensors. MEMS devices like MEMS vector hydrophone have great potential in under water acoustic applications, especially for the use in light weight autonomous underwater vehicles (AUVs). Traditionally, ocean acoustic signal has been acquired using typically omnidirectional hydrophones, which measure the acoustic pressure. MEMS based vector hydrophones are capable to provide both parameters, i.e., acoustic pressure and direction of particle motion. Designing and fabricating vector hydrophone using MEMS technology will be a new attempt in India in the field of sensors technology.

**Keywords:** MEMS, Micro electro mechanical systems, AUVs, vector hydrophone, acoustic pressure

### 1. INTRODUCTION

Hydrophones are electrical devices which convert acoustic signals into electrical, and then this signal is used to listen to underwater sounds. Low cost, highly sensitive hydrophones are of interest in homeland security and ocean research. Underwater hydrophone arrays towed by small autonomous submarines are being investigated as a possible way to monitor ocean-going threats in America's waterways.

Mostly hydrophones are designed and fabricated using piezoelectric transducers. Piezoelectric materials have the property to convert changes in pressure, acceleration, strain or force to electrical signals. Frequency response, sensitivity, directivity pattern and maximum operating depth, etc. are the major parameters for the characterization of Vector hydrophones. Major drawbacks of PZT's are high density, high acoustic impedance, higher weight factor, and narrow bandwidth. Sensors made using MEMS are better than PZT's / their

conventional counterparts because these are Smaller in size, Have lower power consumption, more sensitive to input variations, cheaper due to mass production, and less invasive than larger devices.

This paper focuses on the approaches to design, simulate and fabricate a MEMS-based vector hydrophone. Many research institutes have manufactured MEMS cilia bionic micro-sensors-based on piezoelectric, piezo-resistive, and piezo-capacitive by adopting the fish's lateral line organ and cricket's auditory cilia. MEMS vector hydrophones are designed, simulated, and realized by some researchers / professors to be used as acoustic sensors using silicon piezo resistive approach in the form of T structure and four beam structures. In case of T-shape structures, a T-Shape cantilever beam with piezo-resistors and metal leads have been developed and in the case of a four beam Structure, a four-beam micro-structure which consists of four vertical cantilever beams (mass) and a rigid

plastic cylinder fixed on the centre of the Four Beams microstructure is being developed, and the whole structure is completely axial symmetry in the x-z plane and y-z plane.

## 2. TECHNICAL DESIGN APPROACH

A fish has lateral lines which act as sensory organ consisting of neuromasts, pores, and nerves, the neuromasts are covered by a jelly like cupola located on the canals along the body of the fish. The water enters the pores through the lateral lines which reaches the mucus and the flow of mucus will cause the movement of sensory hairs. As a result, sensory cells are stimulated and then effect is transmitted along the sensory path of fish lateral line organs.

### 2.1 T- Shape Structure

A T-shape hydrophone works on the same principle as fish lateral line in which a signal acts on a cantilever beam, which leads to deformation of cantilever beam, which further causes the change in resistance of the piezo-resistors (R1 and R2). The piezo-resistors and the reference resistors (R3 and R4) are arranged in the Wheatstone bridge which generates the output voltage due to change in resistances (R1 and R2). With the help of output voltage, both the direction and pressure of the underwater acoustic signals can be mapped / estimated.

### 2.2 Four-Beam Structure

In this proposed design, hydrophone's structure will be the combination of two parts : first one-high precision four-beam microstructure and second-rigid plastic cylinder of the same density of water. Below figure shows the proposed design of the structure. This four-beam microstructure will consist of four vertical cantilever beams. The rigid plastic cylinder is mounted on the mass which is the center of the four-beam microstructure.

The mass undergoes horizontal displacement and an angular rotation, whereas the rigid plastic cylinder undergoes an ideal horizontal stress. Then the whole structure will get deformed and an amplified and concentrated strain is generated on the slim-sensing beams. The four piezo-resistors are arranged in the Wheatstone bridge used to sense the deformation of the beams. When a signal is transmitted, there is a change in resistance of piezo-resistors placed in the sensitive structure and the bridge's change will be detected due to the incentive direct current. Therefore, the vector underwater acoustic signal will be detected.

## 3. SIMULATION

To simulate and determine the size / geometry of hydrophone ANSYS or COMSOL software may be used.

To determine the size of the hydrophone structure, the resonant frequency and fabrication feasibility are considered. Positions of the piezo-resistors are chosen to be in the linear region of the longitudinal stress distribution curve of the beam. Being small in magnitude, the transverse stress can be ignored.

## 4. FABRICATION

The steps used in the fabrication of hydrophones are:

- Cleaning and oxidising the SOI (silicon on insulator) wafer to form a  $SiO_2$  wafer.
- The oxide layer ( $SiO_2$ ) is patterned with photolithographic and wet etching. To form the piezoresistors, boron is implanted using  $SiO_2$  pattern as the implantation window.
- The wafer is oxidized again and this oxide is patterned for ohmic contact holes.

A second layer of denser boron implanted to form ohmic contact.

- d)  $TiPtAu$  is deposited to form the metal wire.
- e) The cantilevers have been etched in ICP (Inductively Coupled Plasma) reactor, and then make the back cavity by EPW (Ethylene Pyrocatechol Water) aeolotropic Corrosion.

## 5. PACKAGING OF HYDROPHONE

The packaging of the hydrophone must be sound-transparent, insulated, and waterproof. According to the neuromast structure, SU-8, polyurethane or fibre are used instead of cupola and castor oil instead of mucus. Special care must be taken for cable at the time of packaging to have good electrical shielding to avoid high electromagnetic interference. Aluminium-bronze alloy is used to support the body of the hydrophones which is extremely high corrosion resistant when immersed in seawater.

Commonly different materials used for encapsulation of miniaturised hydrophones are epoxy, polyurethane, silicon rubber.

## 6. CONCLUSION

Radiated noise level of submarines is becoming lossier and lossier each year, traditional methods for submarine detection are not effective. The application of vector hydrophone will provide several advantages for meeting the requirement of submarine sound detection. It is desirable that the application of piezo-resistive effect and ingenious structure of the hydrophone may improve the low-frequency sensitivity of vector hydrophones. It provides significant operational advantages over traditional hydrophones by providing the amplitude and direction of the acoustic signal without left / right ambiguity, that occurs in towed array scenario.

Considering the significant advantages of silicon based four beam structures of MEMS vector hydrophone like : lightweight, miniaturized, highly sensitive, Low cost, reduced energy consumption, increased speed, rigidity enhanced, we are intended to design, fabricate, and characterise MEMS-based piezo-resistive, piezo capacitive, non-piezo resistive and other variants of vector hydrophones to obtain high S/N ratio and high sensitivity. It is also proposed to make use of these MEMS hydrophone arrays for light-weight AUV platforms and mines applications. These vector hydrophones and hydrophone arrays can be realized through collaborative programmes within DRDO and with Educational Institutions for best results.

### निष्कर्ष

पनडुब्बियों का प्रसारित शोर का स्तर प्रत्येक वर्ष कम से कमतर होता जा रहा है, पनडुब्बियों का पता लगाने की पारंपरिक पद्धतियां अब प्रभावी नहीं हैं। वेक्टर हाइड्रोफोन का अनुप्रयोग पनडुब्बी की ध्वनि का पता लगाने की अपेक्षाओं को पूरा करने हेतु अनेक लाभ प्रदान करेगा। यह वांछनीय है कि पाइजो प्रतिरोधी प्रभाव का प्रयोग और हाइड्रोफोन की शानदार संरचना वेक्टर हाइड्रोफोनों की निम्न-आवृत्ति संवेदनशीलता में सुधार कर सकती है। यह बांधाहिने भ्रम के बिना, जो कि रस्सों की श्रृंखला वाली स्थिति में उत्पन्न होती है, ध्वनिक सिग्नल का एम्प्लीट्यूड और दिशा प्रदान करके पारंपरिक हाइड्रोफोनों की तुलना में महत्वपूर्ण प्रचालन लाभ-स्थिति प्रदान करता है।

एमईएम वेक्टर हाइड्रोफोन की सिलिकन आधारित चार बीम वाली संरचनाओं के महत्वपूर्ण लाभों पर विचार करते हुए, जैसे- हल्का वजन, सूक्ष्मीकृत, अत्यधिक संवेदी, निम्न लागत, कम ऊर्जा खपत, वर्धित गति, वर्धित सुदृढ़ता, हम उच्च एसधएन अनुपात और उच्च संवेदनशीलता प्राप्त करने के लिए वेक्टर हाइड्रोफोनों के एमईएम आधारित पाइजो प्रतिरोधी, पाइजो कैपेसिटिव, गैर-पाइजो प्रतिरोधी और अन्य रूपों को डिजाइन करने, संरचित करने और विशेष रूप देने का इरादा रखते हैं। इन एमईएमएस हाइड्रोफोन अरै का हल्के वजन के एयूवी प्लैटफार्म और खान संबंधी प्रयोगों के लिए उपयोग किए जाने का भी प्रस्ताव है। इन वेक्टर हाइड्रोफोन और हाइड्रोफोन और को डीआरडीओ के भीतर और सर्वोत्तम परिणामों हेतु शैक्षणिक संस्थाओं के साथ सहयोगात्मक कार्यक्रम के माध्यम से साकार किया जा सकता है।

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## प्रयोक्ता की पसंदें और गुणवत्ता आधारित वेब सेवा चयन User's Preferences and Quality Based Web Service Selection

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### सारांश

वेब सेवा के लिए सेवा की गुणवत्ता इंटरनेट प्रयोक्ता की उच्च पसंद बन रही है। किंतु, इस क्षेत्र में अधिकतर शोध वेब सेवा की प्रत्येक स्वतंत्र विशेषता का अध्ययन करने पर केन्द्रित अथवा विशेषता की उनकी पूर्व-परिभाषित प्राथमिकता पर आधारित है। यहां, हमने एक ऐसी प्रणाली का प्रस्ताव किया है जो प्रत्येक विशेषता की प्रत्येक अनुवर्ती विशेषता से तुलना करके प्रयोक्ता की पसंद पर आधारित विशेषता की प्राथमिकता का परिकलन करती है। महत्व के परिकलन के लिए, हम गुणनफल के योग की पद्धति का प्रयोग करते हैं। वेब सेवा का समग्र गुणवत्ता मान महत्व योग रीति का उपयोग करके परिकलित किया जाता है। श्रेणीकरण प्रयोक्ता को उनके लिए उपयुक्त वेब सेवा चुनने में मदद करेगा।

### ABSTRACT

Quality of service for a web service is becoming a high priority of internet users. However, most of the researches in this field are concentrated on study of each independent attribute of web service or based on their pre-define-priority of attribute. Here, we proposed a system that calculates priority of attribute based on user preference by comparing each attribute to each succeeding attribute. To calculate the weight, we apply the sum of products approach. Overall quality value of web service is calculated using weight sum mode. The ranking will help the users to choose appropriate web service for them.

**Keywords:** Selecting of web services, quality of web services, user's preference, web service discovery, web service

### 1. INTRODUCTION

The amount of information stored on the Internet grows every day. Users are forced to deal with an overwhelming number of possibilities, and to continuously make decisions if they want to obtain meaningful information or services<sup>5</sup>.

Web service discovery is a key component in service-oriented computing. However, without Web service quality standards and quality-based discovery mechanisms, the trustworthiness of business-to-business interactions can't be guaranteed<sup>3</sup>.

Currently web Service architecture consists of 3 roles: Web Service provider, web Service Consumer and UDDI (Universal Description, Discovery and Integration) registry. The Current UDDI registries only support web services discovery based on the functional aspects of services<sup>2</sup>. However, service consumers are interested in not only the functionalities of web services, but also their quality of service (QoS) which is a non-functional attribute (e.g. response time, availability,

etc.) that may have impact on the quality of service provided by Web services<sup>2,8,9</sup>.

There is multiple web services provider who provides the same functionality. User can search these service providers using UDDI registries/Search engines. But these methods don't provide result-based on QoS of web service. Search engine result-based on information of web page, not the service. Such techniques are inherently impractical for Web services because of key structural differences between Web pages and services<sup>3</sup>. Many papers analysed QoS of web service. These are focused to generate pre-define rule to measure the quality of service. Most studies have not considered the relation between each quality attribute and the overall quality but applied each attribute independently as a constraint to select a web service. However, web service quality cannot be determined by only one quality attribute, and the degree of influence of each attribute is not the same. That is, each attribute has a different priority weight

that depends on the degree of influence on the overall quality. The priority weight of each quality attribute can be determined according to the purpose of the quality evaluation or the subjectivity of the user searching the services. Quality has a strong subjective element<sup>1</sup>.

However, determining the weight of each attribute to select web service is a burden for a user. To reduce the burden one research paper proposed in 2014, used Analytic Hierarchy Process (AHP) method to generate the weight of each attribute. AHP method needs  $n(n-1)/2$  input to perform operation. These values must be consistent to generate weight which is used to calculate QoS rank of web service. The probability of getting consistent value is very low. Therefore, this paper presents an algorithm in which user has to give only  $n$  value as input and the probability of getting consistent of the value is better than previous method. Proposed algorithm comparing each attribute to its next attribute and then calculating sum of products of input value in decreasing order to generate weight. This method is used to calculate the degree of importance of multiple decision criteria and alternatives in an Analytic Hierarchy Process and ANP<sup>6,7</sup>.

## 2. RELATED WORKS

Ran<sup>2</sup> proposed a web services discovery model in which a certifier was added to the existing three roles of service provider, service consumer, and UDDI registry. The purpose of the certifier was to verify the advertised QoS of a web service before its registration. The consumer can also verify the advertised QoS with the certifier before binding to a web service. This system can prevent service providers from publishing invalid QoS claims during the registration phase and help consumers to verify the QoS claims to assure satisfactory transactions with the service providers. A set of quality attribute metrics was established for the proposed framework but they didn't introduce any method how to do these things.

Al-Masri, Eyhab, and Qusay H. Mahmoud<sup>3</sup> proposed Web Service Broker and test using commercial tools. They used nine parameters to measure the QoS of web service. These parameters are Response Time, Availability, Throughput, and Likelihood of Success, Reliability, Compliance, Best Practices, Latency and Documentation. They proposed Web Service Broker has automatic collection and validation of data and generates rank-based on QoS. They didn't introduce any method how to do these things. They used commercial tool for validation that did not consider user preference and quality weightage.

Patil and Gopal<sup>4</sup> proposed a model for web service selection based on the QoS and an algorithm for matching.

If services are found to match both the functional and QoS requirements and the ratings requirements which have been specified, then the web service broker ranks the services based on the consumer's QoS and ratings requirements. They are using recent models data to calculate the rank.

Yager, Gumrah and Marek<sup>5</sup> proposed a method to select the most suitable information and web service that fit users needs. They applied the lexicographical preferences that are required for the user to set up users criterion, satisfaction levels defined with a single threshold that represents a boundary value between acceptable and unacceptable values of attributes of alternatives. This method has an advantage in that it reflects users preferences but, since the user has to decide the weights of attributes and alternatives and the threshold, the problem of inconsistency can arise as a result of the users decision. Furthermore, they did not suggest a method to decide the weight and the threshold objectively.

Choi, Cheol Rim, and Hwa Young Jeong<sup>1</sup> developed a broker-based evaluation system for service selection according to the QoS preferences of users. Here, they use AHP as a method to calculate priority weight. To calculate the weights, they apply a pairwise comparison matrix and an eigenvector of the matrix. The algorithm generated weight of each attribute based on users preference and then according to users functional requirement, it displays set of service with their QoS value, then rank these services based on their overall value. However, AHP method needs  $n(n-1)/2$  input to perform operation. These values must be consistent to generate weight which was used to calculate QoS rank of web service. The probability of getting consistent value is very low.

## 3. PROPOSED SYSTEM

Currently, there is no standard web service quality exist. Here, we are not focusing on the standard for web service quality attributes, so we are using six attributes that are selected from literatures<sup>1-4</sup>. These are cost, fault rate, response time, availability, privacy, and operability. First four attributes are quantitative and last two are qualitative. Table 1. We listed the attributes and their meaning and how to measure these. Some attribute are qualitative, for that we use scale to measure their quality. Here to calculate weight of attribute, we first check the value of product of all value is one. If not need to enter the value of attribute again, because it shows that current possible values are inconsistent. If value is 1 then in reverse order we perform products of all elements from second last to first. Finally add the value and divided to each attribute from the sum, which gave us weight of each attribute. To generate rank of web service,

**Table 1. Attributes of web service**

Parameter	Description	Unit of measurement
Cost	Requesting and use of service	USD/10 min
Fault rate	Failure in service	Percentage
Response time	Time taken to response the service	Millisecond
Availability	Fraction of time web service is present	Percentage
Privacy	Ability of the service to protect the disclosure of the private information	-
Operability	Ability of the service to enable the use to operate and control it.	-

**Table 2. Scales for qualitative attributes**

Value	Scale value
Excellent	1.00
Good	0.80
Average	0.60
Fair	0.40
Poor	0.20

we need to convert all attributes to one standard scale because all have different units of measurement. Table 3 have information of that point value that we refer from literature<sup>[1]</sup>.

Algorithm:weight calculation

Input; set of attribute value

Begin

For (i = 0; i <n ; i++)

a<sub>i</sub>

product =  $\prod_{(i=0)}^{(n-1)} a_i$

if(product==1)

for(i=n-2;i>=0; i--)

for(j=n-2;j>=i;j--)

result =  $\prod a_i$

w<sub>i</sub> = result

sum=  $\sum_{i=0}^{n-2} w_i + 1$

For (i = n; i <0; i--)

rank<sub>i</sub> = w<sub>i</sub>/sum;

QOS RANK USING THIS FORMULA

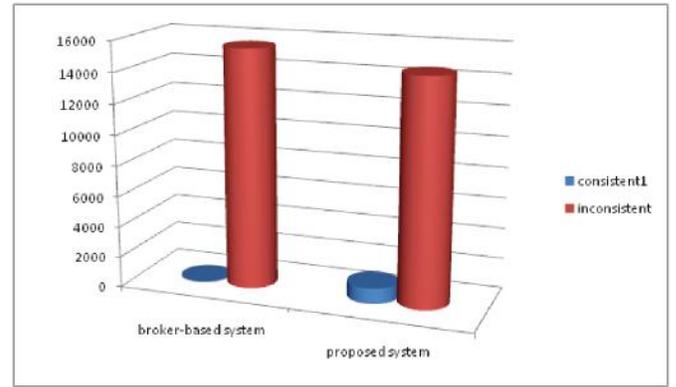
QoS of WS=  $\sum_{(i=1)}^n$ (Weight of attribute i \*scale point of attribute i).

#### 4. IMPLEMENTATION AND RESULT

To show the performance of our proposed system , we develop one web based application. The application was implemented on Window 8 with APACHE sever and using PHP programing language. We took sample input value that was inserted manually in database (MYSQL). We checked performance of proposed

**Table 3. Scales for quantitative attributes**

Cost	Fault rate	Response Time	Availability	Scale Point
<0.01	<0.05	<0.50	>99.9	1.00
<0.03	<0.10	<0.75	>99.5	0.80
<0.05	<1.00	<1.00	>99.0	0.60
<0.10	<5.00	<2.00	>95.0	0.40
≥0.10	≥5.00	≥2.00	≤95.0	0.20



**Figure 1. Comparison between Web Broker and proposed system.**

system against the Broker-based system<sup>[1]</sup> we also performed input consistency check by inserting sample data in database. Here, we have plotted graph based on the results in Fig 1. The rank of web service in both systems is the same but the proposed system has less complexity.

#### 5. CONCLUSIONAND FUTURE WORK

In this paper, we proposed algorithms for Web Service Discovery based on QoS and users preference. We also show of our proposed system has better consistency than the current system. Current system has very low consistency value 58 out of 15625 but proposed system has 998 out of 15625 as shown in graph.

As future research we are going to develop a system that will be able to predicate the future change in service based on old behaviour of web service improvement.

#### निष्कर्ष

इस पत्र में, हमने क्यूओएस और प्रयोक्ता की पसंद पर आधारित वेब सेवा खोज के लिए एल्गोरिथ्म का प्रस्ताव किया है। हमने यह भी दिखाया है कि मेरी प्रस्तावित प्रणाली वर्तमान प्रणाली से अधिक बेहतर स्थायित्व रखती है। वर्तमान प्रणाली 15625 में से 58 का बहुत कम स्थायी मान रखती है, लेकिन प्रस्तावित प्रणाली 1565 में से 998 का मान रखती है जैसाकि ग्राफ में दर्शाया गया है।

इस शोध के भविष्यगत कार्य के रूप में हम ऐसी प्रणाली विकसित करने जा रहे हैं जो वेब सेवा सुधार के पुरातन व्यवहार

के आधार पर सेवा में भविष्यगत परिवर्तन का पूर्वानुमान कर सकती है।

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## सामाजिक टैगिंग और इसका प्रचलन Social Tagging and its Trends: A Review

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### सारांश

उपयोगकर्ताओं द्वारा किसी भी सामाजिक नेटवर्किंग वेबसाइट की सबसे अधिक इस्तेमाल की जाने वाली फीचर टैगिंग हैं। कई शोधकर्ताओं और लेखकों ने विभिन्न तकनीक जैसे लीनियर क्लासीफायर, बैसियन नेटवर्क, के-नियरस्ट नेबर प्रस्तावित की हैं और टैगिंग की कार्यकुशलता की समीक्षा की है। टैगिंग ने समान प्रकार के डेटा का वर्गीकरण में उपभोक्ता की मदद की है। जो कि डेटा तत्व के आधार पर या रंग, आकार और टैग से संबंधित डाटा की अन्य विनिर्देश पर आधारित हैं। लीनियर क्लासीफायर विधि संबद्ध चरित्रों को पक्ति रूप में लेबल करता है। बैसियन नेटवर्क विधि एक नेटवर्क में नोड्स के बीच क्लोज्ड प्रोबेबिलिटी प्रदान करता है। संभावना पद्धति का उपयोग करके वस्तुओं की समानता में पहचान की जाती है और उन्हें एक विशेष टैग से वर्गीकृत किया जाता है। टैग उस मैटाडाटा को कहा जाता है जो वस्तुओं की समान वर्गीकृत सूचना दूढ़ने में मदद करता है। के मीन्स विधि को भी टैग के वर्गीकरण के लिए प्रयोग किया जाता है। यह पड़ोसी के बीच निकटता की गणना के द्वारा वस्तुओं को वर्गीकरण प्रदान करता है। इंडक्सन नियम विधि द्वारा टैगिंग नियमों और सुधार नियमों का प्रयोग उपयोगकर्ता द्वारा निकाली गई जानकारी वर्गीकृत करने के लिए किया जाता है। उपयोगकर्ता की जानकारी एस जी एम एल टैग डालने से निकाली जाती है। इस अध्ययन टैगिंग विकास के तरीकों के विप्लेशणात्मक विश्लेषण को दर्शाता है। इन तकनीकों का प्रयोग अधिक सटीक और तेज टैगिंग सुविधा के विकास के लिए किया जाता है।

### ABSTRACT

Tagging is the most used feature of any social networking website used by users. Many researchers and authors proposed different techniques like linear classifier, Bayesian network, rule induction, K-nearest neighbour and reviewed the efficiency of tagging. Tagging helps the user to classify the similar kind of data using similarities based on content of the data or by colour, size and other specifications of data related to the tag. The liner classifier method labels the characters associated in a linear form. The Bayesian network method provides the closed probability between the nodes in a network. Using the probability method, the similarity of the objects is recognized and these are classified in a unique kind of tag. Tags are so called the metadata which helps in searching the similar classified information about the objects. K-means method is also used for the classification of the tags. It provides the classification of the objects by calculating the nearness between its neighbours. Tagging rules and correction rules are used by the rule induction method for classifying the information extracted by the user. The user information is extracted by inserting the SGML tags. This study shows analytical analysis of tagging development methods. These techniques are used for developing the tagging feature faster and more accurately

**Keywords:** Collaborative tagging, social tagging, social metadata

### 1. INTRODUCTION

The availability of metadata (i.e., tags) describing Web resources has been considered as a key issue as soon as the Web became a public information space. Tags represent quite a few different aspects of the resources these describe and it is not obvious whether and how these tags or subsets of these can be used for search OR NOT. In this paper, we present a study on tagging techniques for very different kind of resources and systems like Web pages (twitter), mass (Last. FM), and images (Instagram). Social tagging is an online

community that has become an important method for reflecting classified thoughts of individual users.

Tagging is the method for classifying the data based on similarities in different aspects of the data. Tagging help the user to classify the group of objects by their basic features like colour, size, height and width, etc.

There are basically three types of tagging approaches used for classification of data. The traditional manual annotation approach is the first type in which user labels the content manually. However, it is a tedious

task to do, but it is relevant to small data which leads to improvement to the tagging approach. The second approach is content -based annotation, which provides the tagging on the basis of similarity in content. This approach uses the low-level characteristics of the data like shape, size, colour, texture. The automated annotation technique is the third approach in which the semantic model concept builds & uses the concept model of image labeling by automation.

In this paper we have provided a review of techniques used for developing the tagging feature. The following four techniques are studied in this paper: the Bayesian network, the K-nearest neighbour, rule induction & linear classifier. The Bayesian network is the popular method used for developing the tagging technique in which the closed probability between the nodes is measured. The Bayesian network is an acyclic graphical model used to handle uncertainty. This model is developed to represent the probabilistic dependencies among random variables. the K-nearest neighbour is an efficient & highly adaptive method for clustering. It uses the iterative process to calculate the centroids of clusters and assign each object to its closest cluster until no object is left. Then the clusters are labeled with the unique identifier which works as metadata for the data grouped in the cluster. The decision tree or the rule induction method is another way to develop the tagging feature. The rule induction algorithm learns from a temporary collection of information where it has highlighted the information to be extracted using SGML tags. The symbolic rules that insert SGML tags into text are indicated in two steps. These two rules are tagging rules and correction rule. The linear classifier makes the decision of classification based on the value of a linear combination of characteristic. These feature value presented typically to a system in a vector called feature vector.

## 2. LITERATURE REVIEW

Social annotation has received major attention in recent literature. Existing research on social tagging has been focused on the usage patterns and semantic values of social annotation<sup>2</sup>, the network structure of social tagging system and its application in information retrieval. In order to measure the semantic values of social tags, Al-Khalifa and Davis<sup>5</sup> compare social tags with the keywords automatically extracted using the Yahoo Term Extractor and concluded that social tags were semantically richer than automatically extracted keywords<sup>2</sup>.

Collaborative tagging has been early recognized as a challenging research topic<sup>1</sup>, for instance recent work has proposed intrusting approaches to tag recommendation and prediction. Tag prediction concerns the possibility of identifying the most probable tags to be associated with non-tagged resources, whereas tag recommendation

is meant to suggest to users the tag to be used to describe resources they are bookmarking<sup>1</sup>.

Automatic image annotation is tedious and highly relevant machine learning task. The tag annotation is more important for searching the image database of many social network sites and other websites such as Facebook, Google plus, Picasa, Flickr, etc. However, the big fraction of image database has no tag, so they never retrieve for queries. Annotation methodologies for contents can be generally classified into three types. The first are a manual annotation, in which users provide semantic information manually to explain documents, photographs, and video data. Manual annotation guarantees the appropriate semantic information about the content based on the user's subjective view. However, this method requires a great deal of time and effort. Furthermore, human fatigue can reduce the reliability of the semantic information<sup>6</sup>.

## 2.1 Techniques of Tagging

### 2.1.1 Bayesian Network

The Bayesian network tells us dependencies of probabilities on external interventions. Organization of casual Bayesian network premises one to predict of the effect of external interventions. Bayesian network model use to handle uncertainty. This is also known as directed acyclic graphical model that represents the probabilistic dependencies among random variables. The closed probability of the variables is measured in the Bayesian network model. The closed probability is determining the basis of the classification of the data. It relies on Bayes' rule Eqn. (1) and conditional independence to estimate the distribution over variables.

$$P(X|Y) = \frac{P(X|Y) * P(X)}{P(Y)} \quad (1)$$

Where  $P(X|Y)$  is the probability of node  $X$  over  $Y$  and  $P(Y|X)$  is the probability of  $Y$  over  $X$ .  $P(X)$  is the probability of node  $X$  and  $P(Y)$  is the probability of node  $Y$ .

### 2.1.2 K-Nearest Neighbour

K-mean is a highly adaptive and more efficient algorithm based on iteration to form the clusters. K-Mean clustering is based on user tag. It iteratively calculates the cluster centroids and reassigns each document to the closest cluster until no document can be reassigned. Taking into account the social annotations, the web documents can be clustered with K-means based on the following models:

#### 2.1.2.1.Tag Vector Model

- During the clustering process, the distance from a document to a cluster centroid is calculated based on the tag vector which user tagged only.

#### 2.1.2.2. (Word+Tag) vector model

- The distance from a document to a cluster centroid is calculated using combined vector.

#### 2.1.2.3. Word vector + Tag vector model

Each document is represented with two independent vectors: word vector and tag vector. During the clustering process, the distance from a document to a cluster centroid is calculated as the linear combination of the distance value based on word vector and the distance value based on tag vector.

#### 2.1.3 Rule Induction

The rule induction method use the symbolic rules that inserts the SGML () tags into text. These additional rules are used for correcting mistakes. The symbolic rules which insert the SGML tags are induced in two steps. These two rules are:

##### 2.1.3.1. Tagging rules

Sets of tagging rules are induced by bottom-up generalization of tag instances in the temporary classification. Shallow knowledge about NLP( natural Language Processing) is used in the generalization process<sup>7</sup>.

##### 2.1.3.2. Correction rules

Correction rules are induced that refine the tagging by correcting mistakes and imprecision<sup>7</sup>.

The tagging rules contain a conditional pattern on a connected sequence of words and an action introducing a single SGML tag into texts.

#### 2.1.4. Linear Classifier

Text classification is an process of taking decision about the related or non-related data to a given set of predefined categories. This is the important component in many organizations. The linear classifier is a group of classifiers which produce an model which is an linear combination of features. Linear classifier is based on machine learning .it uses characteristics of objects for identifying class or group it belongs.

### 3. REVIEW METHODOLOGY

For performing this review are, we had built up some stages based framework which includes data collection, acceptance and rejection criteria, search strategy, quality assessment and data extraction.

#### 3.1 Data Sources and Data Collection

The data searching strategy included online electronic data searches and manual searches of various national and international conference proceedings. In this context, following online journal's databases were

searched-

- IEEE Explore
- ASQ Digital Library
- Springer Link
- Academia.edu
- Research Gate
- Google trends
- Science Direct
- Elsevier

#### 3.2 Acceptance and Rejection Criteria

The studies which presented quality data on tagging techniques were accepted. We included the studies of both students and professionals. The language medium of all studies was English.

Some very old studies were rejected if they were not up to the mark. The author's main focus was to accept qualitative and tagging methods based research studies.

#### 3.3 Search Strategy

For searching research papers, we used Google search engine and MSN search engine. For this activity, we made some combinations from the area of tagging techniques. Some of those combinations are as follows-

- collaborative tagging
- Bayesian network
- linear classifier
- K-nearest neighbor
- rule induction
- social annotation

#### 3.4. Quality Assessment

For doing quality assessment the authors did follow the criteria defined in<sup>3</sup>. The three main issues defined in<sup>3</sup> are as follows-

- *Rigour*: Has a thorough and appropriate approach been applied to key research methods in the study?
- *Credibility*: Are the findings well-presented and meaningful?
- *Relevance*: How useful are the findings to the software industry and the research community?

#### 3.5 Data Extraction

On this final stage, data was extracted from each study. The data were extracted on the basis of parameters like the research method used, TAGGING methods, domain, publication, and remarks. Table 2 is representing this data. This table shows research methods, Tagging methods, domains remarks and publications of these selected research papers.

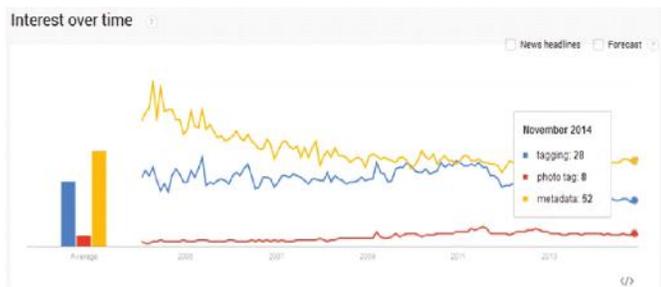


Figure 1. Graph on various tagging keywords search (as per Google trends).

4. RESULT AND DISCUSSION

In this paper we have four studies on tagging. The keywords tagging, photo tagging and metadata. Graph in Fig.1 represents the popularity and interest in tagging throughout the globe in recent 10 years (2005-2014).

Graph in Fig.2 represents the concern of tagging among people worldwide. New Zealand, Australia and Singapore are the top 3 countries that shown have interest in tagging (as per the Google trends).



Figure 2. Graph on regional interest of tagging.

Graph in Fig.3 reflects the using trends of tagging techniques from 2005 to 2014 around the world (as per the Google trends). Graph is generated for tagging techniques: Bayesian network, rule induction, linear classifier and k-means.

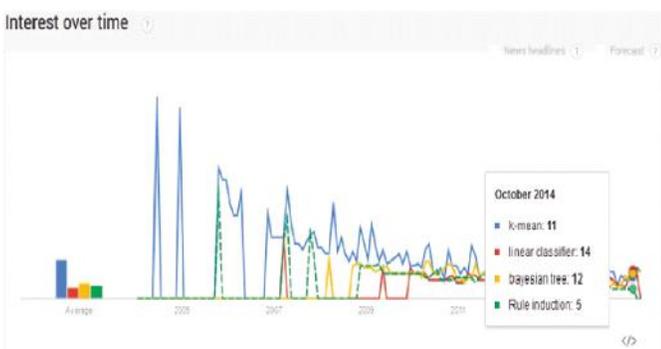


Figure 3. Graph on using trend of tagging techniques.

Table 1 shows the related work on tagging by different authors who have contributed in research of tagging.

Table 1.

S.No.	AUTHORS	YEAR	METHODS
1	Javier parra-arnau et al. [1]	2014	collaborative tagging using tag suppression
2	Young-Seol Lee et al. [7]	2013	Image tagging using tree structured Bayesian network
3	Zhang et al. [10]	2012	Automatic tagging algorithm based on the posterior probability computation using KL divergence and tag-to-set correlation analysis
4	Zhang et al. [8]	2012	graph-based reinforcement algorithm for inter-related multi-type objects
5	Sevillano et al. [9]	2012	Extracting geographical relevance from textual metadata and a geo-tagged database
6	Kelm et al. [11]	2011	Assigning geo-tags of visually similar images within geographical boundaries
7	Dong et al. [12]	2011	Semi-automatic tagging process in an incremental manner
8	Yu et al. [13]	2011	Image segmentation and similarity calculation for annotation
9	Larson et al. [14]	2011	Using Markov chain based algorithm
10	Li et al. [15]	2011	Calculating visual weight for image region and similarity comparison with the content of the region
11	Yang et al. [16]	2011	Image tagging approach based on near-duplicate image content and collective multi-tag association mining
12	Badii et al. [17]	2011	Semi-automatic labeling using keywords extracted from visual features and topic-map-based interface

5. CONCLUSION

This paper concludes that within a decade, the tagging feature has got the spotlight worldwide. Many websites are using the tagging for classifying the related data with a tag. This label (i.e. tag) on similar data,

helps in managing searched data more efficiently. There are different techniques has developed for tagging feature and fascinated the developers and users from the recent past. The k-means technique like is most popular for tagging. The other techniques Bayesian network, rule induction and linear classifier also gained the popularity over the years.

## 6. THREATS OF VALIDITY

### 6.1. Internal Validity

- *Instrumentation*: computers and internet application were used to conduct this study. The low speed of internet and inability of computer systems may have affected the result of the study because some websites do not response at low speed of internet connection. To overcome this threat, high quality systems and high speed internet connection were used.
- *Understanding Rate*: Some papers were not directly using the name of tagging, so it was difficult to understand that whether these are papers about tagging or not.

### 6.2 External Validity

The generalizability of the results of the study to others (usually real world) setting or population (Anderson and Bushman, 1997) typically refers to The external validity. Some websites does not use the word tagging so that sites are not used for searching relevant material.

### 6.3 Conclusion Validity

We had tried to cover more and more data for this study. But some tagging techniques might not include here. Some social networking sites were not providing separate data for India and that could improve the data we provided.

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## निष्कर्ष

इस आलेख से निष्कर्ष लगता है कि एक दाक में टैगिंग फीचर ने दुनिया भर का ध्यान खीचा है। कई वेबसाइटो ने टैगिंग फीचर का उपयोग संबंधित डेटा को एक टैक के साथ वर्गीकृत करने में किया है। यह टैग या लेबल समान डेटा को अधिक कुशलता से ढूँढने में मदद करता है। अतीत में विभिन्न प्रकार की तकनीको का विकास टैगिंग फीचर के लिए और विकास को और उपभोक्ताओं को सुविधा प्रदान के लिए किया गया है। के-मीन तकनीक टैगिंग हेतु सबसे लोकप्रिय है। अन्य तकनीकों में बेसियन नेटवर्क, रूल इंडेक्शन और लीनियर क्लासीफायर ने भी पिछले कुछ वर्षों में लोकप्रियता हासिल की।

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योजना निगरानी सूचना प्रणाली के वेब अनुप्रयोग के लिए ग्राहक सर्वर अनुप्रयोग:  
एक प्रकरण अध्ययन  
**Client Server Application to Web Application of Schemes Monitoring  
Information System: A Case Study**

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**सारांश**

जावा, एएसपी, पीएचपी जैसे वेब अनुप्रयोग उपकरणों की शुरुआत के बाद से, डेस्कटॉप/क्लाइंट-सर्वर अनुप्रयोग से वेब अनुप्रयोगों के लिए अनुप्रयोग विकास का काफी उन्नयन किया गया है। वेब अनुप्रयोगों को केवल उपयोगकर्ताओं (जो कहीं से भी अनुप्रयोग का उपयोग कर सकने को बेहतर पाते हैं) द्वारा ही नहीं बल्कि डेवलपर्स और कार्यान्वित करने वालों द्वारा भी वरीयता दी गई है, जो ग्राहकों के सभी ठिकानों से अद्यतित करने की बजाय एक ही स्थान से इसे उन्नत/अद्यतित करने में आसानी का अनुभव करते हैं। वेब अनुप्रयोगों की लोकप्रियता ने पहले से विकसित डेस्कटॉप अनुप्रयोगों को वेब अनुप्रयोगों में उन्नयन की चुनौतियों को पीछे छोड़ दिया है। वर्तमान प्रकरण अध्ययन सूचना प्रणाली की निगरानी योजनाओं (आगे एसएमआईएस के रूप में संदर्भित) के क्लाइंट-सर्वर संस्करण को वेब संस्करण में उन्नत बनाने से संबंधित है।

**ABSTRACT**

Since the introduction of web application tools like Java, ASP, PHP etc., the application development has significantly upgraded from desktop/client-server applications to web applications. Web applications have been given preference not only by the users (who finds it better to access the application from anywhere) but also by the developers and implementers who find it easy to upgrade/update at one place rather than trying to update at all client locations. The popularity of web applications have thrown up the challenges of upgrading the already developed desktop applications to web applications. The present case study is of upgrading client-server version of schemes monitoring information system (SMIS) to the web version.

**Keywords:** Client-server, web application, desktop applications, schemes, SMIS

**1. INTRODUCTION**

Software application development began with desktop applications, which could be used on standalone machines only. With the introduction of the networking concepts and relational database management systems (RDBMSs) like MS SQL server etc. the software applications were developed in client-server mode where the data was kept on the servers and also the complex applications were decomposed into two parts, one which runs on server and other which runs on personal computers (PCs) known as clients. The client-server version of SMIS was one such application

which was developed to help the planning cells in deputy commissioner (DC) offices of all the Districts in Himachal Pradesh. DCs being developmental head of districts, receive a number of proposals through various channels, viz., government, public representatives, gram panchayats, non-government organisations (NGOs) and other social bodies, etc., for execution of development works/schemes. It is very tedious and difficult job to disburse the development funds rationally across all geographical and social segments so as to have an equitable growth of all. In addition to fair distribution of funds, it is also extremely important to monitor

the progress of sanctioned schemes on regular basis so that the ongoing works can be completed within specified time frame, without cost escalation and as per scheme guidelines. To meet these requirements, software named schemes monitoring information system was developed by National Informatics Centre (NIC), Himachal Pradesh state unit in the year 2005. This application was based on client-server technology and developed using Visual Basic and Microsoft SQL server. The application had codes for many entities which needed to be standardised like Scheme Heads, Sub Heads, Districts, Blocks, Urban Bodies, Panchayats, Urban Wards, Sub divisions, Tehsils, constituencies (Assembly as well as Parliamentary), executing agencies, work types etc. The data was usually kept in the servers available at NIC district units and the executable version of the software was installed on all the PCs of district planning officer (DPO) and the dealing assistants at the planning cells of the DC offices.

## 2. LIMITATIONS OF CLIENT-SERVER APPLICATIONS

The client-server software is difficult to manage. Many times the software needs changes after implementation for removing bugs or improving the software. Every time the software changes, it is required to change the executable files on every client wherever the software is installed. This is huge task. The user has to ensure that every client has the latest executable file as the older version can throw errors or may perform erroneously.

It is also required to have a dedicated IT professional to maintain the network, servers, implement any changes in the structure of the database/tables/stored procedures, etc., at each site.

Apart from above limitations which are common to any client-server software, SMIS had few more issues/limitations which are:

- Since the software was implemented at different DC offices in the state with limited data for that particular district only, the compilation of the data at state level was a difficult task. The master codes as described in the introduction were added/updated locally at each location to suit their demands. For example, the executing agencies are different for different districts, so a code representing 'X' executing agency in one district could represent 'Y' executing agency in another district. Due to this problem, state level data compilation became very complex job. It necessitated to ensure the addition of the codes at the state headquarter only. This also led to another problem of code mismatching as whenever a code was added at the state level, it was many times skipped by the district(s) who did not need that code.

- The physical and financial progress was entered by the dealing assistants in the DC office as per the status provided by the executing agencies, which usually does not give the real time status of the scheme (s). The executing agencies did not have any access to data or software so they were sending monthly or as-and-when-required status reports to update data which does not show the real time position.

Keeping in view all above limitations, it was decided to have a web application for the SMIS.

## 3. ADVANTAGES OF WEB APPLICATIONS

The web applications are also a type of client-server applications as they have web server at the back end and all the devices accessing the application act as clients. But apart from this similitude, web applications have many other key advantages over the client-server applications like:

- Web applications do not require any complex 'roll out' procedure to deploy in large organizations. Network connectivity and a compatible web browser is all that is needed.
- Browser applications typically require little or no disk space on the client.
- They require no update procedure since all the modifications are implemented on the server and automatically delivered to the users.
- Web applications integrate easily into other server-side web procedures, such as email, SMS services and searching, etc.
- They also provide cross-platform compatibility in most cases (i.e., Windows, Mac, Linux, etc.) because they operate within a web browser window.
- With the advent of HTML5 (hyper-text markup language, version 5), programmers can create richly interactive environments natively within browsers. Key features include native audio, video, animations as well as improved error handling.
- Modern web applications support greater interactivity and greatly improved usability through technologies such as AJAX that efficiently exchange data between the browser and the server.
- Web applications are accessible over new user devices (e.g. smartphones, tablets, palmtops, etc.).

In the web version of the SMIS application, we could also achieve added advantage of standardisation of codes and access to the state wide data.

## 4. APPROACH TAKEN

Once decided to have a web application in place of the client-server application, the first issue was to decide about the platform for the new application. There were plenty of choices available like Java, PHP, ASP. Net, etc. The data in the client-server application was

being stored using MS SQL so it was decided that we should use. Net technology which is also Microsoft product. Another advantage of using .Net technology was being language-independence, it allows to choose from a bunch of over 25. Net languages including VB.Net, C#, JScript .Net, etc. that best applies to the application. ASP.Net is also a better option for object oriented programming and hence favoured our choice. The client-server version of SMIS was developed using VB6, hence it was also easier to switch over to ASP.Net technology. Once the platform was decided, the next task was to do database changes to suit for web application.

**5. CHANGES IN DATABASE DESIGN AND USAGE**

Changes in database design and usage are must for upgrading from client-server application to web application. The following steps underline its importance:

- (a) In the client-server application, the database is usually designed and created as per the particular site requirements and many times it is omitted to add parameters to uniquely identify the offices/ departments/users of the application with other locations. For example, as mentioned in Table 1, the Executing Agencies were stored in ‘Common Codes’ table with data type as Char(3), means only 999 Executing Agencies can be stored in it. Also there was no distinction which agency will be used in which district - thus every district would have got the whole list and it would have been a tough job to select the agency belonging to a particular district. To overcome this issue, the Executing Agency in that table was left to represent only the Common Name of the Executing Agency, and another table to record the District wise places of work for that agency was created as mentioned in Table 2 and Table 3. For example, all districts have BDO (Block Development Officer) as Executing Agency, but its location is different in every district and a district would have more than one BDO in its jurisdiction. So we had the code for BDO in the original table and another table was used to represent the location. Same information is available with the combination of two tables after changes in database design.
- (b) While designing client-server application, usually database queries are embedded in the code. For example any select or update query can be written as it is and since the application is compiled no one can actually get to know the structure of the query. But in the web application, such queries can make the application vulnerable to hacking attacks. Therefore, instead of writing queries in the application code, all the queries are written

**Table 1. Executing agencies detail as was in the old system**

Code Type	Code	Description
Executing agency	013	BDO Solan
Executing agency	014	BDO Dharampur
Executing agency	015	BDO Nalagarh
Executing agency	016	BDO Kunihar

**Table 2. Executing agencies detail as used in the new system**

Code Type	Code	Description
Executing agency	001	BDO
Executing agency	002	X.EN. HP PWD
Executing agency	001	X.EN. IPH

**Table 3. Final mapping of executing agencies as used in the new system**

District	Executing agency common code	Place name
10	001	Dharampur
10	001	Kunihar
10	001	Nalagarh
10	001	Kandaghat
10	001	Solan

in the database end as stored procedures which limits the direct access to tables and provide an ‘interface’ to the underlying data structure hence implementation and even the data itself is shielded. Securing the data and code that accesses the database is easier than applying the security within the application code itself. Therefore, stored procedures were written to perform all the data access and manipulation tasks.

- (c) Data optimisation was another key requirement. Since the complete data of the state related to schemes sanctioning irrespective of the location was to be hosted on a single data server to be accessed over the net, hence due care was provided to keep the data optimised.
- (d) As the data is being kept on the data server installed at the state data centre, hence all the issues related to hacking, data security, backups etc. are being managed by the professional team managing the data centre.
- (e) Earlier in the client-server version, the data was hosted and managed at the district level; therefore it was desirable but very complicated job to port the old data of all the locations to the central server. For this, a generic utility was designed to map their codes with the new codes and port their data to the centralised database in a standard format.
- (f) Another key design enhancement was the addition

of Executing Agencies role. Earlier, only District Planning Cell was maintaining the whole application but in the web version, Executing Agencies were provided the access to enter physical and financial progress of the schemes.

### 6. APPLICATION DEVELOPMENT

After database design and updation, the next step was the actual development of the web application. This was entirely a new task as there was no scope of code and screens reusability in the development of the web application. Also to maintain the consistency and feel of the earlier version, there were constraints to maintain the major entry screen design the same as it was in the client-server application. After all this ground work, the next step was to start the development in ASP.Net. Microsoft Visual Studio 2005 was used for creation of website. Visual Basic.Net was used as the coding language. It was given preference over C# due to the developer’s familiarity with the Visual Basic. The deployment in the ASP.net website is also very easy as ASP.NET 2.0 provides a very simple model for file organization, code registration, etc.

### 7. THE OUTCOME

The motive behind taking up this project for computerization was not just digitization of the processes involved in sanctioning of the development schemes. Rather, it was an opportunity for introspection, use of the experience gained over the years and implementation of the best practices. Many new reports and queries were added in the web application.

Once through with the teething problems while bringing all the stake holders to a common platform, the SMIS system proved a great help in sanctioning and monitoring of the schemes by the district administration in one hand and in proper execution and reporting by the executing agencies on the other hand. Table 4 shows the glimpse of one of the monitoring reports displaying schemes pendency. Figure 1 can further be drilled down to the gram panchayat level.

As a common database is being used by all the stake holders, hence no reentry of data at any level is required. The redundancy and duplication of the

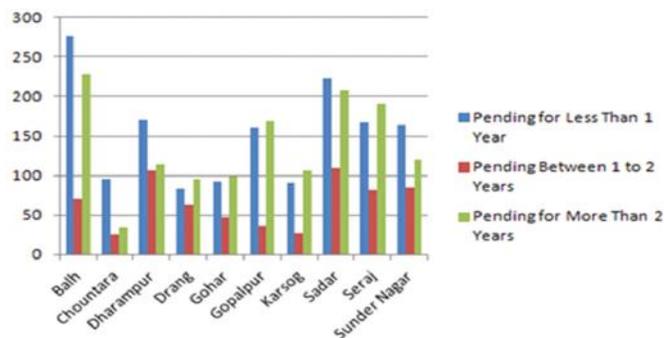


Figure 1. Periodic pendency.

Table 5. Schemes status in Himachal Pradesh

Schemes type	Schemes (numbers)
Not started	1956
In progress	54872
Completed	86091
Cancelled	4653
Total	147572

processes has been totally eliminated which also resulted in higher efficiency and transparency. It is also a step towards greener world as reports are online available to all the stakeholders and generally transmitted electronically due to which paper consumption is minimised.

As the reporting is based on the real-time data and centralised database is accessed by all the users, no fudging in status reports is possible and up-to-date status is provided to all thereby making the system completely transparent and everybody involved is made fully accountable.

Since the emphasis is made on the timely completion of the works through excellent online monitoring, there happened a quantitative reduction in the requirement of additional funds due to cost escalation.

### 8. RESULTS AND DISCUSSION

The SMIS system testifies the intentions behind this project. The introduction of the web enabled application, the real-time reporting has been proved as an eye-opener to pin point the gaps and loop holes

Table 4. Monitoring report

Summary Report Schemes Pendency from 01/11/2014 to 30/11/2014

Report of Pending Works for : BDO

Executing agency	Less than 1 year	Between 1 to 2 years	Over 2 years	Total pending	UC/CC received during the period
Balh	276	71	228	575	0
Chountara	95	25	35	155	4
Dharampur	171	107	114	392	1
Total	1522	650	1365	3537	16

**Table 6. Schemes cancelled - year wise**

Schemes cancelled - year wise	
Sanctioning year	Schemes cancelled (numbers)
1997	5
1998	2
1999	7
2000	4
2001	3
2002	22
2003	16
2004	30
2005	58
2006	86
2007	94
2008	124
2009	304
2010	80
2011	45
2012	48
<b>Total</b>	<b>928</b>

in the traditional system of sanctioning of schemes.

Immediately after the scheme is sanctioned, the key concern of the sanctioning/monitoring agencies is to complete the execution work at the earliest so that no additional funds are required and the scheme is made usable. This application provided a robust system of monitoring right from state level down to the gram panchayat level to check as how many schemes are pending within a year, pending between 1 to 2 years and pending beyond 2 years.

The second major concern is to check as how many schemes are not started. It is always required to check if a schemes is not started due to any dispute etc., then same may be cancelled and that amount be sanctioned to some other scheme.

This system also helped to trace some schemes as old as ten years or more which were not started and the money was lying unspent with the executing agencies unnoticed. This led to the cancellation of such schemes and the money could be sanctioned to other schemes.

It also helped in achieving another goal of equitable growth to all as lot of gram panchayats were found where either a sizeable number of schemes were sanctioned or very few schemes were sanctioned. The state authorities were also helped in planning and sanctioning of funds across all the districts.

The new system has another enhancement as integrated module for entry and settlement of the comptroller and auditor general of India (CAG), public accounts committee (PAC), and general audit para (s). Initially the audit para (s) detail as raised by the auditors is entered in the system which is subsequently updated as and when some action for the settlement of the audit para (s) till the final removal of the para (s). Intermediary directions by the auditors are also recorded in the system. This module has helped in settlement of good number of audit para (s) which were lying unsettled for the years.

## 9. ACKNOWLEDGMENTS

At the outset, we would like to thank Advisor Planning, Government of Himachal Pradesh for allowing us to take up this project for computerisation. We would also like to thank Deputy Commissioner Mandi for taking this activity for pilot testing in his district. Heartfelt thanks are due to all the officers and officials of the state planning department and NIC HP for the support provided time to time.

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## संस्कृत भाषा के लिए रूप और अभिव्यक्ति और संस्कृत वाक्यांशों का इस्तेमाल करते हुए व्याकरण संबंधी रचना का ज्ञान प्रतिनिधित्व

### Knowledge Representation of Grammatical Constructs for Sanskrit Language using Morpheme and Parts-of-Speech Tagging using Sanskrit Corpus

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#### सारांश

संस्कृत भारत की प्राच्य भाषा के रूप में कई हजार वर्षों से मौजूद है। यह अधिकांश भारतीय भाषाओं का आधार है। प्राकृतिक भाषा का सांख्यिकीय प्रसंस्करण रूप पर आधारित है (एकवचन रूप)। लिखित और बोले गये शब्दों का ग्रंथ संग्रह भाषा कोष के रूप में जाना जाता है, जिसे भाषाई शोध के उद्देश्य से इलैक्ट्रॉनिक मीडिया में एक संगठित तरीके से संग्रहित किया जाता है। इसे भाषा जाँचकर्ताओं द्वारा योजनाबद्ध तरीके से 'परामर्श' होने के लिए एक संसाधन के रूप में प्रस्तुत किया जाता है। प्रस्तुत लेख संस्कृत में शब्द और रूप स्तरों पर स्वचलित तरीके से वाक्यांश समूह के लिए एक दृष्टिकोण बताता है। यह दोनों स्तर पर इस्तेमाल किये गये अलग वाक्यांश समूह देता है।

#### ABSTRACT

Sanskrit since many thousands of years has been the oriental language of India. It is the base for most of the Indian languages. Statistical processing of natural language is based on corpora (singular corpus). Collection of texts of the written and spoken words is known as language corpus, which is collected in an organized way, in electronic media for the purpose of linguistic research. It presents as a resource to be systematically 'consulted' by language investigators. This paper explains an approach for tagging the corpora automatically at word and morphemic levels for Sanskrit. It also gives different tag sets used at both the levels.

**Keywords:** Part-of-speech, tagging, noun, verb, parsing, lexical analysis

#### 1. INTRODUCTION

Understanding of actual sense of word is very tricky. Most of the words having more than one meanings like in English language word 'book' plays two different role in the sentences i.e., Book that flight and this is a book. two major approaches to deal with the problem of sense disambiguation of words. The knowledge-based approach uses explicit sets of lexicon, while the corpus-based approach uses information obtained from corpus. As we prefer to work with the corpus based approach, we try to extract information from the analysis of corpus. Information which we get will be processed to understand actual contextual sense.

Besides linguists and lexicographers potentiality of large corpora (in English and other European Languages) has been identified by speech and information technologists. Again corpora are analyzed, and the linguistic information is enclosed at various levels (tagged corpora). Automatically retrieve selective information

for the convenience of researchers to. The various sectors where corpora are found to be functional are linguistics, lexicography, natural language processing, language teaching and speech processing.

#### 2. LITERATURE REVIEW

'Development of Corpora of text of Indian Languages' started in 1991 by Department of Electronics (DOE), Govt. of India for the first time the texts of Indian languages are made available in machine readable form through the project. Six various sectors at which, corpora development project for the 15 scheduled languages has been chosen. For formation of corpus, later languages newly added to the 8th schedule have also been added. Elaborately by Annamalai (1994) have been discussed objective, size of the corpora, coordination between centers, etc.. The Central Institute of Indian Languages, Mysore has taken up the corpora development work for Sanskrit, Kannada, Malayalam, Tamil and Telugu Languages. This paper explains an

approach for tagging the corpora automatically at word levels and morphemic levels for Sanskrit. It also gives different tag sets used at both the levels.

Various studies have been done for Part-of-speech (POS) tagging, Dinesh Kumar and Gurpreet Singh Josan suggests prime factor in evaluating any POS tagger<sup>1</sup>. Dipanjan Das, Slav Petrov introduced unsupervised part-of-speech taggers for languages that have no labeled training data, but have translated text in a resource-rich language<sup>2</sup>. Doug Cutting, Julian Kupiec, Jan Pedersen, and Penelope Sibun introduced part-of-speech tagger is a system that uses context to assign parts of speech to words<sup>3</sup>. B. Megyesi introduced In Hungarian language; it is shown that the present system does not obtain as high accuracy for Hungarian as it does for English<sup>4</sup>. Mitchell P. Marcus, Beatrice Santorini and Mary A. Marcinkiewicz proposed first design POS tagset and presenting the tagset itself, after that two-stage tagging process, in which text is first assigned POS tags automatically and then corrected by human annotators<sup>5</sup>. Cem Bozsahin described lexicon to formulate semantically transparent specifications<sup>6</sup>. Namrata Tapaswi and Dr Suresh Jain introduced how to morph the Sanskrit sentences<sup>7</sup>. Evangelos Dermatas, and George Kokkinakis described stochastic tagger that is able to predict POS of unknown words<sup>8</sup>. Doug Cutting, and Julian Kupiec described implementation strategies and optimizations which result in high speed operation<sup>3</sup>. Mitchell P. Marcus, Beatrice Santorini and Mary A. Marcinkiewicz described how to construct one such large annotated corpus-the Penn Treebank<sup>10</sup>.

We qualitatively analyze our results by examining the categorization of several high impact papers. With consultation from prominent researchers and textbook writers in the field, we propose simple corpus tagging for Sanskrit language. It uses rule based approach to tag each word of the sentence.

### 3. CORPUS MANAGEMENT

Corpus contains a number of various information rather than texts which, in turn, makes the information retrieval a relatively trivial task.

Mainly information is categorized in two types:

1. Representative information (actual form of the text) and
2. Interpretative information (adding linguistic information to the text).

### 4. CORPUS ANNOTATION

Individual sentences, words, morphemes, etc, Corpus can be made to provide more valuable information about these. It could be gained by including linguistic information (interpretative information) to the text. The electronic representation of language material itself is called corpus annotation including the

practice of adding linguistic information to an existing corpus of spoken or written language by some kind of coding attached to, or interspersed with. Annotations can be made at different levels, namely, orthographic, phonetic/phonemic, prosodic, grammatical, syntactic, semantic and pragmatic/discourse level.

Basic advantages of annotated corpora are that the structural information at various levels could be retrieved based on linguistic tags, which are the frequent requirements of linguists, lexicographers and NLP researchers.

## 5. GRAMMATICAL TAGGING

In English and other European languages grammatical tagging is the popular and common type of annotation successfully implemented in a number of corpora. It is the procedure, to indicate its grammatical category, which adds a tag at the end of a word.

It can be achieved in two ways:

1. Manual tagging and
2. Automatic tagging (with manual post-editing).

The former is labour intensive, slow and legally responsible for error and inconsistency. There are various approaches in the latter, but can be broadly categorized into two methods:

### 5.1 Rule based Tagging

These taggers are based on a defined set of hand written rules. Most of the existing rule based POS taggers are based on two-stage architecture. The first stage assigns a list of probable tags (or the basic tag) for a particular word. The second stage, uses large list of hand written disambiguation rules, to reduce the list (or change a wrong tag) to a single right tag. Here all the rules are pre-defined. They may be language dependent or independent.

### 5.2 Statistics based Tagging

Stochastic taggers used hidden Markov Model or HMM tagger. The per pose behind all stochastic tagger as a simple generalization of the 'pick the most likely tag for this word' approach. Stochastic taggers generally resolve the ambiguity by computing the probability of a given word (or the tag). The probability is calculated using a training corpus. The training corpus is a tagged corpus, which is assumed 100% correct. The probabilities are calculated using unigram, bigram, trigram, and n-gram methods.

The former method is explained in the following sections.

## 6. TAG- SETS

A tag set is the set of POS categories, in which, any word in a language can fall in to any one of

those categories. And it gives the representation for each of the POS tag. There are various tag sets used for tagging an English corpus. The tag set for suffix stripper contains 12 major categories.

They are:

1. N - Noun
2. V - Verb
3. ADJ - Adjective
4. A - Adverb
5. Q - Quantifier
6. C - Conjunction
7. P - postposition
8. PRO - Pronoun
9. QUES - Question word
10. VBN – Verbal Noun
11. SYM - Symbol
12. NUM – Number

As the corpora envisage multiple uses, it was decided to limit the tagging only to the major twelve parts of speeches. Currently Sanskrit corpus has been tagged with more number of tag sets at word level and an elaborated labeling at morpheme level are carried out in order to meet the requirements different user group. There are 34 tags at word level and 132 tags at morpheme level.

## 7. PROBLEMS PERTAINING TO TAGGING OF SANSKRIT CORPUS

- (1) Identification of words: Normally a sequence of characters between two successive spaces is considered as a word. It is even convenient to the computers to identify a unit as a word. But in real sense, the unit need not always be a simple word, i.e., it may be a compound or conjoined word, where the base form does not find a place in the dictionary.
- (2) Internal Sandhi: The morphophonemic changes that take place when a suffix is added to a stem depend on the final phoneme of the stem and the initial phoneme of the suffix and which are too many in the agglutinative languages.
- (3) External Sandhi: The operation of external, the morphophonemic change that takes place when two words are conjoined is not consistent in some languages like Sanskrit
- (4) Inconsistency in spacing between words: In Sanskrit two or more independent words are written jointly as a single unit. Sometimes inconsistency persists in spacing between main and auxiliary verb, noun and particle, etc.

## 8. TAGGING SCHEME

The approach for grammatical tagging adopted is mainly based on the morphological analysis of these languages. To segment a word (if it has more than

one morph) to its stem and suffix (es), the word can be approached either from the beginning (left to right) or from the end (right to left). The scheme, which we follow, approaches the word from the end in order to detach the suffix (es) one by one from the stem, as suffixes are finite in any natural language. The system first identifies the valid morph in the word one by one and labels them at morpheme level then the entire word is tagged for its grammatical category at word level. This system has three major components:  
 (1) Stem- MRD (Machine Readable Dictionary)  
 (2) Suffix – MRDs and  
 (3) A set of morphophonemic rules.

### 8.1 Stem – MRD

The stem is the ‘main’ morpheme of the word, suppling the main meaning .The major tasks involved in the preparation of stem are the collection of words, identification of their stem alternates and classification. Stem consists of all the possible roots and stems in the language.

For example, if a word has four stem alternates; the entire four stem will be included in the dictionary as independent entries. They are classified into various types on the basis of the first suffix they take. The basic structure of the stem-MRD is as follows:

Stem / Category / Type / Status

### 8.2 Suffix – MRDs

Suffixes follow the stem. The basic principles underlying in the design of different MRDs for suffixes are the position of a suffix in a word and its companion. In our system the searching begins from the end of a word. The system identifies and detaches the suffix (es) one by one till it finds a stem. It is performed using a number of suffix- MRDs rather than one. The basic structure of the suffix – MRD is as follows:

Suffix / Type / Morpheme-tag / Word-tag

The suffix – MRD also consists of four fields. The actual suffix occupies the first field. The number in the second field indicates the type of suffixes, which could occupy the immediate left position of the present suffix. It actually helps to select the proper MRD for searching. The third field gives the grammatical information of the suffix which would be used to tag at the morphemic level. The last field indicates word-tag information, if this suffix is the determining element. The last two fields may contain more than one entry, when the suffix has different grammatical functions in different contexts. As the order of suffixation is unique for any word form, it would be easy to condition the occurrence of a given suffix. So the type number that explains this condition plays a crucial role in the analysis. S1, S2, etc. given in the type-field indicate that the possible previous

element would only be a stem and that stem belongs to a particular group. The information on the stem group is made available in Sfile. The S-file for the above example is as follows:

### 8.3 S-file

S1 > 1,2  
S2 > 2

If the suffix indicates the type as S1, then the possible stems are of type 1 and 2 (type given in the stem – MRD) only.

### 8.4 Morphophonemic Rules

The third component of the system is a set of morphophonemic rules, which operate externally. It is necessary for reverting the sandhi operation in order to obtain the stem and suffixes of the word encountered, as given in the MRDs.

## 9. ALGORITHM

The suffix stripper uses a list of suffixes, pronouns, adjectives and adverbs. The input format is one sentence per line in which each word is separated by a white space. On the input text, it performs the following steps:

Algorithm 1: (part of speech tagger) POST

Step1: Begin

Step2: [initialization] Split the sentence in to words called lexeme.

Step3: [reading for each word]

3.1. Find the longest suffix at the End.

3.2. Find the table number of the suffix and eliminate the suffix from the word.

3.3. Go to 3.1 until the word length is 2.

Step 4:[Applying rules] Using the combination of suffixes and the rules, apply the lexical rules and assign the category.

Step 5: [Checking] For each sentence

5.1. Apply the context sensitive rules on the unknown words.

5.2. Apply the context sensitive rules on the wrongly tagged words.

5.3. If no context rule applies for any unknown words, tag it as noun.

Step 6: END.

Suffix stripper is depicted in Fig. 1.

## 10. OPERATION OF THE SYSTEM

The system reads a word from the corpus and tries to identify with those entries marked ID as status in the stem – MRD. If it possible, it finds the category in the second field and tags the word suitably. If it does not happen, it tries to categorize the last suffix and to match with suffixes, listed in L1 – MRD. If it finds a match, based on the value in the type-field

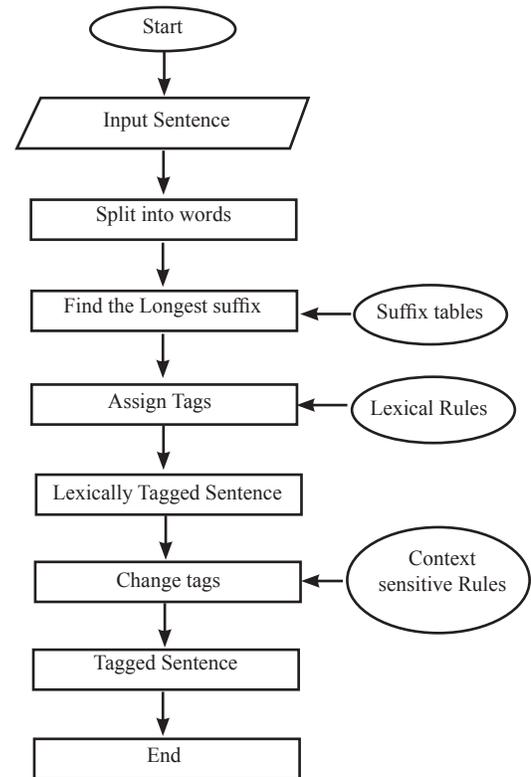


Figure 1. DFD for Suffix stripper.

it proceeds to the respective suffix–MRD or the stem– MRD. This process is continued till a stem is reached. At every suitable point the grammatical value and the word–tag information (if any) is stored along with the morpheme and the position. When the word encountered is totally analyzed, the stored information as needed will be written into the output file. If the system does not find a match in the last element itself, it tries to use the morphophonemic rules to revert the sandhi operation. If there is any possibility, the system repeats the procedure from the starting. In case of uncertainty, the word will be left untagged and the next word will be taken for analysis. Similarly, and disagreement in the matching at any stage beyond L1 leaves the word untagged. As all the alternant forms of stems and suffixes are included in the MRDs, the problem of the internal sandhi is easily solved. In this model, when the system encounters more than one grammatical

category for a suffix, it first attempts to analyses the whole word for the first category and then restarts the analysis for the second category, and so on. So the system is capable of analysing the homophonous forms for all their possible structures. This model also resolves the problems of compound and conjoined words which are found with or without space to a maximum extent. Most commonly used compound forms are included in the stem – MRD. The other compound and conjoined words are tackled using

repeated procedure i.e., every time after finding a stem, the system looks for any remainder. If there is, it repeats the analysis from the very beginning, as if the remainder is a new word.

The untagged words and the words with more than one tag can be manually tagged.

## 11. EXPERIMENTAL RESULT

One set of 100 words have been taken and manually evaluated, which gives following results. Few of them are illustrated below in Tables 1 and 2.

1. जननी रामचन्द्राय शेजनं यच्छति।
2. अश्वः मुखेन घासं चर्वति ।

The system gives 90% correct tags for each word.

$$\text{Precision} = \frac{\text{No. of correctly tagged words}}{\text{No. of total words}}$$

**Table 1. POST output for जननी रामचन्द्राय शेजनं यच्छति।**

SNo.	Word	Root	Group	Relation
1	जननी	जननी	noun	1 relation 2
2	रामचन्द्राय	रामचन्द्र	noun	2 subject 3
3	शेजनं	शेजन	noun	3 object 4
4	यच्छति	यच्छ	verb	4 verb 4

The sentences were taken randomly from the database

**Table 2. POST output for अश्वः मुखेन घासं चर्वति।**

Sno.	Word	Root	Group	Relation
1	अश्वः	अश्वः	noun	1 relation 3
2	मुखेन	मुख	adverb	2 adverb 3
3	घासं	घास	noun	3 object 4
4	चर्वति	चर्व	verb	4 verb 4

and evaluated. The evaluation table is given below in Table 3.

**Table 3. Evaluation Table**

No. of Tested Words	Totally Tagged words	Correctly Tagged Words	Precision
100	100	90	90%
100	100	91	91%

The evaluation was done in two stages. Firstly by applying the lexical rules and secondly, after applying the context sensitive rules.

## 12. CONCLUSION

The concept analyzed in this paper is basically evolved to handle the languages, which are morphologically rich Languages like Sanskrit,. The concept is language independent. After deducting some procedures this model

can be used for spell- checker as well as considering the speed, consistency, accuracy indicated by Leech (1993:279), for a tagging scheme, this system may be slow. But according to speed point of view, it need not be considered on particular with the other two criteria as tagging as corpus is a one on time job. More then that speed of application can be considerably in this concept, by building a single suffix-MRD depend on the situation only, in this case the corpora should be free from spelling and grammatical errors.

## निष्कर्ष

प्रस्तुत लेख में विश्लेषण की हुई अवधारणा को मूलरूप से भाषाओं को संचालित करने के लिए विकसित किया गया है जो संस्कृत की तरह रूपविज्ञानात्मक संपन्न भाषाएँ हैं। यह भाषा निष्पक्ष अवधारणा है। लीच (1993:279) के अनुसार कुछ विधियों में कमी करके इस प्रतिमान को वर्तनी या उच्चारण जाँच, गति, स्थिरता, सटीकता पर विचार करते हुए इस्तेमाल किया जा सकता है, वाक्यांश उपाय के लिए यह प्रणाली धीमी हो सकती है। लेकिन गति के विचार से इस पर अन्य दो मानदंडों, वाक्यांश विशेष या राशि विशेष के एक समय पर एक के रूप में विचार करने की जरूरत नहीं है। केवल परिस्थिति पर निर्भर एक एकल प्रत्यय-एमआरडी के निर्माण से इन इस अवधारणा में अनुप्रयोग की गति काफी अधिक हो सकती है, इस मामले में समूह को व्याकरण और वर्तनी की त्रुटियों से मुक्त किया जाना चाहिए।

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## बड़ा डेटा विश्लेषण : भविष्य की सूचना प्रौद्योगिकी के लिए चुनौती Big Data Analysis: Challenge for Future Information Technology

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### सारांश

नई जानकारी और दूरसंचार प्रौद्योगिकी की घातांक बढ़ती की वजह से उत्पन्न बड़े डेटा का विश्लेषण सबसे बड़ी चुनौती है। बिग डेटा सूचना प्रौद्योगिकी के उत्पन्न अवधारण हैं जिसमें अर्थपूर्ण और अंतर्दृष्टि जानकारी निकालने के लिए प्रोग्रामिंग और डेटा विश्लेषण में अत्यधिक कुशल और पेशेवरों की आवश्यकता है। यह शोधपत्र वैश्विक आईटी उद्योगों की अवधारणाओं, उपयोग, विशेषता, लाभ, सॉफ्टवेयर/प्लेटफार्मों उपलब्धता और बड़े डेटा विश्लेषण में भविष्य की चुनौतियों को दिखाता है। बड़ा डेटा केवल बड़ा हो रहा है क्योंकि संस्था उपलब्ध डेटा से सूचना प्राप्ति हेतु ज्यादा और बेहतर रास्ते निकाल रही हैं जो कि महत्वपूर्ण फैसले लेने में व प्रश्नों के उत्तर देने में काम आ रहा है। उत्तर जो पहले उपलब्धता से बाहर थे अब उनके कारण नया और नये तरह का डेटा तैयार हो रहा है। डेटा का दोहन करके सूचना तैयार करने के लिए विभिन्न प्रकार के तरीके मौजूद हैं जो सभी उद्योगों के लिए तेजी से और बेहतरीन निर्णय ले सकते हैं।

### ABSTRACT

Analysis of the big data, generated due to exponential growth of new information and telecommunication technology is biggest challenge. Big data is a concept of the information technology which requires professional with highly skilled in programming and data analysis to extract meaningful information and insights. The paper covers the concepts, usage, characteristic, advantages, softwares /platforms available in global IT industries and future challenges of big data analysis. Big data should only get bigger as organizations look for more and better ways to tap into existing data and gather new and emerging types of data to make critical decisions, answering questions that were previously considered beyond reach. There are tremendous opportunities to harness data for information to help us make better and faster decisions across all industries in a variety of functions.

**Keywords:** Relational database management system, big data analysis platform, information and telecommunication technology

### 1. INTRODUCTION

With the growth of new information technology and telecommunication sectors, a huge amount of big datas are generated every second. Managing the big data is becoming the most difficult task for government, industrial, science, educational sectors. Analysis of big data basically a process of collecting, organizing, analyzing, preserving and dissemination of processed data/information to discover newer patterns and helping in future planning and decision making. Although big data doesn't refer to any specific quantity, the term is often used when speaking about petabytes and exabytes of data, much of which cannot be integrated easily<sup>1</sup>. Big data is a term used to describe the exponential growth and availability of data, both structured and unstructured. The biggest challenge is variety of structured as well as unstructured data, with about 75 per cent of data being unstructured, which is more

difficult to handle, coming in from a variety of data sources, such as text, sensor data, audio, video, click streams, log files and more<sup>2</sup>. Big data is a concept of the information technology which requires professional with highly skilled in programming and data analysis to extract meaningful information and insights. The volume of data is increasing exponentially, data generated at rest as well as data in motion, which is real-time data. The challenges for big data analysis for future information technology include capture, curation, search, sharing, storage, analysis, transfer, visualization, and privacy violations<sup>3</sup>.

Big Data has become the backbone of all sectors today. It can be used in healthcare to handle a variety and volume of data linking hospital information system with clinical trials for personalised medicine. This is evident from the fact that we could get over 20 per cent decrease in patient mortality by analysing

streaming patient data in healthcare or over 90 per cent decrease in processing time by analysing networking and call data in telecommunications<sup>2</sup>. More accurate analyses of Big Data may lead to more confident decision making. And better decisions leads to greater operational efficiencies, cost reductions and reduced risk<sup>4</sup>.

**Data Measurement Units**

Unit	Size
Bit	Single Binary Digit (1 or 0)
Byte	8 bits
Kilobyte (KB)	1,024 Bytes
Megabyte (MB)	1,024 Kilobytes
Gigabyte (GB)	1,024 Megabytes
Terabyte (TB)	1,024 Gigabytes
Petabyte (PB)	1,024 Terabyte
Exabyte (EB)	1024 Petabytes
Zettabyte (ZB)	1024 Exabytes
Yottabyte (YB)	1024 Zettabytes
Brontobyte (BB)	1024 Yottabytes
Geopbyte (GeB)	1024 Brontobytes

**2. DEFINITION**

Big data is defined as “Big data is a large volume unstructured data which cannot be handled by standard database management systems like DBMS, RDBMS or ORDBMS”<sup>5</sup>.

The large complex sets of data are generated that must be managed, analyzed and manipulated by skilled professionals. The compilation of this large collection of data is collectively known as “big data.”<sup>6</sup>

Big data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making<sup>7</sup>.

“Big data is the term increasingly used to describe the process of applying serious computing power – the latest in machine learning and artificial intelligence – to seriously massive and often highly complex sets of information.”<sup>8</sup>

“Big Data refers to the massive amounts of data that collect over time that are difficult to analyze and handle using common database management tools. Big Data includes business transactions, e-mail messages, photos, surveillance videos and activity logs (see machine-generated data). Scientific data from sensors can reach mammoth proportions over time, and Big Data also includes unstructured text posted on the Web, such as blogs and social media.”<sup>9</sup>

**3. USES OF BIG DATA**

The present environment is changing rapidly with increased connectivity and globalisation. With more and more electronic channels available, large volumes

of digital data are generated. Such huge volumes of data cannot be analysed in real-time or near real-time using conventional computing technology. After analysis, Big Data can be use in diverse fields such as

- Generating web application for users in social media, research & development, telecommunication, etc;
- Healthcare applications including diagnosis of diseases;
- Revenues generation in e-commerce;
- In science research for origin of life, etc.

The industries wherein the huge Big Data are generated and used in future growth & taking right decisions at right are<sup>2</sup>

- 1) Healthcare:
  - (a) Genome mapping
  - (b) Drug discovery
  - (c) Patient care using real-time data
  - (d) Analysis of correlation between treatment and outcome.
- 2) Retail functions:
  - (a) Target segment identification
  - (b) Loyalty management
  - (c) Customer experience
  - (d) Customer attrition management
  - (e) Brand perception.
- 3) Banking, finance and insurance:
  - (a) Real-time trading in global markets
  - (b) Adherence to compliance and country regulations
  - (c) Real-time fraud detection
  - (d) Risk management
  - (e) Anti money laundering
  - (f) Financial inclusion
  - (g) Cross-selling and up-selling.
- 4) Manufacturing:
  - (a) Demand forecasting and inventory management of a large number of SKUs (Stock Keeping Units)
  - (b) Supply chain management
  - (c) Collaborative planning and design.

**4. ADVANTAGES OF BIG DATA**

Big data are generated and acquired from many sources. The real advantage of Big Data technologies lies in collecting relevant data and analyse it timely so as enable to<sup>10</sup>:

- Improve productivity across their organisations;
- Improve understanding of customers, their needs, and purchase patterns;
- Increase business revenues and profitability.
- Increase cost reductions,
- Time reductions,
- New product development and optimized offerings, and

- Smarter decision making
- Determine root causes of failures, issues and defects in near-real time,
- Recalculate entire risk portfolios in minutes.
- improvements in overall operations by giving organizations greater visibility into operational issues

## 5. CHARACTERISTICS

Big data can be described by the following characteristics<sup>11</sup>

**Volume:** The quantity of data that is generated is very important in this context. It is the size of the data which determines the value and potential of the data under consideration and whether it can actually be considered as Big Data or not. The name 'Big Data' itself contains a term which is related to size and hence the characteristic.

**Variety:** The next aspect of Big Data is its variety. This means that the category to which Big Data belongs to is also a very essential fact that needs to be known by the data analysts. This helps the people, who are closely analyzing the data and are associated with it, to effectively use the data to their advantage and thus upholding the importance of the Big Data.

**Velocity:** The term 'velocity' in the context refers to the speed of generation of data or how fast the data is generated and processed to meet the demands and the challenges which lie ahead in the path of growth and development.

**Veracity:** The quality of the data being captured can vary greatly. Accuracy of analysis depends on the veracity of the source data.

**Variability:** This is a factor which can be a problem for those who analyse the data. This refers to the inconsistency which can be shown by the data at times, thus hampering the process of being able to handle and manage the data effectively.

**Complexity:** Data management can become a very complex process, especially when large volumes of data come from multiple sources. These data need to be linked, connected and correlated in order to be able to grasp the information that is supposed to be conveyed by these data. This situation, is therefore, termed as the 'complexity' of Big Data<sup>12</sup>.

## 6. SOFTWARE TO BIG DATA ANALYTICS: TOP PLATFORMS

Big data are enormous in size which cannot be handle by traditional databases. Available tools are becoming inadequate to analysis large data sets. Big data analytics is associated with cloud computing because the analysis of large data sets in real-time requires a platform like Hadoop to store large data sets, combine and process data from multiple sources.

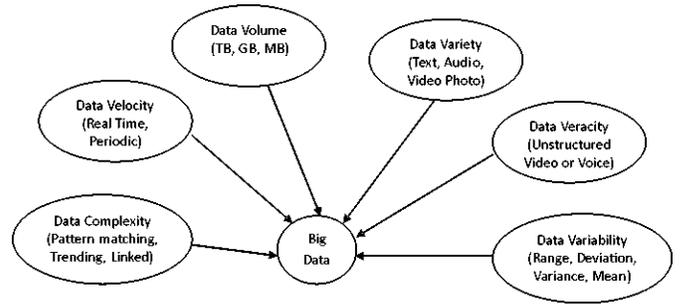


Figure 1. Expansion of big data.

Apache Hadoop, a nine-year-old open-source data-processing platform, for writing and running distributed applications that process large amount of data. This software is designed to analyse massively parallel processing on relatively low-cost servers that pack plenty of storage close to the processing power. Hadoop is main platform of computing infrastructure many well known giant companies such as Yahoo, LinkedIn, Twitter and Facebook, leads the big-data revolution. Cloudera software (2008) came in support for commercial applications for enterprises, and MapReduce and Hortonworks came in existence in 2009 and 2011, respectively. Google was the first to introduce MapReduce that is used to process large data sets. Among data-management incumbents, IBM and EMC-spinout Pivotal each has introduced its own Hadoop distribution. Microsoft and Teradata offer complementary software and first-line support for Hortonworks' platform. HP, SAP, etc are working with multiple Hadoop software providers. 1010 data and Amazon Web Services (AWS) have staked their entire businesses on the cloud model<sup>13</sup>.

Action, InfiniDB/Calpont, HP Vertica, Infobright, and Kognitio are some more big data commercial processing software platforms working around relational database management systems focused entirely on analytics rather than transaction processing.



Figure 2. IT Companies providing big data analysis platform<sup>13</sup>.

## 7. FUTURE CHALLENGES

The rate at which this data arrives has dramatically changed over time and hence velocity of data is another IT challenge that has to cope up with. As big data grows bigger, so too will its importance in our everyday lives – business and personal. But with great opportunity comes great challenges, and there is a host of upcoming obstacles which we must tackle as we seek to unlock the full potential of analytics.

Relatively speaking, big data and the analytics that we use to try and understand it are still in their infancy. As big data grows bigger, so too will its importance in our everyday lives – business and personal. But with great opportunity comes great challenges, and there is a host of upcoming obstacles which we must tackle as we seek to unlock the full potential of analytics<sup>14</sup>.

Therefore, big data should only get bigger as organizations look for more and better ways to tap into existing data and gather new and emerging types of data to make critical decisions, answering questions that were previously considered beyond reach. In today's world, we can harness data for information to help us make better and faster decisions across all industries in a variety of functions. With almost every organisation now focusing on data and analytics, there is a tremendous demand for skilled talent in the industry<sup>15</sup>.

Big Data is a big deal, and it is a big opportunity for librarians and information professionals to play a role in the Big Data universe. Why? Librarians have the skills, the knowledge, and the service mentality to help our businesses, governments, universities, and nonprofits capitalize on all that Big Data has to offer.<sup>16</sup>

## 8. CONCLUSION

The collection of data is only one half of the solution. One should have effective softwares for measurement and better understanding how to make the right decisions from the data collected and analyse that data for our benefit.

Individuals are itself generating and transmitting information. This is happening as they are using new smart gadgets. It has also seen find that there is a definite problem relating to big data management and, even more importantly, the management of the information generated by analysis of “big data”. At the end of the day, big data provides an opportunity for “big analysis” which is leading towards “big opportunities” to gain a competitive edge in global market, to enhance the quality of life, or to solve and dig out the solutions for many complex problems of the world. The rate of data acquisition is accelerating quickly enough that perhaps we can eventually coin a new term “Sea data.”

## निष्कर्ष

डेटा के संग्रह समाधान का केवल एक आधा हिस्सा है। किसी को भी मापने और बेहतरीन समझ के लिए एक प्रभावशाली साफ्टवेयर लेना चाहिए जो एकत्रित डाटा में से सही निर्णय ले सके और हमारे फायदे डाटा विश्लेषण कर सके।

प्रत्येक व्यक्ति अपने आप सूचना पैदा कर रहा है और प्रेषित कर रहा है। यह नए स्मार्ट गैजेट का उपयोग करने के कारण हो रहा है। यह देखा गया है कि बड़ा डाटा प्रबंधन एक निश्चित समस्या है और अधिक महत्वपूर्ण उस सूचना का प्रबंधन जो कि बड़ा डाटा के विश्लेषण से उत्पन्न हुई है।

दिन के अंत में, बड़ा डेटा बड़े विश्लेषण का अवसर प्रदान करता है जो वैश्विक बाजार में प्रतिस्पर्धा में बढ़त हासिल करने के लिए बड़ा अवसर प्रदान कर जीवन की गुणवत्ता को बढ़ाता है और विश्व की जटिल समस्याओं के समाधान करता है। डाटा अधिग्रहण की दर की तीव्रता के कारण हमें नया शब्द “सागर डेटा” प्राप्त हो सकता है।

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## आर का उपयोग कर अपराध विश्लेषण Crime Analysis using R

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### सारांश

भारत में पिछले कुछ वर्षों में अपराध दर में एक सामान्य वृद्धि को देखा गया है। पुलिस संसाधनों के उचित उपयोग के लिए, विशेष रूप से कंप्यूटर के शामिल किए जाने वाली प्रौद्योगिकियों की पुलिस की रणनीतियों में सुधार की गुंजाइश है। ये प्रौद्योगिकियाँ कानून लागू करने वाली एजेंसियों को आयाम देती हैं और पुलिस के नए उभरती जिम्मेदारियों को पूरा करने में मदद करती हैं। यह आलेख आर (सांख्यिकीय प्रोग्रामिंग भाषा) का उपयोग कर अस्थायी और स्थानिक आयामों के विश्लेषण को हाइलाइट करता है और एक मॉडलिंग इंजन, एक अपराध विश्लेषण उपकरण जो बीट स्तर पर पुलिस की गतिविधियों में उनकी सहायता कर सकता है, का विचार भी देता है। इसके बाद प्रभावी ढंग से अपराध हॉट स्पॉट को संभालने के लिए गश्त टीमों को सक्रिय करता है।

### ABSTRACT

The past couple of years have observed a general increase in the crime rates in India. There is a scope for improvement in the policing strategies, especially the inclusion of computer-aided technologies for productive application of police resources. These technologies give the law enforcers much needed edge and help fulfil the new emerging responsibilities of the police. The paper highlights temporal and spatial analyses using R (statistical programming language) and also proposes a modelling engine as a crime analysis tool that could assist police in its activities at the 'beat level' itself. Thereafter, enabling patrolling teams to administer crime hot-spots effectively.

**Keywords:** Crime analysis, statistical programming language R, spatial analysis, crime hot-spots, predictive policing, modelling engine using R

### 1. INTRODUCTION

There has been an enormous increase in the crime rates in India in the recent past. Crime deterrence is a challenging job. One of the problems faced by the police is how to enhance their investigatory efficiency.

Predictive policing is a growing area of research. Various statistical techniques are used to identify criminal hot-spots in order to support preventive and precautionary applications of police resources.

Given a crime report dataset, the goal of crime analysis is to gather, process and harness the copious real-time data. We have discussed various techniques that would be applicable and the different dimensions involved in such analysis within the central theme of the powerful statistical programming language R.

Presently, there are several crime analysis tools available in the market. The main aim of this paper is to introduce the application of R in the police's statistics. R is an open source language and fairly

simple to use, it makes an ideal mean to deal with the amount of data collected by police, simplify, process, and interprets it.

### 2. PROBLEM DEFINITION

Crime analysis includes looking at the data from two different dimensions – spatial and temporal. Temporal dimension involves observing the characteristics of a particular region over time. Spatial dimensions involves observing the characteristics of a particular region along with its neighbours. The enormous amount of data collected by National Crime Record Bureau (NCRB) can be put to use by analyzing it not only through just temporal dimension but through spatial dimension as well. And not just at a central level, but at a police beat level. For sake of this analysis, we have used real and publically available criminal data of Chicago (Chicago, 2012). In the attempt to address a real world problem, our primary focus is on the fundamentals of data analysis.

### 3. THE DATASET

The data are stored at crime incident level, that is, for each crime incident that occurred in the past 12 months, we have the location, date, type, beat, and ward. The location is available in the form of latitude and longitude coordinates. Also, we have used shape files for territorial identity of police beats.

### 4. TEMPORAL ANALYSIS

We have visualized data by year, month and day using simple plots. We used the date of incidence to determine which day of the week and which month of the year the crime occurred to find a possible pattern in the way crimes are committed depending on the day of a week and a month.

A plot between months and number of crimes depicts the months in which police needs to be more alert.

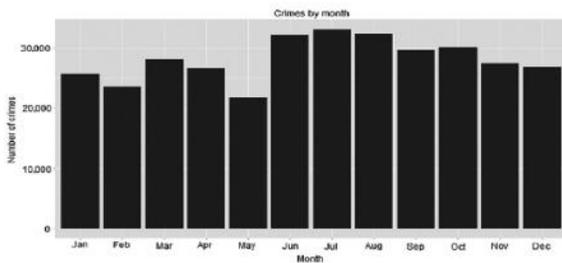


Figure 1. Distribution of crimes by month.

Also, the frequency of crimes need not be consistent throughout the day. There could be certain time intervals of the day where criminal activities are more dominant as compared to other intervals.

We created four six –hour time window beginning at 12 midnight. The intervals we then get were – midnight to 6:00 AM, 6:00 AM to noon, noon to 6:00 PM, and 6:00 PM to midnight.

These plots show the distribution of all the crimes against the intervals of time.

Looking at the plot above, we can say that crimes are more common during the latter half of the day. We could suggest higher patrol during the time interval 12:00PM – 18:00 and 18:00 – midnight.

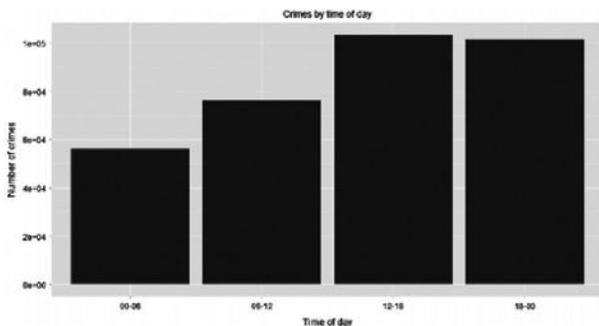


Figure 2. Distribution of crime by time of the day.

Similarly, we can demonstrate the same plots with additional information by splitting out the different crime types. For example, we can see how different crimes vary by different times of the day.

To get the number of different crimes by time of the day, we need to have four rows for each crime type – one for each time interval of the day. We rolled-up this data using the aggregate ( ) function and to construct the plot we used the ggplot ( ) function from the ggplot2 library (Wickham, 2009).

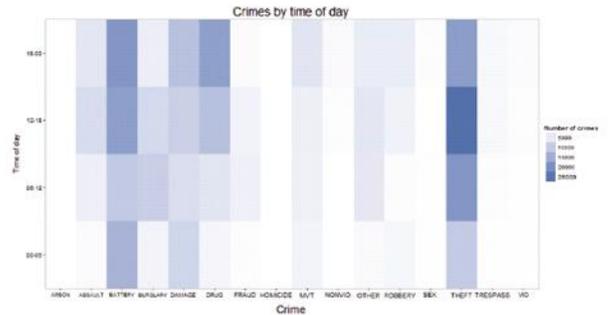


Figure 3. Heat map of different crimes by time of the day.

The heat map above illustrates that major number of incidents of theft/robbery occur in the afternoon while crimes related to drugs are more prevalent in the evening. A similar analysis is shown by month as well.

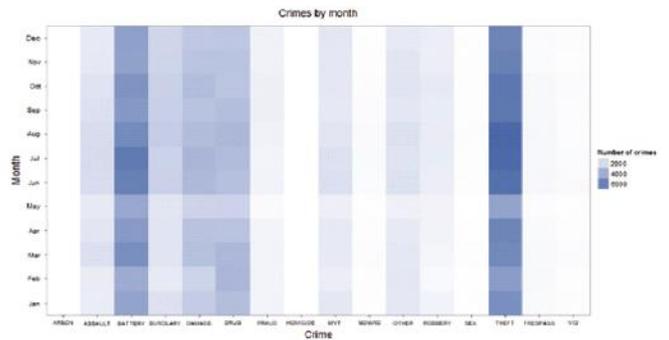


Figure 4. Heat map of different crimes by month wise.

### 5. SPATIAL ANALYSIS

Crime vary extensively with respect to geography. Typically, within an area like a pin code or a city, there are zones with higher criminal activities as compared to others. These zones maybe called as crime hot-spots and are often the focus area for predictive policing. We have the location of each crime incident in our data set that can be used to look for these spatial patterns.

For this purpose, we will utilized the shape files for Chicago Police Department’s beats by processing them in R using the maptools library (Bivand, 2014). We plotted the shape file to get the city of Chicago cut up into beats. Then, we plotted the crime incidences by mapping them to the coordinates of the shape files.

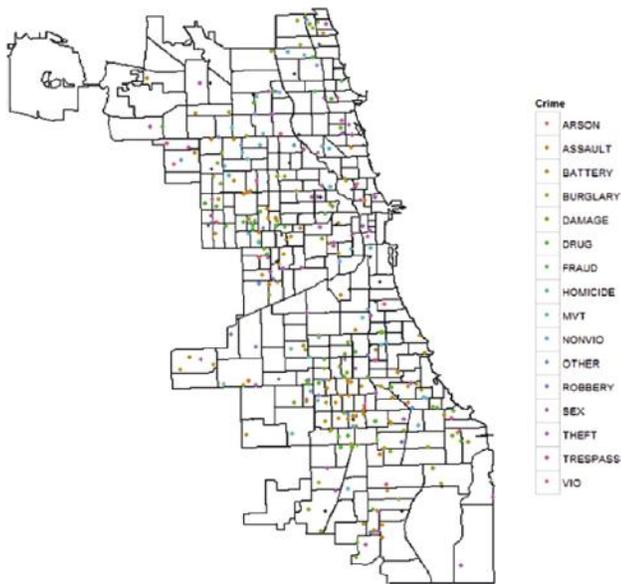


Figure 5. Crime in Chicago on May 22, 2011.

We can also plot the coordinates of police stations or CCTV cameras and see if there is any relation between these incidences and the location of the police station or the number of CCTV cameras and number of arrests.

This plot, however, just shows the crime instances for one particular day. A better way to understand the crime pattern would be to observe these crimes for a larger bracket of time, for example, a month or a year. This can be done in R using the animation library (Xie, 2012). We can create a series of plots for each date, and hence, obtain a plot showing patterns for the entire year in one file.

And, the analysis doesn't end here. There are plenty of R packages available that can be applied in advanced analysis of the spatial data.

## 6. CONCLUSION

Keeping in mind, the ultimate goal of predictive policing, we could construct a modelling engine which would be based on a reasonably sized area, for instance a police beat, and for a predefined time interval, an hour or a couple hours or a day.

The purpose behind the proposal to build a model is to build a resource that would help each of the police station at a 'beat level'. Patrolling teams can effectively administer the crime hot-spots. But, zoning down to one beat as a crime hot-spot ignores the impact of crimes in neighboring areas. That is, there could be a connection between criminal events in adjoining beats. Including crime history of the adjoining beats in the model could be a simple way to control this.

It is common that the law enforcers are generally a step behind the offenders. But what if each of the police stations in India are able to store, manage, and

analyze the data collected by them, and predict the offender's next move. We are certain that efficient implementation would definitely help authorities in effective crime deterrence.

## निष्कर्ष

पुलिस के भावी सूचक के अंतिम लक्ष्य पर ध्यान देना है, हम एक मॉडलिंग इंजन का निर्माण कर सकता है जो एक उचित आकार क्षेत्र के आधार पर किया जाएगा उदाहरण के लिए एक पुलिस बीट, और एक पूर्वनिर्धारित समय अंतराल के लिए, एक घंटा या एक दो घंटे या एक दिन।

एक मॉडल बनाने के प्रस्ताव के पीछे उद्देश्य एक संसाधन का निर्माण करना है जो 'बीटस्तर' पर प्रत्येक पुलिस स्टेशन में मदद करेगा। गश्त टीम प्रभावी ढंग से अपराध हॉट-स्पॉट का प्रशासन कर सकते हैं। लेकिन, एक बीट को अपराध हॉट-स्पॉट लेने से पड़ोसी क्षेत्रों में अपराधों के प्रभाव रोके जाते हैं। यही कारण है कि समीपस्थ बीट में आपराधिक घटनाओं के बीच एक कनेक्शन हो सकता है। मॉडल में समीपस्थ बीट के अपराध इतिहास को शामिल करना, इस पर नियंत्रण करने के लिए एक सरल तरीका हो सकता है।

यह सामान्य है कि कानून लागू करने वाली एजेंसियाँ आम तौर पर अपराधियों से एक कदम पीछे हैं। लेकिन ऐसा हो कि भारत में प्रत्येक पुलिस स्टेशन उनके द्वारा एकत्र डेटा को स्टोर, प्रबंधन और विश्लेषण करने में सक्षम होएँ और अपराधी की अगली चाल की भविष्यवाणी करे। हम निश्चित हैं कि कुशल कार्यान्वयन से निश्चित रूप से प्रभावी अपराध निवारण में अधिकारियों को मदद मिलेगी।

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## आंकड़ा खनन के एकीकरण के साथ मामला पुनर्प्राप्ति निर्णय सहायता प्रणाली Case Retrieval Decision Support System with Integration of Data Mining

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### सारांश

आज प्रत्येक उद्योग को फलने-फूलने के लिए एक सहायता तंत्र की जरूरत होती है, इस तंत्र में केवल मानव और मशीन ही नहीं शामिल होते हैं बल्कि वे मॉडल भी शामिल होते हैं जो उन्हें व्यापार परिदृश्यों का पूर्वानुमान लगाते हुए निर्णय लेने में पर्याप्त सहायता देते हैं। निर्णय सहायता प्रणाली 1970 में अस्तित्व में आई और इसने व्यापार प्रक्रिया पर और उद्योग के विचार समूह पर बहुत गहरा प्रभाव डाला। कई तकनीकी और संगठनात्मक मांगों ने डीएसएस दृष्टिकोण में क्रांतिकारी परिवर्तन लाने में प्रभाव डाला। पहले अधिकतर मॉडल मुख्यतया सांख्यिकीय विश्लेषण, लक्ष्य प्रोग्रामिंग और ओएलएपी आधारित साधनों पर, जो आंकड़ों को अनेक स्थानों पर दिखने को संभव बनाते थे, ध्यान केंद्रित करते थे। इस पत्र में, हमने एक ऐसे मॉडल (केडी2एस2, ज्ञान प्रेरित निर्णय सहायता प्रणाली) को लागू किया जो आंकड़ा खनन, निर्णय सहायता के लिए सीबीआर दृष्टिकोण के अनुसंधान क्षेत्रों के बीच गठबंधन पर जोर देता है। चूंकि आंकड़ा खनन पैटर्न और संबंधों को खोजकर निर्णय सहायता के लिए संभावनाओं को बढ़ाता है, आंकड़ा विश्लेषण और सीबीआर के प्रति एक विवेचनात्मक दृष्टिकोण को सक्षम बनाना, बुद्धिमत्तापूर्ण (इंटेलिजेन्ट) प्रणालियों को बनाने के लिए एक पद्धति के रूप में इसके अपील के कारण एक महत्वपूर्ण अनुसंधान क्षेत्र के रूप में उभरा है। यह पत्र हमारे पूर्व के कार्य का विस्तार है जिसमें हमने आंकड़ा खनन और सीबीआर पर आधारित निर्णय सहायता प्रणाली के लिए एक अवधारणात्मक संरचना का प्रस्ताव किया था। यहां हम प्रयोक्ता के प्रश्न का सीबीआर के विद्यमान मामलों से मिलान करने के लिए एक नया एलॉगरिदम दर्शाते हुए विशेष रूप से मॉडल के सीबीआर घटक पर जोर दे रहे हैं।

### ABSTRACT

Today to flourish, every industry needs a support mechanism, this mechanism not only includes men and machine but also those models which provide them enough support to take a decision anticipating business scenarios. Decision support system came into existence in 1970s and made a huge impact on the business processes and on the think tank of the industry. Many technical and organizational demands have made an impact on the revolutionizing of DSS approach. Earlier majority of models focused mainly on statistical analysis, goal programming and OLAP-based tools enabling multiple view on data. In this paper we introduced a model (KD2S2, Knowledge Driven-decision Support System) which emphasizes on the coalition between the research areas of data mining, CBR approach for decision support (DSSs). As data mining extends the possibilities for decision support by discovering patterns and relationships, enabling an inductive approach to data analysis and CBR has emerged as a major research area due to its appeal as a methodology for building intelligent systems. This paper is the extension of our previous work<sup>1</sup> where we proposed a conceptual framework for Decision support system based on Data Mining and CBR. Here we emphasize particularly on the CBR component of the model, illustrating a new algorithm for matching user query with the existing cases in the CBR.

**Keywords :** Data mining, decision support system, case based reasoning, intelligent system

### 1. INTRODUCTION

In recent years data mining has become a very popular technique for extracting information from the database in different areas due to its flexibility of working on any kind of databases and also due to

the surprising results<sup>2</sup>. An approach has been made to develop a decision support system which will take decision under complex environment. CBR isto solve problems by comparing a new case to previously experienced ones. With case-based reasoning, experiences

are stored in memory. These experiences encode relevant features, courses of action that were taken, and results that ensued.

When a new case arrives, it will find the situation that is most similar, and reuse, or revise it to match the new problem if the most similar problem does not match sufficiently. CBR has been successfully applied to a wide variety of areas including medical and engineering tasks. However, problems remain with the case based approach.

Some of the most important issues that need to be addressed are:

- The integration raw facts and knowledge into a linking case base knowledge to enhance the potential of the candidate system and to improve the probability of finding the correct measure.
- Finding effective parameters for indexing and retrieving methods used for recovering the past cases. There are several main types of retrieval, knowledge-based search, classification network search, nearest neighbor search, inductive approaches, etc.
- The automation of feeding the results from data mining tools to a CBR so that a corresponding case can be retrieved effectively. Cases are retrieved based on the knowledge stored in CBR, which further is a main issue of consideration.

## 2. PROCEDURE

*Step1:* Initially populate the case base with data mining result.

*Step2:* Take input from the user and convert into cases.

*Step3:* Search the case base for the relevant solution and present to the user.

*Step4:* If solution not in case base then search the knowledge base for the solution and update the case base.

End.

## 3 COMPONENTS OF THE MODEL

### 3.1 Knowledge Base

Knowledge base is an organized collection of facts about the system's domain. It consists of some encoding of the domain expertise for the system. This can be in the form of semantic nets, procedural representations, production rules, or frames. Knowledge base contains the knowledge necessary for understanding, formulating, and solving problems in the form of rules and expressed in the form. If the conditions are true then the actions are executed.

### 3.2 Data Mining

Data mining includes predictive data mining algorithms, which result in models that can be used for prediction and classification, and descriptive data

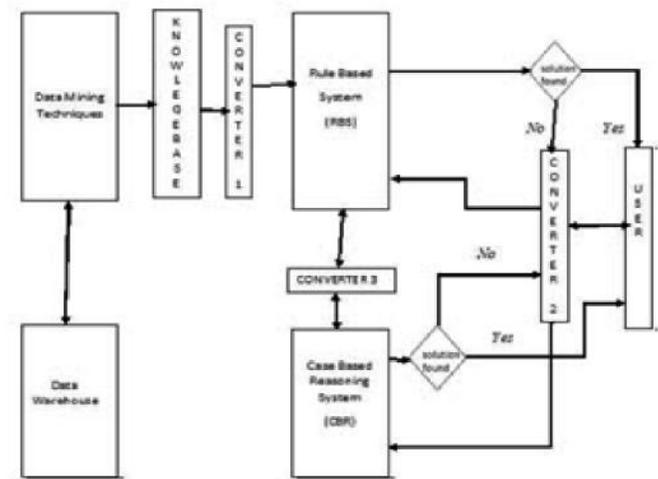


Figure 1. Components of the model.

mining algorithms for finding interesting patterns in the data, like associations, clusters and subgroups<sup>8</sup>. The overall process of discovering and extracting valid, implicit and previously unknown knowledge from large databases is often referred to as data mining<sup>2</sup>.

We are using data mining engine to populate out case base. The data mining engine will be used to fetch the structured and unstructured data from the data base and data warehouse. Data mining techniques such as clustering, classification and association will be applied to the selected data results in generation of the knowledge in the forms of clusters, rules, etc.

### 3.3 Case-Based Reasoning

Case based reasoning (CBR) is a popular problem solving methodology which solves a new problem by remembering previous similar situations and reusing knowledge from the solutions to these situations.<sup>3</sup> CBR enables retrieval of relevant data by comparing the user's current problem situation with previous situations (cases). Cases are situation-specific knowledge, stored in an experience base together with the necessary general knowledge (concept hierarchies, relationships, decision rules, associations, etc.)<sup>2</sup>.

#### 3.3.1 Case Based Reasoning Sub-Component

We have proposed a case based reasoning component which will have a case base (collection of relevant cases). A case is represented in foam (identification, attribute, value). Similar cases are identified in one location, i.e in certain types of sorting.

A problem will be first transformed in to a case called problem case (in the format specified) and some sophisticated matching algorithm is used to retrieve the similar cases. Then re-use the similar case. The solution part of the retrieved case is modified, i.e., revised. That is the solution for problem case. It is presented to the user. At the same time, the problem

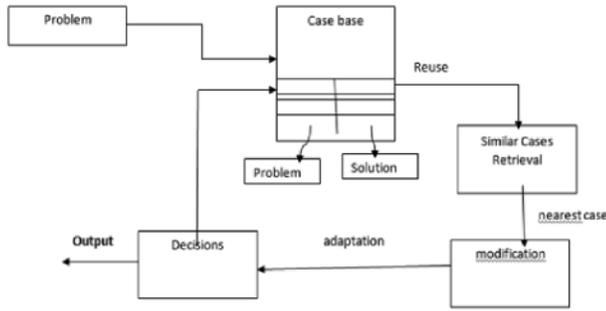


Figure 2. CBR sub-component.

case together with modified solution is added to the case base i.e. retained in the case base.

*Sample Case Structure*

Case 1

- Problem: Sales is not as per last year
- Model: Alto
- Advertisement: Newspaper
- City: New Delhi
- Year: 2013
- State: Delhi

*Solution : Diagnosis*

- a. Dealer incentives needs to be revised
- b. Service station needs to be improved

Approaches to case retrieval from CBR : The main concern of all the CBR system is the retrieval of similar cases rapidly and efficiently with the following objectives

- a. The retrieve cases must be as few as possible
- b. The retrieved cases must be as relative and similar to the current problem as possible<sup>7</sup>.

CBR is an approach to problem solving that emphasizes the role of prior experience during future problem solving (i.e new problems are solved by reusing and if necessary adapting the solutions to similar problems that were solves in the past An important step in the CBR Cycle is the retrieval of previous cases that can be used to solve the target problem. Improving retrieval performance through more effective approaches to similarity assessment has been the focus of a considerable amount of research.

There are various retrieval methods inductive, nearest neighbor, knowledge based method, Decision tree, Fuzzy based approach which have both the advantages and disadvantages<sup>3-6</sup>.

**3.4 K-NN Approach**

K-nearest neighbour (KNN) search method has been extensively used in the case retrieval phase of CBR [10]. Traditional KNN method adopts an exhaustive search strategy to scan the overall case-base, and then select K prior cases which have the minimum dissimilarities with the new case from the case base. The performance of a CBR system is indeed influenced

by the value of the parameter K when using the KNN method. However, determining the value of K is never such a simple task, especially when users do not have sufficient domain knowledge. If K is too small to find a representative pattern, so that it may reduce the reasoning accuracy. Also, the reasoning accuracy may be reduced if K is so large since the selected prior cases would include some irrelevant or distorted cases. Up to now, several studies have developed their individual methods to determine the value of K for KNN<sup>9</sup>.

**4. PROPOSED APPROACH**

This paper has proposed a new case retrieval model for finding the best possible solution for multicolumn values.

Proposed Algorithm to retrieve similar cases from Case base

- Step 1:* Consider a Target case T with T[i],T[i+1].... T[n] features
- Step2:* Consider an array S and fill the S with the first feature/attribute of the case base
- Step3:* Compare T[0] with all the elements of S[i]... S[n]  
FOR i = 1 TO N  
Compare T[0] with S[i]..S[n]
- Step4:* Store all the cases where T[0]==S[i] and generate the resultant set
- Step5:* Repeat step 3 to 4 for rest of the elements of T with as, filling S with new features set values for every element of T.
- Step6:* From the resultant sets count the number of occurrences for each case considering only those which are in resultant set and discard the rest.
- Step7:* Fill the occurrences in an array and compare each occurrence with the minimal value and if the occurrence is greater than minimal value change the values of minimal with the occurrence value and record the position.
- Step8:* The final value position will be the most similar case.

**5. RESULTS AND CONCLUSION**

This algorithm finds the exact match rather than getting the approximation or the nearest neighbor. The exact match does not mean getting the result based on 100 percent matching criteria but this algorithm matches the given criteria which may or may not be a single column value. It then matches the attributes within the column, thereby counting the occurrences of that attribute within the column, and then retrieving the value of the occurrences in each row so that the best possible match is found.

This this paper we have described the first phase of the three-phased model. This phase deals with the

**Table 1. Comparison of nearest neighbor techniques<sup>12</sup>**

Technique	Key Idea	Advantages	Disadvantages	Target Data
k Nearest Neighbor (kNN)	Uses nearest neighbor rule	Training is very fast Simple and easy to learn Robust to noisy training data Effective if training data is large	Biased by value of k Computation Complexity Memory limitation Being a supervised learning lazy algorithm i.e. runs slowly Easily fooled by irrelevant attributes	large data samples
Weighted k nearest neighbor (WkNN)	Assign weights to neighbors as per distance calculated	Overcomes limitations of kNN of assigning equal weight to k neighbors implicitly. Use all training samples not just k. Makes the algorithm global one	Computation complexity increases in calculating weights Algorithm runs slow	Large sample data
Condensed nearest neighbor (CNN)	Eliminate data sets which show similarity and do not add extra information	Reduce size of training data Improve query time and memory requirements Reduce the recognition rate	CNN is order dependent; it is unlikely to pick up points on boundary. Computation Complexity	Data set where memory requirement is main concern
Reduced Nearest	Remove patterns affect the training data set results	Reduce size of training data and eliminate templates Improve query time and memory requirements Reduce the recognition rate	Computational Complexity Time Consuming	Large data set
Model based k nearest neighbor (MkNN)	Model is constructed from data and classify new data using model	More classification accuracy Value of k is selected automatically High efficiency as reduce number of data points	Do not consider marginal data outside the region	Dynamic web mining for large repository
Rank nearest neighbor (kRNN)	Assign ranks to training data for each category	Performs better when there are too much variations between features Robust as based on rank Less computation complexity as compare to kNN	Multivariate kRNN depends on distribution of the data	Class distribution of Gaussian nature
Modified k nearest neighbor (MkNN)	Uses weights and validity of data point to classify nearest neighbor	Partially overcome low accuracy of WkNN Stable and robust	1.Computation Complexity	Methods facing outlets
Pseudo/Generalized Nearest Neighbor (GNN)	Utilizes information of n1 neighbors also instead of only nearest neighbor	Uses n-1 classes which consider the whole training data set	does not hold good for small data Computational complexity	Large data set
Clustered k nearest neighbor	Clusters are formed to select nearest neighbor	Overcome defect of uneven distributions of training samples Robust in nature	Selection of threshold parameter is difficult before running algorithm Biased by value of k for clustering	Text Classification
Ball Tree k nearest neighbor (KNS1)	Uses ball tree structure to improve kNN speed	Tune well to structure of represented data Deal well with high dimensional entities Easy to implement	Costly insertion algorithms As distance increases KNS1 degrades	Geometric Learning tasks like robotic, vision, speech, graphics

k-d tree nearest neighbor (kdNN)	Divide the training data exactly into half plane	Produce perfectly balanced tree Fast and simple	More computation Require intensive search Blindly slice points into half which may miss data structure	organization of multi dimensional points
Nearest feature Line Neighbor (NFL)	Take advantage of multiple templates per class	Improve classification accuracy Highly effective for small size Utilises information ignored in nearest neighbor i.e. templates per class	Fail when prototype in NFL is far away from query point Computations Complexity To describe features points by straight line is hard task	Face Recognition problems
Local Nearest Neighbor	Focus on nearest neighbor prototype of query point	Cover limitations of NFL	Number of Computations	Face Recognition
Tunable Nearest Neighbor (TNN)	A tunable metric is used	Effective for small data sets	Large number of computations	Discrimination problems
Center based Nearest Neighbor (CNN)	A Center Line is calculated	Highly efficient for small data sets	Large number of computations	Pattern Recognition
Principal Axis Tree Nearest Neighbor (PAT)	Uses PAT	Good performance Fast Search	Computation Time	Pattern Recognition
Orthogonal Search Tree Nearest Neighbor	Uses Orthogonal Trees	Less Computation time Effective for large data sets	Query time is more	Pattern Recognition

user query and retrieval of the best possible solution from CBR. The solution is appropriate for categorical attributes. Where in our domain if we want to search for model x with other supporting attributes, then we cannot replace model x with model y.

### निष्कर्ष

यह एल्गोरिथम आसन्न या सबसे नजदीकी परिणाम प्राप्त करने के बजाए एकदम सटीक मिलान प्राप्त करता है। सटीक मिलान का यह अर्थ नहीं है कि 100 प्रतिशत मिलान मानदंडों पर आधारित परिणाम प्राप्त करना बल्कि यह एल्गोरिथम दिए गए मानदंडों से मिलान करता है जो एक एकल कॉलम मान हो भी सकते हैं और नहीं भी। तत्पश्चात् यह कॉलम के भीतर विशेषताओं का मिलान करता है और इसके द्वारा कॉलम के भीतर उस विशेषता की बारंबारता की गणना करता है और तब प्रत्येक पंक्ति में बारंबारता के मान को पुनः प्राप्त करता है ताकि सर्वोत्तम संभावित मिलान पाया जा सके।

इस पत्र में हमने तीन चरण वाले मॉडल के प्रथम चरण का वर्णन किया है। यह चरण प्रयोक्ता के प्रश्न और सीबीआर से सर्वोत्तम संभावित समाधान की पुनर्प्राप्ति से संबंधित है। यह समाधान स्पष्ट विशेषताओं के लिए उपयुक्त है जहां अपने डोमेन में यदि हम अन्य समर्थनकारी विशेषताओं के साथ मॉडल एक्स को खोजना चाहते हैं, तो हम मॉडल एक्स को मॉडल वाई से बदल नहीं सकते हैं।

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## रक्षा से संबंधित पारंपरिक वेब पृष्ठों से कंटेंट की निकासी Content Extraction in Traditional Web Pages Related to Defence

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### सारांश

भारत ने रामायण और महाभारत के समय से ही में रक्षा और युद्धकला के मुद्दों के सदा मुकाबला किया है। ताड़ के पत्तों और पत्थरों के टुकड़ों पर बने अभिलेख और लिखित रिकार्ड से विभिन्न प्रकार के हथियार, रणनीति, बचाव विधियाँ जोकि धूल कणों और अन्य निर्माण से होती है का ज्ञान होता है। चाणक्य का अर्थशास्त्र, उत्तरी भारत में कुरुक्षेत्र की लड़ाई, और दक्षिण भारत में पराणी इत्यादि रक्षा और युद्ध से सम्बन्धित मुद्दों का चित्रण रिकार्ड किया गया है। इनमें से बहुत कुछ आज के संदर्भ में प्रासंगिक हैं। वर्तमान अध्ययन सूचना, ज्ञान और उत्कृष्टता को उपलब्ध टेक्स्ट से निकालने में और इसे बाद में डिजिटल रूप में बदलता है। यह पद्धति इसे बेसिक पीक्सल-मैप पर बदलती है जिसके कारण भाषा, टेक्स्ट लिपि और प्रारूप कोई समस्या पैदा नहीं करते और अच्छी तरह से विकसित की गई कुंजी-कलस्टर का किसी सर्चिंग साफ्टवेयर में मुख्य शब्दों के आधार पर सूचना निकालने जैसा आसान वेब और डिजिटल सर्चिंग प्रदान की जाती हैं। विशिष्ट केस अध्ययन इसकी पद्धति और साधारणता का विवरण दे रही हैं।

### ABSTRACT

India is known to have dealt with defence and warfare related issues way back from the period of Ramayana and later Mahabharatha. Records and writings in scriptures of palm leaves and stone-cuttings reveal different types of weapons, strategies and defending methods through mote and other construction aspects. Chanakya's Arthasastra, war of Kurukshetra in Northern India and Parani in South India are all recorded depictions of defence and war related issues. Many of these are becoming very relevant in today's context. The present study focuses on extraction of information, knowledge and even expertise from the available text and media-type data after it is converted to digital form. The approach is based on converting to basic pixel-maps, so that issues of language, text-script and format do not pose problems, and through well developed key-clusters-similar to keywords used in any search- content is extracted for easier web and digital surfing. Typical case studies give the details of the approach and its generality.

**Keywords:** Defence, information extraction, pixel map, text script, key cluster, content extraction

### 1. INTRODUCTION

The web is an encyclopedia of information. It has millions of sites and billions of pages providing information in all fronts from ancient history to 22<sup>nd</sup> century. The content of the web page is in the form of flat files, databases and other repositories. The content may be structured or unstructured. With the type of data they can be simple relational or multimedia database. Considering the language aspect they are multilingual. To start with the research was with web mining. Next advancement in mining is the streaming both audio and video. Hence, media mining is gaining popularity. The internet is for sharing of knowledge or entertainment.

The usage of the internet has spread across the nook and corner of the world. In a country like India, which has many official languages the need for multilingual mining arises. The language need not be only in English but also regional languages. The mining industry gives importance to the English Hence the need arises for multilingual search or mining. A multilingual web page can consist of text more than one language along with images, streaming videos, scrolling news which makes the user in seeing lot of information on a single web page.

The focus of present work is to extract the content from the multilingual web pages and understand what actually the web page considered tells about. Method

should preferably be not translation as in text mining, preferably be computer understandable and software-independent. Pixel-based processing to assess overall content is the focus of the study. The objective of the present study is to extract the features dealing with web documents either in English or in a regional language like Sanskrit, and to conclude the relevancy of the content with respect to the interest<sup>1,2</sup>.

## 2. CONTENT REPRESENTATION AND FEATURE EXTRACTION

Since the method is not translation, computer understandable and independent of the software used none other than the basic representation is used which is of course the pixel. Internally data are represented only by pixels. Hence the pixel representation is considered for processing. To create key cluster a sample of 10 words Army, Weapon, Missiles, Pistol, Rifle, Submarine, Soldier, Battlefield, Navy and Intruder-related to defence are taken in English and its equivalent in Tamil and Sanskrit. As the web page is multilingual transliteration is frequently used for representation. For example, Bus is an English word. This word has penetrated to all linguistic people This sort of representation reaches the audience quickly rather than their equivalents. For the above said Ten words nine combinations as mentioned below are considered. For example if army is taken

- |   |          |
|---|----------|
| (a) English equivalent in English                 | ARMY     |
| (b) English equivalent in Tamil                   | ஆர்மி    |
| (c) English equivalent in Sanskrit                | आर्मि    |
| (d) Sanskrit equivalent represented in Sanskrit   | सेनासेना |
| (e) Sanskrit equivalent transliterated in English | senasena |
| (f) Sanskrit equivalent transliterated in Tamil   | சேனா     |
| (g) Tamil equivalent in Tamil                     | ணாவம்    |
| (h) Tamil equivalent in English                   | Ranuvam  |
| (i) Tamil equivalent in Sanskrit                  | रनुवम्   |

The pixel map of the image is of higher dimension. Hence, dimension reduction is done to the pixel map of the image using the nonzero concept. The reduced matrix size is 2x2 and 3 x 3. The features extracted are the statistical properties of the images. To the reduced pixel map of the image the various attributes like mean, standard deviation, and Eigen value, determinant, diagonal, rank and norm are considered as attributes. Normalization is done to the attributes. The influence of the attribute on distance and clustering algorithm is used for better classification. Attribute is the basis of all further inferences and since the choice of attribute and its closeness to actual matrix of the data are not clear, one can study the influence of each one, the subsequent formulations which finally result in grouping.

So the attribute which makes the groups more or less similar irrespective of the methods used in the process can well be the basis for future classifications. This could be one attribute or a cluster with attributes forming what can be called as 'key cluster' like key words. Key clusters can be used to search any kind of data-unstructured and heterogeneous. Finding key clusters and checking with more data is the core. Superficially images of defence equipments, sketch or drawings/scanned images can be a cluster but whether word can also enter into that is the study. Likewise words of defence in different linguistic representation can be considered as different key cluster.

## 3. CLUSTERING

For grouping clustering technique of Data mining is used. Clustering is a grouping method where by grouping is done by similarity. Variety of similarity metrics is available. Out of which Euclidean Distance metric is used to find the similarity. Fuzzy C Means algorithm is used for grouping. Fuzzy C Means is a variant of Hard C Means Algorithm. The difference is that in FCM each data point belongs to a cluster to a degree of membership grade, while in HCM every data point either belongs to a certain cluster or not. So FCM employs fuzzy partitioning such that a given data point can belong to several groups with the degree of belongingness specified by membership grades between 0 and 1. However, FCM still uses a cost function that is to be minimized while trying to partition the data set.

The membership matrix U is allowed to have elements with values between 0 and 1. However, the summation of degrees of belongingness of a data point to all clusters is always equal to unity:

$$\sum_{i=1}^c u_{ij} = 1, \forall j = 1, 2, 3, \dots, n \quad (1)$$

Where c is the number of clusters and n is the total number of data points

The cost function for FCM is:

$$J(U, c_1, c_2, \dots, c_c) = \sum_{i=1}^c J_i = \sum_{i=1}^c \sum_{j=1}^n u_{ij}^m d_{ij}^2 \quad (2)$$

here  $u_{ij}$  is between 0 and 1;  $c_i$  is the cluster center of fuzzy group i;  $d_{ij}$  is the Euclidean distance between the  $i^{\text{th}}$  cluster centre and  $j^{\text{th}}$  data point

$M \in [1, \infty]$  is a weighting exponent

The necessary condition for (2) to reach its minimum are (3) and (4)

$$c_i = \frac{\sum_{j=1}^n u_{ij}^m x_j}{\sum_{j=1}^n u_{ij}^m} \quad (3)$$

$$u_j = \frac{1}{\left(\frac{d_j}{d_k}\right)^{\frac{2}{m-1}}} \quad (4)$$

The algorithm works iteratively through the preceding two conditions until the no more improvement is noticed. In a batch mode FCM determines the cluster centers  $c_i$  and the membership matrix  $U$  using the following steps:

Step 1: Initialize the membership matrix  $U$  with random values between 0 and 1 such that the constraints in Equation (1) are satisfied.

Step 2: Calculate  $c$  fuzzy cluster centers  $c_{i,1}, \dots, c$  using (3).

Step 3: Compute the cost function according to (2). Stop if either it is below a certain tolerance value or its improvement over previous iteration is below a certain threshold.

The performance of FCM depends on the initial membership matrix values; thereby it is advisable to run the algorithm for several times, each starting with different values of membership grades of data points<sup>1,2</sup>.

#### Euclidean Distance

The Euclidean distance or Euclidean metric is the ordinary distance between two points that one would measure with a ruler. It is the straight line distance between two points. In a plane with  $p_1$  at  $(x_1, y_1)$  and  $p_2$  at  $(x_2, y_2)$ , it is  $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ . The distance is calculated using the formula

$$\sqrt{\sum_{i=1}^n (x_i - y_i)^2} \quad 5$$

#### 4. RESULT

For the training phase a set of above said ten words are taken. The nine combinations of each text could be in the form of 4.

- English equivalent in English
- English equivalent in Tamil
- English equivalent in Sanskrit
- Sanskrit equivalent represented in Sanskrit
- Sanskrit equivalent transliterated in English
- Sanskrit equivalent transliterated in Tamil
- Tamil equivalent in Tamil
- Tamil equivalent in English
- Tamil equivalent in Sanskrit

Ninety words are taken altogether for creating key clusters. For testing 3 different web pages are taken. The web pages are preprocessed by removing the tags and special characters. The preprocessed pages are tokenized. The tokens are converted to pixel map for finding the fuzzy membership. With this conclusion can be drawn whether the web page

is relevant or irrelevant. The first test page is that of <http://in.mathworks.com/help/matlab/ref/urlwrite.html> which is absolutely irrelevant to defence. The second web page is the one created by the author which contains defence terms. The third web page is one which contains few terms of defence. The third web page is that of <http://ibnlive.in.com/news/pistol-tamil-actor-vijay-to-shake-a-leg-in-the-hindi-remake-of-thuppakki/376479-71-180.html>. This web page is that of cinema remake which contains the word pistol and thupaki. The code is developed in matlab and other language texts are created using Azhagi+ software. The result from the matlab source code is found to be correct with first two pages and false positive with the third page since this page is about a movie remake.

#### 5. CONCLUSIONS

The conclusion is that the web page ‘MAY BE DEFENCE RELATED’ or not. Fuzzy C means is used for clustering. For analysis the language is restricted to the three languages only and the input is only text in various representations. This needs to be extended to various other images and hand written format.

#### निष्कर्ष

इस षोध से यह निष्कर्ष निकलता है कि वेब पृष्ठ रक्षा से सम्बन्धित हैं या नहीं। फज्जी सी का उपयोग क्लसटरिंग में होता है। विप्लेशण के लिए केवल तीन भाशाओं का उपयोग है और विभिन्न अभ्यावेदनों में इनपुट केवल टेक्सट हैं। इनपुट को विभिन्न आकृतियों और हस्तलिखित प्रारूप में ग्रहण करने तक बढ़ाना होगा।

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# एक ऑफलाइन हस्ताक्षर डाटाबेस में से रोमन और देवनागरी लिपि में गुण प्राप्ति Feature Extraction from an Offline Signature Database in Roman and Devanagari Script

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## सारांश

हमारे देश में विभिन्न भारतीय लिपियों में भारतीय हस्ताक्षर डाटाबेस के निर्माण और जाँच में स्वचालित ऑफलाइन हस्ताक्षर प्रमाणन प्रणाली का इस्तेमाल हो रहा है। स्वप्रथम हमारे डाटाबेस में रोमन और देवनागरी लिपि में हस्ताक्षर का वर्णन करते हैं। तब सम्मेलन डेटाबेस में से गुणों की प्राप्ति का परिणाम दिया जाता है। यह परिणाम दो लिपियों में हस्ताक्षर से प्राप्त किये गये गुणों कुछ बुनियादी मतभेद को दिखाता है।

## ABSTRACT

Indian signature database in various Indian scripts is necessary for building and testing automatic offline signature verification system to be used in our country. Our database for signatures in Roman and Devanagari script is described at first. Then the results of feature extraction from the sample database are given. The results show some fundamental differences in feature values extracted from the signatures in two scripts.

**Keywords:** Hand-written signature, offline verification, feature extraction

## 1. INTRODUCTION

Handwritten signature is a biometric to identify and authenticate a person in legal, financial and business documents. Although use of other biometrics like fingerprint, iris, face and voice has increased in recent years, handwritten signature is still in use because of two basic reasons. The first reason is its easy availability and accessibility - it can be produced easily without any sophisticated device. The second reason is people's acquaintance with this time-tested method of identification. A signature is verified by measuring its similarity with its prototype collected earlier, thereby confirming or denying a signer's claimed identity. In general, signature verification is done manually in our country. But given our population and the number of persons accessing financial and business transactions everyday, manual verification becomes a tough and time-consuming job.

An automatic signature verification system is a software that verifies a signature without any manual intervention. Depending on input such a system can be categorized into one of the two types; online and offline. Input for an online system is online signature data which is acquired during the process of signing using a pressure-sensitive digitizing tablet or a camera.

Input for an offline system is offline signature data which is written on a paper using a normal pen and acquired as a two-dimensional image of the signature after the process of signing. An online system uses dynamic characteristics of the hand movement like position, velocity, acceleration and pen pressure as functions of time. An off-line system makes use of static characteristics like structural or statistical properties of a signature image. Absence of stable dynamic characteristics makes offline verification difficult. But offline signatures have some advantages as well. For example, signing on a paper is a simple and inexpensive process. It requires no sophisticated device like stylus, pressure tablet or computer, nor any source of energy like electricity. So it can be produced anywhere and anytime. This is possibly the reason why off-line signatures are so popular till today. Designing a signature verification system requires exploring the characteristics of handwritten signatures. A good signature database is of great help in that. The characteristics are recorded in terms of features extracted from the individual signatures in the database. Extracted features are used to design the verification algorithm. Finally the algorithm is tested with genuine and forged signatures samples. A

good system accepts genuine signatures and rejects the forged ones. Acceptance and rejection rates are standard measures for evaluating a system.

Developing an automatic offline signature verification system is a challenging task due to many reasons. Firstly, a variety of languages and scripts are used across the globe. Each script has its own characteristics. Even for the same script signature-styles may differ across the countries. So a signature database developed in a country may not be useful for developing a system in some other country. Secondly signature is a behavioral biometric and any signature verification scheme thrives on the following principle – two signatures of a person are very much similar and signatures of two persons are considerably different. But signature of a person may change over time because of change in physical and mental states of the person. So considerable intra-personal structural variations in signatures may exist and they may not be repetitive in nature. Thirdly, feature extraction may become difficult since segmentation of signatures is not an easy and trivial task due to italicized and unconventional writing styles.

Developing a signature verification system to be used in India is even more difficult due to the following additional facts. Firstly, India is a multilingual country and people sign in different scripts, and each script may have completely different characteristics than some other script. Secondly, literacy rate varies highly among the people; some people can just sign their names and cannot write anything else, some can read and write properly but use their writing skills rarely, for example only when they require signing, and there are educated people who are used to writing very often. A system must be able to accommodate all these. Finally, since culture and upbringing may influence signature styles, signature database developed in some other country may not be suitable to be used in our country. So testing the system after designing is difficult due to lack of availability of an authentic Indian signature database. These challenges motivate us to build a multi-script Indian signature database comprising of signatures from various sections of the society and then design an efficient offline signature verification system. We are partially successful towards our goal. We have built a database of signatures in Roman and Devanagari scripts and we have extracted a number of features from the signatures.

## 2. PREVIOUS WORK

Since handwritten signatures are a standard means of authentication, their analysis started long back. Expert document analyst Osborn<sup>[1]</sup> states that the simulating another person's writing by a forger involves not only copying the features of the genuine signature but also

hiding his own personal handwriting characteristics. Another analyst Locard<sup>[2]</sup> categorizes the signature characteristics into two broad classes: the ones that are difficult to imitate and the ones which are easy to imitate. The first class includes the rhythmic line of a signature, local variation in width of the signature; and variation in the aspect ratio of the complete signature. The second class includes the overall orientation of the signature and its position on the document. Nagel & Rosenfeld<sup>[3]</sup> deal with detection of freehand forgeries of signatures on bank checks. The detection process makes use of size ratio and slant features derived from Eden's kinematic stroke model for handwriting, which is modified to make it applicable to pre-written material. Kalera<sup>[4]</sup>, *et al.* describe a novel approach for offline signature verification and identification based on a quasi-multiresolution technique using gradient, structural and concavity features and weighted Euclidean distance. Pal<sup>[5]</sup>, *et al.* presented a survey on the state-of-the-art in the field of non-English and non-Latin signature verification systems. Above work does not explore any Indian signature database.

## 3. MULTI-SCRIPT SIGNATURE DATABASE

Now we give a short description of the multi-script signature database built by us. Genuine and forged signature samples are collected on white A4-size sheets of papers designed for data collection. Most of the signatures are done by black pens, although some are written by blue pens.

### 3.1 Genuine Signatures

Genuine signature samples are collected from 31 signers, 10 samples from each person, so we have 310 genuine samples. Among the 31 signers 25 have signed in Roman script and 6 have signed in Devanagari script. The signature samples are collected through a span of one year so that intra-personal variations in respect of time are included in the database.

### 3.2 Forged Signatures

For each of 31 different genuine signers, 10 skillfully forged signatures are collected. So we have a total of 310 skillfully forged signature samples. Forged signatures are done by 6 of the 31 signers.

### 3.3 Data Acquisition and Cropping

After collection of signatures, A4-size sheets of papers are scanned as grayscale images using an HP Scan Jet G2410 scanner at a resolution of 1200\*1200 dpi. A scanned image of the sheet is shown in Fig.1. From the scanned images, individual signature samples are cropped manually and stored as separate grayscale images.

प्रीतम वाल्मीकि	राम किलास राय
Name: _____	Name: _____
Dept: _____	Dept: _____

Figure 1. Scanned sheet of signatures.

**4. PREPROCESSING OF SIGNATURES**

Before feature extraction, a signature image requires preprocessing. Following preprocessing steps are applied sequentially on an image. Results of these steps on a sample image are shown in Fig. 2.

- (a) Noise-removal: There may be noises in the scanned signature images due to the following facts – unintentional marks and dirt on the paper, intensity variations in scanner-light, scratches or dirt on the scanner lens etc. Median-filtering is used for noise-removal [6].
- (b) Binarization: In this step, the grayscale signature image is converted into a binary (two tone) image by using a threshold obtained by Otsu’s method [7].
- (c) Skew correction: A skew-angle may be introduced in a signature during its production if the signer signs in a rotated manner or during the scanning process if the paper is set in a rotated manner. To rectify it, the skew-angle is detected in the method described in [4] and the signature image is rotated in the inverse direction.



Figure 2. Results of preprocessing steps for a sample.

- (d) Bounding box: Manual cropping and skew correction may result in unwanted white and black pixels surrounding a signature image. So it is cropped automatically by its bounding box.
- (e) Scaling: Two signatures of the same person may vary in size thereby affecting the feature values. So every signature is scaled to width 400 pixels keeping its aspect-ratio same as before [6].
- (f) Thinning: Two signatures of the same person may vary in thickness depending on the type of pen used or the pressure on pen during writing. Varied thickness may produce different feature values of the same signer. So a thinning method[9] is applied to get one pixel thick signature images.

**5. FEATURE EXTRACTION**

Characteristics of signatures of a person are determined by their feature values. Comparisons of feature values of genuine and forged signatures of a person help in deciding the verification procedure. The features extracted from the preprocessed signature images are described below.

1. Aspect ratio: Aspect ratio of a signature is calculated by the height in pixels to width (in pixels ratio).
2. Occupancy ratio: It is calculated by the ratio of total number of black pixels to total number of white pixels in the signature.
3. Signature area: It is calculated by the total number of black pixels in the signature.
4. Number of white columns: A signature may be written continuously without lifting the pen from

the paper. In this case, there is no gap in the signature. Signatures of a signer who signs with non-continuous lines may have varied amount of gaps in his or her signature. This is an important characteristic and the number of white columns in a signature helps in measuring the total amount of gaps.

5. Maximum horizontal frequency: It is the maximum of all frequencies along the horizontal rows of a signature.
6. Maximum vertical frequency: It is the maximum of all frequencies along the vertical columns of a signature.
7. Number of horizontal line segments of length two or more pixels.
8. Number of horizontal line segments of length three or more pixels.
9. Number of vertical line segments of length two or more pixels.
10. Number of vertical line segments of length three or more pixels.
11. Number of diagonal (+45°) line segments of length two or more pixels.
12. Number of diagonal (+45°) line segments of length three or more pixels.

13. Number of cross-diagonal (-45°) line segments of length two or more pixels.
14. Number of cross-diagonal (-45°) line segments of length three or more pixels.

The features numbering 7-14 give insight on lengths and orientation of strokes which are important in finding structural characteristics of a signature.

## 6. EXPERIMENTAL RESULTS

Feature extraction is done by using the software MATLAB Version 7.9.0.529 (R2009b) in a 32-Bit processor. Each feature is designated by the numbers shown above. Values for a particular feature are obtained for ten genuine signatures of a signer and then standard-deviation of the values is calculated. Each signer is designated by a number. Standard-deviations for 10 genuine signatures in Roman script and 4 genuine signatures in Devanagari script are shown in Tables 1 and 2 respectively.

## 7. DISCUSSION

Since standard deviation is a measure of variability, its low value means less variability and hence more stability. From tables 1 and 2 it is seen that for each row, column 2 has the lowest value. In that sense,

**Table 1. Standard deviation of feature-values extracted from signatures written in Roman script**

Signature Sl. No.	Feature number						
	1	2	3	4	5	6	7
1	0.486	0.005	109.551	13.123	4.915	3.040	42.302
2	0.581	0.010	178.565	16.925	8.628	5.220	49.086
3	0.657	0.012	361.354	23.122	20.220	5.936	82.022
4	0.701	0.004	61.482	12.042	7.102	5.422	20.302
5	0.496	0.004	80.390	13.773	5.004	5.442	24.327
6	0.556	0.014	1199.106	10.149	25.330	13.100	88.870
7	0.454	0.004	226.665	20.245	9.605	5.001	69.929
8	0.359	0.006	250.703	13.513	14.225	4.490	60.219
9	0.325	0.009	523.171	8.488	14.221	9.994	105.555
10	0.458	0.012	328.270	15.931	21.709	3.951	55.252

Signature Sl. No.	Feature number						
	8	9	10	11	12	13	14
1	23.297	23.367	16.877	230.100	101.000	158.900	65.600
2	33.128	24.639	25.385	239.900	121.700	226.800	114.200
3	65.338	54.136	46.590	286.300	135.200	294.400	131.700
4	7.595	16.667	7.695	201.100	93.000	250.400	120.500
5	10.945	21.941	10.756	277.300	114.000	175.200	62.500
6	106.452	48.002	60.516	863.200	740.300	737.500	598.300
7	31.215	63.406	35.856	384.100	176.600	163.300	52.800
8	33.500	46.045	39.493	356.000	169.600	340.700	168.800
9	67.430	49.809	40.085	838.100	701.700	894.200	616.000
10	64.508	59.084	56.187	444.800	249.900	429.200	228.600

**Table 2. Standard deviation of feature-values extracted from signatures written in Devanagari script**

Signature	Feature number						
Sl. No.	1	2	3	4	5	6	7
1	0.382	0.021	469.537	49.238	46.997	5.696	45.107
2	0.196	0.056	2095.326	17.009	49.841	8.297	65.630
3	0.565	0.008	450.398	33.187	64.664	6.007	98.004
4	0.967	0.029	1093.934	11.874	29.323	10.931	145.992

Signature	Feature number						
Sl. No.	8	9	10	11	12	13	14
1	72.450	85.463	98.767	556.100	428.900	533.200	411.200
2	86.343	94.752	134.939	914.800	835.700	738.900	657.100
3	37.750	74.564	31.225	518.400	177.000	451.400	163.400
4	149.298	177.854	159.091	773.200	494.500	702.300	485.000

aspect ratio is the most stable feature among the ones that are extracted. On the other hand, for most of the rows column 11 has the highest value whereas column 3 has the highest value for the rest. Hence among the extracted features, number of diagonal (+45o) line segments of length two or more pixels is the most unstable feature followed by the area. We plan to work towards finding out some more stable features, and designing an algorithm for comparing genuine and forged signatures. Furthermore, we need to study the variations of feature values for Roman and Devanagari scripts.

### निष्कर्ष

स्टैर्ड डेविएसन परिवर्तनशीलता का मापक हैं। इसकी कम संख्या का मतलब हैं कम परिवर्तनशीलता अर्थात अधिक स्थिरता। टेबल 1 और 2 यह देखा गया हैं कि प्रत्येक रो और कोलम 2 में न्यूनतम संख्या हैं। इस संदर्भ में, जिन अनुपात को प्राप्त किया गया हैं उनके गुण अधिक स्थिर हैं। जबकि दूसरी ओर, प्रत्येक रो के कोलम 11 में उच्चतम संख्या हैं जबकि बचे हुए रो के लिए कोलम 3 में उच्चतम संख्या हैं। इसलिए, निकाले गुणों में, कर्ण लाइन पंक्ति लंबाई पर दो या दो से ज्यादा पिक्सल अत्यधिक अस्थिर गुणों को दर्शाते हैं। हम कुछ स्थिर गुणों का पता लगाने तथा वास्तविक एवं जाली हस्ताक्षरों की तुलना के लिए एक एल्गोरिथ्म डिजाइन कर रहे हैं। इसके अलावा, हम रोमन और देवनागरी लिपियों के गुणों के अन्तर को अध्ययन करने की जरूरत है।

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## मोबाइल प्रौद्योगिकी के लिए फ्यूजिटसू सर्वर पर सीड्रियोड ओ एस आधारित क्लाउड संगणना Cloud Computing with CDroid OS based on Fujitsu Server for Mobile Technology

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### सारांश

21वीं सदी ने हमें काफी स्मार्ट बना दिया है, वित्तीय और पर्यावरण की खातिर ऊर्जा की खपत को ज्यादा से ज्यादा बचाना अब अनिवार्य है। यह राष्ट्रीय सुरक्षा और मानव जाति के लिए भी उतना ही महत्वपूर्ण है। आज दुनिया की बहुत बड़ी आबादी स्मार्टफोन बैटरी के बारे में चिंतित है। कई एप को उपयोग करने वाले ऊर्जा के बहुत सारे उपभोक्ता हैं। हमारी प्रणाली सीड्रियोड आपरेशन सिस्टम के साथ क्लाउड संगणना विकसित करती है जो कि मोबाइल प्रौद्योगिकी के लिए फ्यूजिटसू सर्वर पर आधारित है, जिसे पूरी तरह से ऊर्जा की बचत, बैटरी जीवन को बढ़ाने और प्रोसेसर चक्र को बचाने के लिए ही नहीं बल्कि मोबाइल फोन, डाटा साझा करने और तेजी से एक्सेस पहुंचने करने के लिए भी उपयोग किया जाता है। सिस्टम ऑफलोडिंग तंत्र का उपयोग करने के साथ साथ सर्वर और फोन दोनों की मेमोरीज को साझा करता है। मोबाइल क्लाउड संगणना अवधारणा ऊर्जा संरक्षण में कई चीजों की मदद करती है। नवीनतम फ्यूजिटसू सर्वर दुनिया की सबसे तेज प्रसंस्करण प्रोसेसिंग प्रदान करता है। हमने ठीक प्रकार से नव प्रस्ताविक प्रणाली की संरचना का वर्णन किया है। यह तेजी से बदलते सेलफोन प्रौद्योगिकी की दिशा में एक और कदम होगा। कुछ वर्षों के भीतर ही अगली पीढ़ी के लिए हाइब्रिड क्लाउड कम्प्यूटिंग मोबाइल प्रौद्योगिकी दुनिया भर में तैयार हो जाएगी।

### ABSTRACT

The twenty first century made us smart enough, it is now mandatory to save power consumption as much as for the sake of financial, environmental stability. It is equally important for national security and mankind. Today a huge number of populations in the world is worried about Smartphone batteries. They are huge consumer of energy when using several apps. Our system is to develop Cloud Computing with CDroid Operation System that is based on Fujitsu Server for Mobile Technology, which is completely used for saving energy, enhancing battery life and saving processor cycles more than ever of mobile phone, sharing data and faster access. The system shares both the memory of server and phone as well by using offloading mechanism. The mobile cloud computing concept helps several things to conserve power. The newest Fujitsu server provides world's fastest processing. We had described thoroughly the architecture of newly proposed system. This will be one more step towards the quickest changing cell phone technology. The hybrid cloud computing mobile technology for the next generation will be ready for our world within few years.

**Keywords:** Smartphone, CDroid, Fujitsu Server, Cloud Computing

### 1. INTRODUCTION

The CDroid operating system in fujitsu server for mobile cloud <sup>[1]</sup> finds easy to save battery lifes of a Smartphone. They are already able to upload or download data, software, mainly Apps to and from server by offloading technique <sup>[2]</sup>. The Android OS is stored completely on the mobile phone device memory on which it runs and consumes power. Our proposed system is to use a CDroid OS in Fujitsu server to best serve cloud computing facility. The system stores, executes in the cloud utilizes electricity at IaaS cloud

location. As we know the current growth rate of battery capacity is just 5% per year (Robinson et al) <sup>[3]</sup>, which is very less according to growing market needs. The Fujitsu server is fastest as because it transfers data between CPU and memory in a way which is best in the world. The energy consuming Apps are installed partly on clouds, so a lot of electricity is saved and enhances battery life.

Throughout this paper we will use several diagrams and figures to make others understand about our proposed system.

## 2. THE PROPOSED SYSTEM

The system need the cloud services (IaaS), where the Fujitsu server is being installed. Smartphones using wi-fi and 3G enabled network connectivity is best for the system. They communicate the server cloud through mobile tower. The phone also needs CDroid OS. The problems and solutions to achieve the goal using our system both will be discussed later in this paper. The basic structure for the proposed system is as follows:

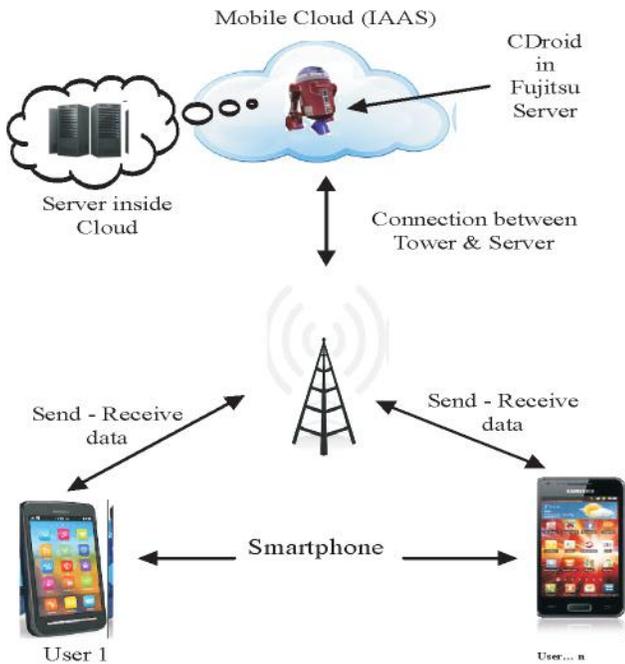


Figure 1. Proposed System Architecture (Basic).

The above diagram (Figure 1) tells us about the basic idea about the smartphones connecting with fujitsu server at clouds provided at cloud systems with the help of communication system like mobile tower. There are lots of intermediate devices and protocols are there, we will discuss them later on this paper.

## 3. CLOUD COMPUTING

Mobile Cloud Computing (MCC) is the greatest factor to reduce power consumption on the mobile devices<sup>[4]</sup>.

Cloud services are internet-service-oriented computing concept, where Hardware, Software and data are shared. The proper definition may be . Share and use of applications and resources of a network environment to get work done without concern about ownership and management of the resources and applications. - (M-S. E Scale, 2009)<sup>[5]</sup>. It is also a combination of preexisting technology, which gives some services. The two different models used in cloud computing are Deployment model and Service model.

The service models are of three types Software as

a Service (SaaS), Platform as a Service (PaaS), and Cloud Infrastructure as a Service (IaaS).

They follow NIST (National Institute of Standards and Technology) model<sup>[6]</sup>. We will concentrate on the IaaS part for our proposed system.

The essential characteristics of cloud computing are On-demand services, Broad network access, Resource pooling, rapid elasticity, measured service, self provisioned, pay per use (lower cost), scalability, ease of utilization, quality of service, reliability, outsourcing, simplified maintenance and upgrade, low barrier to energy etc.

. Mobile Cloud Computing (MCC) at its simplest refers to an infrastructure where both the data storage and the data processing happen outside of the mobile device. Mobile cloud applications move the computing power and data storage away from mobile phones and into the cloud, bringing applications and mobile computing to not just Smartphone users but a much broader range of mobile subscribers.<sup>[7][8]</sup>

As processing task is not done by the mobile device the power and memory consumption is also less in this area and eventually the mobile device became very fast.

For sake of our proposed system Cloud Infrastructure as a Service (IaaS) will be used to store the mobile phones data, Apps etc in the form of Second code segment or CDroid Server. As the system uses cloud services, it does not depend on geographical locations. To reduce cost the cloud infrastructure including fujitsu server must be placed in a country where electricity cost is lowest<sup>[9]</sup>.

## 4. PROBLEMS WITH ANDROID

Android systems hanged a lot, as lots of processes runs on the background. This causes another big problem i.e. drainage of battery. After removing the cover we had seen the Smartphones are heated badly, again for the same reason. Lastly, the malware applications<sup>[10]</sup> cause problems when downloading anything from google play<sup>[11]</sup> or elsewhere.

## 5. CDROID

CDroid is an IaaS cloud-integrated mobile operating system; they can be used in Smartphones (e.g. Android). To enhance speed and increased battery life of mobile phone (Smartphone) the CDroid system is being introduced. It is a system which has two different segments. The first code segment which is named CDroid device here occupies its place within the Smartphone and second one is mentioned by CDroid server that inhabited inside the clouds (private/public)<sup>[12]</sup>.

Some CDroid prototype uses the logo as shown in Figure 2.



Figure 2. A CDroid Logo.

### 5.1 First Code Segment/Cdroid Device

This part will handle all the operations done by the Smartphone like calling, SMS/MMS, internet access, App management etc. and maintain all those using log files. The CDroid device sends all the collected data and information to the cloud side CDroid server as shown in the picture. This process is completely a piggybacking method.

### 5.2 Second Code Segment/Cdroid Server

This is the cloud-side of the system which handles a reliable connection with CDroid device, optimizes the user traffic caching and pre-fetching and content compression. The security issues like uses of different apps, anti-phishing programs, cookie handlers, sensitive information blocker, remote wiper etc. It protects the user's privacy as mobile ad blocker; push notification handler is being used. They also handle mobile computation offloading and data backup synchronization handler, remote code executor<sup>[13]</sup> for better mobile user access.

### 5.3 Working Strategy

CDroid part inside the Smartphone is the operative load environment within it, which works with the other part installed in the clouds as IaaS. The cloud service provider itself is responsible for all synchronization, communication with the Smartphone. So a lot of work is reduced by the Smartphone and it become faster with enhanced battery life. The rest of the parts are already installed in the Smartphone to communicate

with the cloud. We assume the internet connection is on when this system works. A set of userid and password is provided to every Smartphone connected with the cloud network.

CDroid tools are used in Android based mobile phones to switch off/on wi-fi, Bluetooth, data service. There are some free Apps found in google play.

### 5.4 Solution With Cdroid

CDroid systems First code segment is on cloud, so a number background a process executes over the cloud server. It solves several problems like hanging of a cell phone system, saves the energy that was supposed to consume from phone battery. The heat problem of mobile hardware is also solved in this way. The cloud providers use several anti-malware applications, solves the problems when downloading anything from Google play or somewhere else.

## 6. FUJITSU SERVER

High speed interconnecting facility equipped with local disk or as a system with built-in capabilities. Fujitsu server system prototype we are using in the cloud because of high geared speed and flexibility measured so far in simultaneous application. This has been tested and proved that the hardware prototype performs four times more than non-disk pool system. The I/O throughput is increased at about 40% when running actual applications.

Here system performance is measured in every pico second. The next generation server which is using Resource pool architecture (described in the Fig. 3)<sup>[14]</sup>.

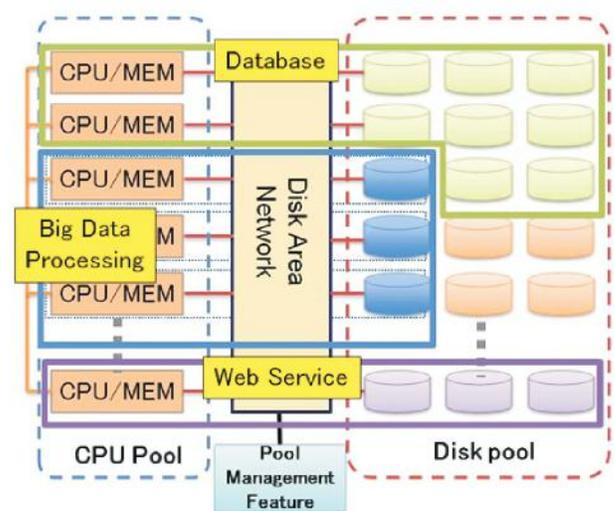


Figure 3. Advanced Resource Pool Architecture.

Pooling or arranging of  $\mu$ -processors, hard disk drives (HDDs) are done for high performance, high utilization and serviceability<sup>[15][16]</sup>. Figure 3 describes

how resource pool works. The above resources are for processing and storing of huge data inside a cloud performs faster and quicker. Other hardware components that comprise the ICT (Information and Communication Technology) infrastructure, and connecting these resources together using high-speed interconnects, high storage capabilities are also needed. The ICT infrastructure developed at its maximum (nearly 86% from 2001 and 2011) globally [17]. In the prototype version, the CPU/HDD interconnects ran at a speed of 6 Gbps [18] without any mutual interference.

As the data transfer rate of this server is very high, that's why it can handle variety of services. Those are the reason behind proposing Fujitsu server for the cloud server. There are big numbers of servers with storage devices are interconnected to provide cloud services in data centers of a cloud provider. Developing ICT infrastructure for Batch compute server, Application on database server, Turning on applications in phases, Complex timesharing server, Workloads that change seasonally, Real-time applications, system utilization etc[19] need high I/O performance or large-scale data processing tasks that use the local disks of servers, as well as for other services requiring a level of performance that had been difficult to satisfy with configurations geared toward traditional cloud systems.

**6.1 Specification**

The system uses a resolution of 600X800 pixels speed of 400MHz. here storage is not specific; it depends upon the cloud service provider companies business needs, according to that the HDD pool is created and maintained. Microsoft CE operating system with remote application enabled.

The networking is done between servers by using Infrared, Bluetooth and wireless LAN as it is required.

Features of the newly developed technology are as follows.

**6.1 Pool Management Feature**

In accordance with user requirements for CPUs, HDDs and other needs, the pool management feature allows for necessary resources to be allocated from the pool, the deployment of OS and middleware resources, and the on-demand provision of servers in a required configuration.

Middleware that offers storage function using servers apportioned from pool. Using server resources from the pool, storage capabilities are delivered by configuring the middleware, which controls HDD management and data management functions. Whether it is a server with multiple local disks tailored for large-scale data processing tasks, or RAID functions for improved data reliability, the system can be flexibly

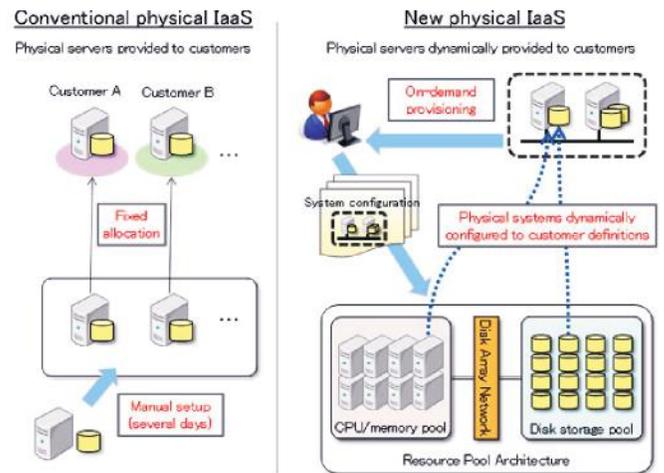
configured to meet performance and power consumption requirements.

High-speed interconnect technology that connects the disk pool comprised of multiple HDDs is connected to the CPU pool via a high-speed interconnect disk area network. The HDDs linked to the CPUs through the disk area network have the same disk access capabilities as the local disks in a typical server, and their performance is not affected by other CPUs. A disk area network was created using prototype interconnects.

Fujitsu cloud services which provide a fully flexible model for IT infrastructure, platforms and applications, allowing companies to match technology systems and costs directly to changing business needs[20].

**7. COMMUNICATION STRATEGY**

The communication strategy is described here as hardware approach, application framework and data transmission in detail.



**Figure 4. Conventional and new physical IaaS (with Resource Pool Architecture).**

**7.1 Hardware Approach**

The Smartphone through the sorting client application (SCA) sends the input file to the nearest access-point. From the access point, the packet gets routed to the service provider edge routers. After edge routers, the packet gets routed to the core routers behind the internet backbone and then to the data centers. The power consumption of switches has been excluded as this has not relevance with our topic. In most cases there will be only a few number of them and their power consumption is insignificant when considered[21].

Figure 5 depicts how CDroid device components inside smartphone have some sort of basic smartphone applications; the device collects information about some user activities and behavior like phone calls, sms send and receiver information, GPS co-ordinates etc. The information (may include voice too) then

send to the cloud side of the proposed system as a piggyback to the user traffic.

Application Framework, Libraries, Android Runtime, Kernel is used to communicate with the Smartphone hardware.

### 7.2 The Application Framework

The application framework of CDroid device includes IEEE 802.11 standard for WLAN which uses Enhanced Data GSM Environment (EDGE). We use EDGE protocol that is several times faster (around 236 Kbit/s or more) than the primeval General Packet Radio Services (GPRS) speed at about 56Kbit/s based on wireless fidelity.

The digital transmission method includes 3G cell phone network protocols like Universal Mobile Telecommunication Service (UMTS), Wideband Code-Division Multiple Access (WCDMA), High-Speed Downlink Packet Access (HSDPA)<sup>[22]</sup>, and Evolution Data Maximized (EV-DO) with Data and voice (EV-DV) too. These technologies provide a maximum data transfer speeds of up to 3 Mbps. it is easy to browse full-fledged Web pages, watch streaming video, tune into live TV or on-demand video programming, make large in seconds, play 3D games, & much more. IP connectivity of this technology is packet based.

A city or village is divided into several cells; each cell is typically sized at about 10 square miles

(26 square kilometers) i.e. the range of one mobile tower. Cells are normally thought of as hexagons on a big hexagonal grid. Each cell has a base station that consists of a tower and a small building containing the radio equipment. Base stations are often called masts, towers or cell-sites; they follow the concept of mesh topology.

### 7.3 Data Transmission

The data transmission of a Smartphone is between 0.6 watts to 3 watts; which is lesser than Citizen Band Radios. The two non-adjacent cells can reuse the same frequency. They fulfill the two requirements, first the frequency will remain within the cell and secondly the saving of phone batteries.

All base station (BS) within a cluster (A group of adjacent cells) are connected to a Mobile Switching Centre (MSC) using land lines. Each MSC of a cluster is then connected to the MSC of other clusters and a Public Switched Telephone Network (PSTN) main switching centre. The MSC stores information about the subscribers located within the cluster and is responsible for directing calls to them. Each carrier in each city also runs one central office called the Mobile Telephone Switching Office (MTSO). This office handles all of the phone connections to the normal land-based phone system, and controls all of the base stations in the region. The Components of the base station include transceivers, which enable the transmission and reception of radio signals through the antennas, plus signal amplifiers, combiners, and a system controller.

A Smartphone deals on digital data (the voice is also converted into binary i.e. 0 and 1). Frequency Shift Keying (FSK) uses two frequencies, one for 1s and the other for 0s, alternating rapidly between the two to send digital information between the cell tower and the phone. The CDroid device using Frequency Division Multiple Access (FDMA) puts all the binary data (including voice) on a separate frequency. The frequency of cell phones, cordless phones, and cell phone tower signals ranges between 800 and 2200 MHz. The frequency it considers is Radio Frequency. Cell phone technology combines the two great technologies named traditional telephone and old radio technology<sup>[23]</sup>.

The wireless spectrum which is a limited resource used by cell phones can communicate on 1,664 channels or more. In addition, cell phones Time Division Multiple Access (TDMA) use a dual band. It assigns each call a certain portion of time on a designated frequency. This means that it can operate in between 800 MHz to 1900 MHz (or around 2.2 GHz) bands. Clearly the bandwidth, a cell phone uses is 1100-1200 MHz.

CDroid Server Components within cloud contains

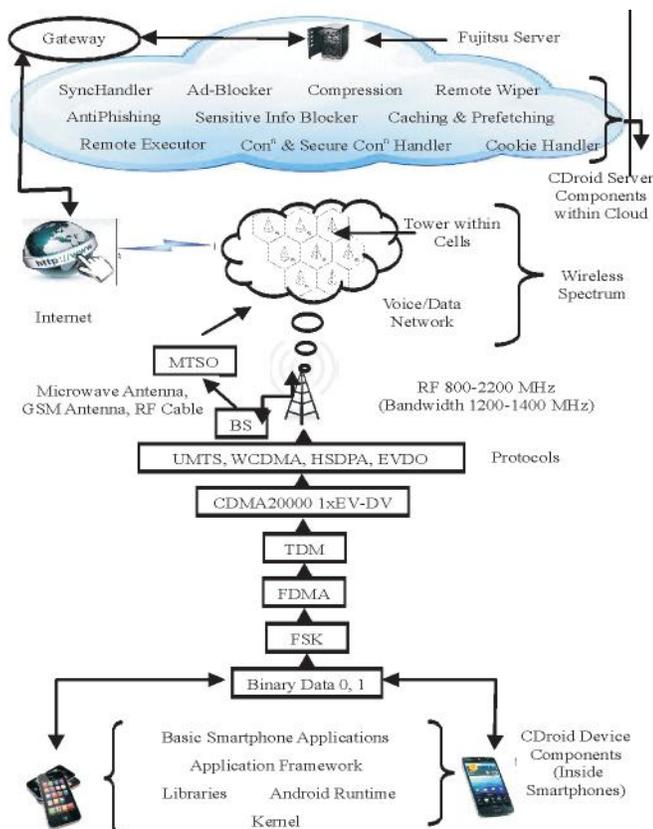


Figure 5. Advanced System Architecture.

connection handler (secure) that handles the connection with CDroid device to optimize users traffic caching & pre-fetching; content compression is also done here. The security issues must contain app, anti-phishing, cookie handler, sensitive information blocker, push notification handler and remote wiper. Mobile advertisement blocker, push notification handler protects users' privacy. Synchronization handler, remote code executor handles mobiles computations and loading the data backup.

Code division multiple accesses (CDMA)<sup>[24]</sup> gives a unique code to each call and spread it over the available frequencies. Here we will use CDMA2000, which is of three types namely CDMA2000 1x, CDMA2000 1xEV-DO (First Evolution Data Optimized) and CDMA2000 1xEV-DV (First Evolution Data and Voice). For our case it better to use CDMA2000 1xEV-DV where the forward link it supports is 3.08 Mbps and a reverse link nearly 1 Mbps<sup>[25]</sup>. The Cloud Radio Access Network (RAN) will be use by the proposed system.

Fujitsu's Business Smartphone F-04F can provide 3 days of battery life, but using the above architecture, it can be extended up to 6 days which is quite surprising in Smartphone produced nowadays.

## 8. LIMITATION

The proposed system needs high speed internet connectivity, which is another cons found in Android based phones; failure of this could stop the Apps in a Smartphone. The 4G technology is also available and that can provide the better result.

## 9. CONCLUSION

It also saves memory spaces as a part of different apps shares cloud server. Also the fastest service should be provided by the system. The proposed system will be beneficial for the cloud computing service providers like Amazon web services, Rackspace, CenturyLink/Savvis, Salesforce.com, Verizon/Terremark, Joyent, Microsoft, Google, IBM, Sales force etc. It will increase their business volume and quality of service. This theoretical approach can be making a practical one if we get proper guidance and funding for welfare of humankind.

## निष्कर्ष

यह विभिन्न एप्स भोयर्स क्लाउड सर्वर के एक हिस्से के रूप में मेमोरी रिक्त स्थान को बचाता है। इसके अलावा प्रणाली द्वारा सबसे तेज सेवा उपलब्ध करायी जाएगी। प्रस्तावित प्रणाली अमेजन वेब सेवाओं, रैक्सपेस, सेन्चुरी लिंक्स/सेविस, सेल्सफोर्स डॉटकाम, वेरीजोन/टेरीमार्क, जोयेंट, माइक्रोसॉफ्ट, गूगल, आईबीएम, सेल फोर्स आदि की तरह क्लाउड कम्प्यूटिंग सेवा प्रदाताओं के लिए भी फायदेमंद होगी। इससे उनके कारोबार और सेवा की गुणवत्ताओं

में भी वृद्धि होगी। यदि हमें मानवजाति के कल्याण के लिए उचित मार्गदर्शन और धन मिल सकता है तो यह सैद्धान्तिक दृष्टिकोण व्यावहारिक बन सकता है।।

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## संवर्धित वास्तविकता: हम जो कुछ 'देखते हैं' उसके लिए एक अलग दृष्टिकोण Augmented Reality: A Different Approach to What We 'See'

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### सारांश

यह शोधपत्र संवर्धित वास्तविकता (एआर) के आगमन की चर्चा करता है जो हमेशा एक उभरती और उन्नत होती तकनीक है। एआर में, हम एक टेबलेट या चश्मे (आईग्लास) जैसे अंतरफलक के माध्यम से भौतिक दुनिया का वास्तविक समय दृश्य देखते हैं और चित्रों को वर्धित आभासी डेटा या वीडियो, चित्रमय छवियों, ध्वनि जैसी जानकारी के साथ उन्नत किया जाता है। एआर प्रौद्योगिकी एक व्यक्ति जो देखता है उसकी वास्तविकता की वर्तमान समझ में विस्तार करने का काम करती है। एआर को वास्तविक समय में और असली पर्यावरण के घटकों के साथ प्रासंगिक जानकारी के तुल्यकालन द्वारा बनाया गया है, जैसे कि किसी मैच के समानांतर टीवी पर उस मैच का स्कोरकार्ड प्रदर्शित किया जाता है। संवर्धित वास्तविकता प्रौद्योगिकी के उपयोग द्वारा, वास्तविक दुनिया परस्पर सक्रिय और सूचनात्मक हो जाती है। एआर नकली जानकारी को असली दुनिया में पर्यावरण पर छा जाने की अनुमति देता है। एक प्रौद्योगिकी जिसके साथ उपयोगकर्ता द्वारा एक तन्मयता, जानकारीपूर्ण और इससे भी अधिक महत्वपूर्ण, एक वास्तविक दुनिया के वातावरण का अनुभव किया जा सकता है—एआर ऐसा कर सकता है!

### ABSTRACT

This paper discusses the advent of augmented reality (AR) which is an ever emerging and improving technology. In AR, we see the real time view of the physical world through an interface like a tablet or eyeglass and that image gets enhanced with added virtual data or information like video, graphical images, sound etc. AR technology works by expanding a person's current understanding of the reality he sees. AR is created in real time and synchronising relevant information with the components of the real environment, such as displaying of match's scorecard live on the TV parallel to that match. By the use of AR technology, the real world becomes interactive and informative. The AR allows simulated information to get overlapped on the real world environment. A technology with which an immersive, informative and more importantly, a real world environment can be experienced by the user – this is what AR can do!

**Keywords:** Augmented reality, eyeglass, global positioning systems, virtual world

### 1. INTRODUCTION

Augmented reality (AR) is the mixing up of two worlds. The one we live in aka the real world and the other being the virtual world.

The AR is the overlaying of the virtual data or information over the real world. It is not the regular virtual world environment which one gets to experience only in a computer simulation known as virtual reality. The AR is much more beyond that. It is the future, it can be considered as the most awaited technology which the people of today have been waiting for.

The AR strategically adds information to a real world entity which one is seeing. The perception of a

viewer about a thing gets enhanced colossally. A thing about which the user didn't have any idea, using AR suddenly makes him feel smarter as he gets to know about the additional information which others may not get to know about. This is what AR does. The power of the AR can be more precisely understood by considering a simple example.

Imagine a device with which user looks at something, it shows information about whatever you point it at. Focus on a hotel, and a display pops up giving a menu and customer reviews, look at a monument or any other building, and you get to know by whom and when it was built. These are the type of potentialities afforded

by the technology of augmented reality. Given a real subject, captured on video or camera, the technology 'augments' (= the action of adding to something in order to make it more substantial) that real-world image with added layers of digital information.

## 2. TECHNOLOGY

### 2.1 Hardware

The hardware components used for AR are: Processing units, displays, input devices, and sensors. Modern mobile devices such as smartphones and tablets have special elements built in such as a camera and devices such as global positioning systems (GPS), accelerometers, compass, etc., which makes them suitable AR platforms.

### 2.2 Spatial Displays

Spatial augmented reality (or SAR) augments data objects and real world entity without using any physical AR display devices like tablets, eyetaps, head mounted displays, etc. Main difference between AR and SAR is that the former uses physical displays but the later uses laser displays on skin or a desk and Skinput technology for taking inputs. The technologies which are used for SAR are known as spatial displays such as mobile projectors and smart projectors.

Some applications of SAR include AR Hand Phone with AR keypad and AR keyboard. The AR Hand Phone allows the user to call a friend using an AR keypad without removing their cell phone from their pocket or purse.

The AR Keyboard takes the place of a physical computer keyboard. Since a physical display is not used but an alternate spatial display's use makes it more exciting and interesting for the person using it.

A spatial display provides flexibility for the user. He can see the display as per his convenience. Spatial displays are not only just simple visible displays but SAR has support for haptic sensations too. Thus, input can be read from these passive haptic inputs.

### 2.3 Eyeglasses

The AR display can be projected onto devices which are similar to eyeglasses and hence the name. The virtual information related to the physical world is projected on the eyeglasses with the help of small projection devices after the real image is captured by a camera and converted into the AR view.

### 2.4 Virtual-Retinal Displays

Virtual-retinal displays (or simply VRDs) are special displaying devices with which a raster image's direct projection onto the user's retina is done in a way which makes it look like to a normal vision to the user. These are also known as retinal projectors or retinal scan displays.

### 2.5 Head Mounting Displays (HMDs)

An HMD is a displaying device coupled to a headset like a helmet or a head harness. A head-mounting display (or HMD) puts the real and simulated world images on the view field of a user. The HMD makes sure that the device shows correct images as per user's movements of the real world by using a special technique known as 6 Degree of Freedom (DOF). The HM displays an amazing and enlightening experience of the real world through them.

### 2.6 Head-up Displays (HUDs)

Head-up displays (HUDs) are the devices which can apply AR on only part of one's view field. For example, Google glass (a HUD) are created to provide an experience of AR technology to its users.

Several alternate devices have come up post Google Glass.

### 2.7 Handheld Displays

The first major success of AR technology's usage commercially can be given to the handheld displays. The major features of these devices are:

- Portability of these devices.
- Availability of great quality of camera in them.

These displays use small screens which and can be easily carried anywhere by the user. Every handheld device AR apps created till now choose the video see-through. Earlier, the handheld AR used to employ fiducial markers, but now MEMS (such as digital compasses and gyroscopes) and GPS sensors have been employed. Nowadays, the SLAM markerless trackers like PTAM have been started to be made in use. The main drawbacks are:

- Users have to always hold the device in their hands,
- Smaller view area of handheld displays because of camera restrictions as compared to the physical view.

The modern day tablets, tablet-PCs, smartphones, etc., are the examples of the handheld displays.

### 2.8 AR Contact Lens

The AR-based contact lens have been a revolutionary stepping stone. These lenses have ICs, light emitting diodes, and antennae for communication purpose. Their functioning is somewhat similar to the Google Glass but with a slight variation that the micro-projection of data is done on the retina. Simultaneously, the real world image is also passed on the retina through a special filter. Thus, both images merge seamlessly looking like one to the viewer.

### 2.9 Tracking

Mobile AR technology-based devices use several tracking methodologies which are:

- Accelerometers

- Gyroscopes
- GPS
- Digital cameras or similar optical sensors
- Wireless sensors
- Radio frequency IDs (RFIDs), and
- Solid state compasses

These methodologies can provide variable levels of precision and accuracy. In tracking, the main thing in focus is the orientation and position of viewer's head or display used. For correct images creation, 6 DOF interacting method is used.

### 2.10 Input Devices

The input device methods include the usage of styluses, data gloves, or other body wearable device which can decode the user input and feed it to the computer for processing purposes. After processing the input received using these devices, the output or the augmented view is shown to the user. Voice-recognition systems are also used as input devices and these provide voice inputs in the system.

### 2.11 Computer

The computer is a very essential and important part of the realisation of AR technology. The input given by the user is processed and desired augmented output is generated and sent over to the display devices by it.

### 2.12 AR Technology Software Development

#### Kits

One of the major features of AR technology is how well the real world environment and data are aligned together in the augmented view.

Major functioning of the AR software includes detection of the user's place using the GPS and comparing the images sent by the camera and compare it with the database. After that, images are aligned with relevant data information. The toughest task is done at the end. This task is the aligning of data and the real world images.

To push start the speedy development of AR apps, several software development kits (or SDKs) have come up<sup>16</sup>. These SDKs have been developed which are based on augmented reality markup language (ARML is an open standard for AR technology and based on XML) given in open geospatial consortium (OGC).

These SDKs make use of cloud computing for improving the performance. Some popular AR technology SDKs are: MetaIO mobile SDK, Qualcomm's Vuforia-SDK, Wikitude's SDK and layar SDK.

The SDK offers developers the creative freedom to build unique experiences that reflect brands and drive business results ensuring reliable experiences in a variety of surroundings. The games and apps for popular

mobile OS platforms like android, iOS, windowsphone OS, etc., can be made using these SDKs. The SDKs provide development using popular app development methods like Eclipse, Unity cross platform games, XCode and a few more. The games and applications created by using these SDKs can identify a range of real-life objects like product packaging, books, magazines, toys, architectural buildings, sportspersons and so on!

## 3. AUGMENTED REALITY APPLICATIONS

### 3.1 Tourism and Exploring Related

Using AR-based applications, a user can get the additional information related to the places he is visiting and have more insight to that place. These applications can be used by travellers to get an experience of simulated places, objects and historical events by imparting them in the user's current view space<sup>3-5</sup>. These apps can also provide the information of the places by dedicated audios combined with that place just by pointing on it. Several AR-based browsers and other apps are available on the android and iOS stores which realize these tasks. By using AR technology, Nokia's city lens (an app on the Windows phone store) provides great user experience and make the lives of users and travellers much easier in a foreign place by showing the information about the place on which we point through the app.

### 3.2 Gaming

Using AR technology, many games have been created. In AR based games, gamers get to experience digitised gaming experience overlaid onto the real world. This has made the possibilities of motion detection consoles of Wii and Play Stations<sup>6</sup>. Some of the games based on AR are: AR Basketball, AR Defender 2 which provide the users with enriched gaming experience simulated over their own real world.

### 3.3 Art

Differently abled persons can now create art by using eye movements and its detection and its projection on an AR monitor<sup>7</sup>. Also, AR technology can be used to increase the user experience by creating an augmented environment for the viewer of a drawing. Additional colours or projections can be added in a drawing's augmented view by the use of AR.F

### 3.4 Architecture

The AR can support conceptualising building project works. Using AR, a system generated view can be seen over the architectural map of a building using which the look of a building can be seen before it is actually realised. The 2D drawings can be animated to 3D by the designers using AR. The AR applications

can be used to view inside the buildings which helps users to get a virtual see through inside the building without actually going in the building<sup>9</sup>.

### 3.5 Medical Field

The AR can provide the surgeon with otherwise unrevealed information like showing the condition of the organ of patient, blood pressure, and heartbeat rate, etc. An example is virtual X-Ray with which foetus in mother's womb can be seen more clearly by using a mixture of pre-tomography images or real-time ultrasound images mixed with confocal microscopy analysis<sup>10</sup>. The patients using a google glass can be prompted about the medicines they have to take<sup>11</sup>.

### 3.6 Military

The AR can be useful during wars. It can be used as a real time battle's data renderer onto the soldier's eye gear to help him know about the potential threats. A camera to produce 360° vision of the battle area can be used to render battlefield on the soldier's eye gear to help him in navigating in the battlefield, and these can also be retransmitted to control area in the base stations from where the officials can have an insight about the battle and guide the soldiers<sup>12</sup>.

### 3.7 Sports

Use of AR has become a common part in today's sports broadcast. The overlaying of scorecard on the screen along with the footage of the match has become a common practice in all kind of sports. In cricket, not only the score but the display of a cricketer's stats are shown when needed. Whether the showcasing of the player's wagon wheel of scoring areas during a match or displaying the projectile followed by the ball during a six on TV, all have been made possible by the use of AR.

The advertisements overlaid along with the playing field during a sports telecast are done using AR technology. During the telecast of swimming competitions, lines showing world records and game records are displayed to let the viewer get the idea about the swimmer's performance. Of course, the swimmer's timings are also displayed. Some more examples are tracking a racer's performance during a race and tracing the puck's movements during an ice hockey match<sup>13,14</sup>.

### 3.8 Translation

Spoken words can be translated and displayed. The foreign writing on signboards and menu-cards in a user's AR view (via an AR device) can be re-displayed in the user's native or familiar language after being changed by the AR system<sup>16</sup>.

## 4. CONCLUSIONS

After discussing the features of AR technology we can comprehend why it is such an exciting area. The perception of reality increases from simply being just 'what we see' to a more informative 'what we understand' - a major transformation. The people get to realize the importance of what is surrounding them using AR. Augmented reality based apps are slowly becoming the ultimate interface as we are getting closer to the mobility. The major issues related to the AR implementation are the aligning of data with the visuals. Of course, a lot of research related to this has made it more prominent today. The full potential of AR technology can only be extracted by development of AR supporting devices.

With creation of AR supporting SDKs, the developers get more resources to create amazing apps and games which make use of such an incredible technology. The future of AR is getting brighter and it will surely be the quintessential part of future applications of important mobile platforms whether Windows phone OS, iOS or Android!

### निष्कर्ष

एआर प्रौद्योगिकी की विशेषताओं पर चर्चा के बाद हम समझ सकते हैं कि यह इतना रोमांचक क्षेत्र क्यों है। साधारण तौर पर 'हम जो देखते हैं' से अधिक सूचनात्मक 'हम जो समझते हैं' एक बड़ा परिवर्तन है— जिससे वास्तविकता की अवधारणा बढ़ जाती है। लोग को इसके महत्व का एहसास होने लगता है, जो एआर का उपयोग कर उन्हें आसपास हो रहा है। जैसे-जैसे हम गतिशीलता के करीब हो रहे हैं, संवर्धित वास्तविकता आधारित अनुप्रयोग धीरे-धीरे मुख्य इंटरफेस होते जा रहे हैं। दृश्यों के साथ डेटा का संरेखण एआर कार्यान्वयन से संबंधित प्रमुख मुद्दा है। बेशक, इस से संबंधित काफी अनुसंधान ने आज इसे अधिक महत्वपूर्ण बना दिया है। केवल एआर समर्थन उपकरणों के विकास द्वारा ही एआर प्रौद्योगिकी की पूरी क्षमता का दोहन किया जा सकता है।

एआर का समर्थन करने वाले एसडीकेएस के निर्माण के साथ, डेवलपर्स को अद्भुत एप्लिकेशन और खेल बनाने के लिए और अधिक संसाधन मिलते हैं जो इस प्रकार की एक अविश्वसनीय प्रौद्योगिकी का उपयोग कर सकते हैं। एआर का भविष्य उज्ज्वल हो रहा है और यह निश्चित रूप से विंडोज फोन ओएस, आईओएस या एंड्रॉयड हर प्रकार के महत्वपूर्ण मोबाइल प्लेटफार्मों के भविष्य के अनुप्रयोगों का एक सर्वोत्कृष्ट हिस्सा हो जाएगा!

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## ग्रीन कम्प्यूटिंग Green Computing

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### सारांश

जैसाकि 21वीं सदी ऑनलाइन एप्स, सशक्त सोशल नेटवर्किंग साइटों, क्लाउड कम्प्यूटिंग, अतितीव्र पीसी और अन्य युक्तियों के सूचना प्रौद्योगिकी विकास के क्षेत्र में तकनीकी उन्नति की साक्षी रही। किंतु, यह तकनीकी युग विभिन्न हानिकर विकिरण और विषाक्त पदार्थ भी लेकर आया है जिन्होंने विभिन्न जीव स्वरूपों पर प्रतिकूल प्रभाव डाला है, इसने पर्यावरणविद् और सूचना प्रौद्योगिकी प्रोफेशनल को मानव संबंधी विषयों में इस उन्नति को लाने के लिए बाध्य किया है और इसलिए ग्रीन कम्प्यूटिंग की अवधारणा को प्रस्तुत किया है। ग्रीन कम्प्यूटिंग कम्प्यूटर संसाधनों का कुशलता से प्रयोग करने का अध्ययन और पद्धति है। अतः, हम कह सकते हैं कि ग्रीन कम्प्यूटिंग ग्रीन रसायन की तरह है, इस पत्र में सूचना प्रौद्योगिकी के विभिन्न घटकों और कैसे वे पर्यावरण को हानि पहुंचा रहे हैं और इस समस्या से लड़ने के विभिन्न वैकल्पिक समाधानों पर विचार शामिल है।

### ABSTRACT

As the 21<sup>st</sup> century marked the technical advancement in fields of information technology (IT) development of online apps, strong social networking sites, cloud computing, building ultrafast PCs, and other gadgets. But this technical era has introduced many harmful radiations and toxins which have adversely affected various live forms. This has forced the environmentalist and IT professionals to bring this advancement to human concern, and hence, introduced the concept of green computing. Green computing is the study and practice of using computer resources efficiently. Thus, we can say green computing is like green chemistry. This paper includes various components of IT and how these are harming environment and suggesting alternate solutions to combat this problem.

**Keywords:** Green computing, computer hardware

## 1. INTRODUCTION

Green computing is the study and practice of designing, manufacturing, using and disposing of computers, servers and associated subsystem effectively and efficiently.

At one side where it focus on environment sustainability, at the other side. It strives to achieve economic viability and improved system performance.

Now this computation is the most burning issue of 21<sup>st</sup> century. As for decades, mechanical engineers worked on substituted fuels for driving vehicles and to reduce pollution emission but now IT experts have been also working upon some alternates to substitute this hazardous technological trend as the following study shocked everyone.

An average  $CO_2$  emission of a car  $\approx$  200 g / km.

Assume that you drive 10000 km/yr = 2,000,000 gr  $CO_2$ /year = 2000 kg/yr. A single Dell (according to the study by msdn.microsoft.com PowerEdge M600 blade) server consumes an average of 383.75 W when idle and 454.39 W under stress. It also produce 3500 kg  $CO_2$ /yr.

1 Dell server  $\approx$  2 car (!!!)

The 3 main components of IT are:

- Hardware
- Software
- Networks

These components are contributing towards emission of  $CO_2$ , harmful radiation and pollutants.

## 2. HARDWARE

Toxins released by hardware overheating or

**Table 1. Health Effects of e-waste constitute health hazards**

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (Pb)	<ul style="list-style-type: none"> <li>• Damage to central and peripheral nervous systems, blood systems and kidney damage.</li> <li>• Affects brain development of children.</li> </ul>
Chip resistors and semiconductors	Cadmium (Cd)	<ul style="list-style-type: none"> <li>• Toxic irreversible effects on human health.</li> <li>• Accumulates in kidney and liver.</li> <li>• Causes neural damage.</li> <li>• Teratogenic.</li> </ul>
Relays and switches, printed circuit boards	Mercury (Hg)	<ul style="list-style-type: none"> <li>• Chronic damage to the brain.</li> <li>• Respiratory and skin disorders due to bioaccumulation in fishes.</li> </ul>
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	<ul style="list-style-type: none"> <li>• Asthmatic bronchitis.</li> <li>• DNA damage.</li> </ul>
Cabling and computer housing	Plastics including PVC	<p>Burning produces dioxin. It causes</p> <ul style="list-style-type: none"> <li>• Reproductive and developmental problems;</li> <li>• Immune system damage;</li> <li>• Interfere with regulatory hormones</li> </ul>
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	<ul style="list-style-type: none"> <li>• Disrupts endocrine system functions</li> </ul>
Front panel of CRTs	Barium (Ba)	<p>Short term exposure causes:</p> <ul style="list-style-type: none"> <li>• Muscle weakness;</li> <li>• Damage to heart, liver and spleen.</li> </ul>
Motherboard	Beryllium (Be)	<ul style="list-style-type: none"> <li>• Carcinogenic (lung cancer)</li> <li>• Inhalation of fumes and dust. Causes chronic beryllium disease or berylliosis.</li> <li>• Skin diseases such as warts.</li> </ul>

decomposition are lethal. They are now termed as e-waste. "E-Waste" is a term used to cover all types of Electrical and electronic equipments (EEE). The hazardous contents of computer, VCR, Cellphones, and Batteries can be harmful to the ecosystem. The change in technology from Nokia 110 to Galaxy S5, from telegram to emails to whatsapp, from smartphones to lightening PCs to G.P.S its hard to imagine life without technology we are well aware of new technology but what about disposal of previous ones. There is a table showing how effects of E-Waste constituents on health. Waste minimizing in industries involves adapting;

- Inventory management
- Production process management
- Volume reduction
- Recovery and reuse

### 3. NETWORKS

The media used to link devices to form a computer network include electrical cable, optical fiber, and radio waves. A widely adopted family of communication media used in local area network (LAN) technology is collectively known as ethernet. Ethernet transmits data over both copper and fiber cables. Wireless LAN standards use radio waves, or others use infrared signals as a transmission medium. Power line communication uses a building's power cabling to transmit data. But the question is are they safe. The research conducted. The wireless networks affect in following ways.

#### 3.2 Risk to Pregnant Women

The foetus inside mother's womb is more susceptible to damage by EM waves owing to repeated exposure during pregnancy period and since foetus is very small it is at risk of suffering from harmful effects of these waves as foetus is growing and its cells are dividing and these radiations are harmful for dividing cells.

#### 3.3 Calcium Ion Release from Cell Membrane

These radiations cause wear and tear of cell membranes because of their harmful effect on calcium ion.

#### 3.4 DNA Damage

These radiations cause single and double strand breaks in DNA molecule and hence cause mutations.

#### 3.5 Interference with other Gadgets Including Pacemakers

Individuals with pacemakers implanted are vulnerable to harmful effects of mobile radiation and thus these cellphones should be avoided inside operation theaters and ICU's.

### 4. SOFTWARE

The use of certain sites or softwares putting great load on CPU accelerating energy consumption and simultaneous CO<sub>2</sub> emission. Study is conducted on Intel(R) Core(TM) DUO CPU T5870.

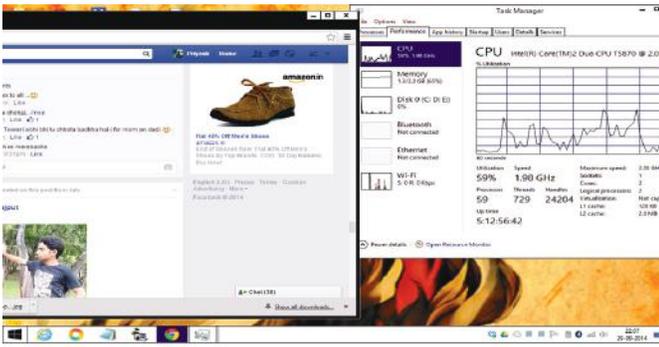


Figure 1. Loading of facebook page puts 59% CPU usage.

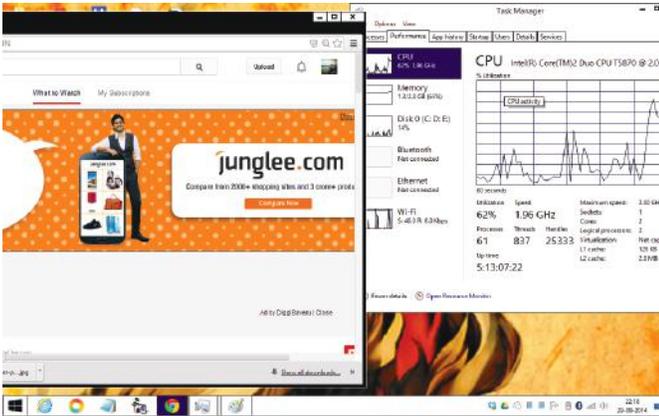


Figure 2. Loading of google page puts CPU usage to 65%.

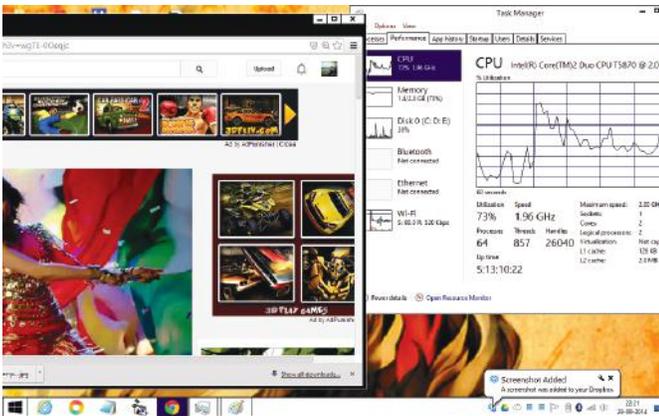


Figure 3. Buffering A video on Youtube puts CPU usage to 73%.

To reduce this we have to develop simple algos which reduce program complexity and in return put CPU to less pressure.

Cache is there to reduce the no. of items so the CPU would stall waiting for memory request.

### 4.1 Certain Norms for Algo Design

Techniques for avoiding suffering from memory fetch latency is typically the first thing to consider, and sometimes helps a long way. The limited memory

bandwidth is also a limiting factor, particularly for multicores and multithreaded applications where many threads wants to use the memory bus. A different set of techniques help addressing the latter issue.

Improving spatial locality means that you ensure that each cache line is used in full once it has been mapped to a cache. When we have looked at various standard benchmarks, we have seen that a surprising large fraction of those fail to use 100% of the fetched cache lines before the cache lines are evicted.

Improving cache line utilization helps in three respects:

1. It tends to fit more useful data in the cache, essentially increasing the effective cache size.
2. It tends to fit more useful data in the same cache line, increasing the likelihood that requested data can be found in the cache.
3. It reduces the memory bandwidth requirements, as there will be fewer fetches.

### 4.2 Common Techniques

- Use smaller data types
  - Sort your struct members by decreasing size in one way so it doesn't introduces alignment holes.
  - Avoid standard dynamic allocations as it introduces alignment holes.
  - Favour linear datastructures as they have regular access patterns.
  - we should also note that there are other ways to hide memory latency than using caches.
  - Modern CPUs often have one or more hardware prefetchers. They train on the misses in a cache and try to spot regularities. For instance, after a few misses to subsequent cache lines, the hw prefetcher will start fetching cache lines into the cache, anticipating the application's needs. If you have a regular access pattern, the hardware prefetcher is usually doing a very good job. And if your program doesn't display regular access patterns, you may improve things by adding prefetch instructions yourself. Regrouping instructions in such a way that those that always miss in the cache occur close to each other, the CPU can sometimes overlap these fetches so that the application only sustain one latency hit (Memory level parallelism).
  - To reduce the overall memory bus pressure, we should apply the concept of temporal locality. This means that you have to reuse data while it still hasn't been evicted from the cache.
- Now seeing all the possible to all disasterous outcome of of our technical leisure we can't sit still now following approaches are very necessary
- a) Process of virtualisation-its the process of running 2 or morelogical computer system using one set

- of physical hardware.
- b) efficient storage devices- i.e. Having prolong battery life, reduced cooling requirement reduced noise
  - c) Power management-issuing and using 80 plus voluntry certificate by manufacturers of power supply.
  - d) Machine recycling- to recycle old hardwares to produce new cheap ones  
And hence reduce the e-waste generation.

## 5. CONCLUSION

Green Computing is a parallelism between environment sustainability and economic viability, though the various suggested methods for reducing the complexity of system may took year's to achieve but as an aware individual we should follow process of virtualisation, efficient storage techniques, wired networking, use power efficient products and start reusing and recycling our old hardware parts various centres of e waste recycling has been opened in different parts of India but need of time is that we should start utilizing these centers.

## निष्कर्ष

ग्रीन कम्प्यूटिंग पर्यावरण वहनीयता और आर्थिक व्यवहार्यता के बीच एक समानांतर संबंध है, यद्यपि प्रणाली की जटिलता को कम करने के लिए सुझाए गए विभिन्न तरीकों में लक्ष्य प्राप्ति में वर्षों का समय लग सकता है, लेकिन एक सजग व्यक्ति के रूप में हमें आभासीकरण, कुशल भंडारण तकनीकों, तारबद्ध नेटवर्किंग की प्रक्रियाओं का पालन करना चाहिए, विद्युत दक्षता वाले उत्पादों का उपयोग करना चाहिए और अपने पुराने हार्डवेयर पुर्जों का पुनःउपयोग और पुनर्चक्रण प्रारंभ करना चाहिए। भारत के विभिन्न हिस्सों में ई-अपशिष्ट पदार्थों के पुनर्चक्रण के लिए विभिन्न केन्द्र खोले गए हैं लेकिन समय की मांग है कि हम इन केन्द्रों का उपयोग करना प्रारंभ करें।

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## ऑपरेटिंग सिस्टम में समय निर्धारण में चुनौतियां Scheduling Challenges in Operating System

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### सारांश

निर्धारण ऑपरेटिंग सिस्टम का सबसे महत्वपूर्ण कार्य है। सभी संसाधनों का सबसे अच्छा उपयोग के लिए उपयोग करने से पहले निर्धारित किया जाना चाहिए। एक ही काम है तो हम अनुसूचक की जरूरत नहीं है, लेकिन वास्तविक समय परिदृश्य में यह संभव नहीं है। तो, अनुसूचक वर्तमान समय में वांछनीय है। किसी भी अनुसूचक के मुख्य कार्य सबसे कुशल और विश्वसनीय संसाधन के लिए रोजगार के अवसर प्रस्तुत करने के लिए है। यह भी रोजगार के अवसर और संसाधनों के प्रभावी रूप से निर्धारित नहीं कर रहे हैं तो यह काफी पूरे ऑपरेटिंग सिस्टम दक्षता नीचा दिखाना होगा कि तथ्यों में से एक है। इस पत्र में हम विभिन्न समयबद्धन एल्गोरिथ्म का अध्ययन करने और अभी भी समय-निर्धारण में मौजूद हैं, जो विभिन्न चुनौतियों का पता लगाना।

### ABSTRACT

Scheduling is the most important function of operating system. All resources must be scheduled before use for best utilization. If there is a single job then we don't need scheduler but in real time scenario it is not possible. So, scheduler is desirable in the present time. The main task of any scheduler is to submit the jobs to most efficient and reliable resource. It is also one of the facts that if jobs and resources are not scheduled effectively then it will degrade the whole operating system efficiency drastically. In this paper are found the various scheduling algorithm have been studied and the various challenges which still exist in scheduling.

**Keywords:** Scheduling, resources, jobs, scheduler

### 1. INTRODUCTION

In operating system, scheduling is a basic function, since almost all computer resources are scheduled before use. It involves the allocation of resources and time to process or tasks in such a way that certain performance requirements are met. In a multiprogramming, computer has multiple processes and they are competing for the CPU at the same time. So, a choice has to be made which process to run next which is done by scheduler. Whenever the CPU becomes idle, it is the job of the CPU scheduler to select another process from the ready queue to run next. A scheduler executes the process with the help of scheduling algorithms. Thus its scheduling algorithm is heart of the OS design. A CPU scheduler is the part of an operating system and responsible for arbitrating access to the CPU<sup>1</sup>. The scheduler is mainly concerned with throughput, turnaround time, response time, fairness, waiting time etc<sup>2</sup>. The key to multiprogramming is scheduling. scheduling of CPU is one of the critical factors that affect the efficiency.

Scheduling of CPU resource has many ways by which it can be scheduled like FCFS, Round Robin, SJF, priority scheduling. Scheduling a CPU which has different types of processes, which are required to run, can be scheduled using multilevel queue and multilevel feedback CPU scheduling techniques. Multilevel queue scheduling is of much importance and is widely used for scheduling of jobs in a processor.

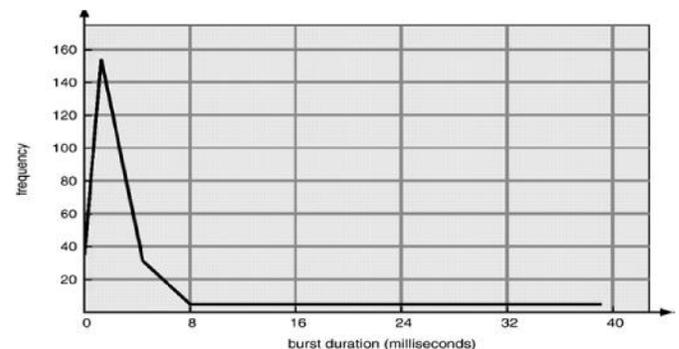


Figure 1. Scheduling behaviour.

## 2. RELATED WORK

Many researchers have been proposed various methods to compare the scheduling policies in operating system. The basic thing which is common in all of work related to comparison of scheduling policies is that they have calculated average waiting time on some input based parameters. As waiting time is directly dependent on the turnaround time and turnaround time is on execution time, so if turnaround time is high then waiting time is also high and average waiting time also.

It is better to have less turnaround time. SJF tries to have lowest execution time first. Pushpraj Singh, Vinod Singh, Anjani Pandey<sup>3</sup>, showed that how SJF is better than all other scheduling algorithms. For every process, average waiting time is lower for SJF and higher for other scheduling algorithms. They also recommended that any kind of simulation for any CPU scheduling algorithm has limited accuracy. The only way to evaluate a scheduling algorithm to code it and has to put it in the operating system, only then a proper working capability of the algorithm can be measured in real time systems.

The very advantageous thing in scheduling can be if we can minimize/optimize the average waiting time. Vikas Gaba, Anshu Prashar<sup>4</sup>, showed waiting time in genetic algorithm is less than even SJF and genetic algorithm is one of the better function optimization methods. This paper introduced the one new algorithm i.e., genetic algorithm and making a comparison of it with SJF and FCFS scheduling algorithms based on the average waiting time of these algorithms at different number of iterations.

It can also be possible that a process may demand for more I/O than the CPU. So, we need an efficient scheduling to compensate CPU process with I/O process. For this, Sanjaya Kumar Panda, Debasis Dash, Jitendra Kumar Rout<sup>5</sup>, proposed group-based time quanta (GBTQ) algorithm, which shows less waiting time than SJF. A GBTQ is proposed in this algorithm. Each group has different time quanta. This algorithm can extend to I/O processes. It also reduces starvation as well as context switching (CS). Selection of time quanta in Round Robin (RR) plays a very big role in deciding average waiting time. If time quanta is extremely large, the RR policy is same as FCFS policy. If time quanta is extremely small, the RR approach is called processor sharing and creates the appearance that each of n process has its own processor running at 1/n the speed of real processor<sup>8</sup>. So, the selection of time quanta can be made easy by choosing dynamic time quantum. For this, Abbas Noon, Ali Kalakech, Seifedine Kadry<sup>6</sup> proposed propose a new algorithm, called AN, based on a new approach called dynamic-time-quantum; the

idea of this approach is to make the operating systems adjusts the time quantum according to the burst time of the set of waiting processes in the ready queue. They also showed that this algorithm increases the performance of RR and stability of the operating system and supports building of a self-adaptation operating system, which means that the system is who will adapt itself to the requirements of the user and not vice versa.

## 3. SCHEDULING ALGORITHMS

When more than one process is ready, the operating system must then use a CPU scheduling algorithm to decide which one is to run first and for how long. Modern operating systems are moving towards multitasking environments which mainly depends on the CPU scheduling algorithm since the CPU is the most effective or essential part of the computer. There are various scheduling algorithms. A basic explanation of scheduling theorems on which we had worked:

### 3.1 First-Come-First-Served (FCFS)

It is the simplest scheduling algorithm, it simply queues processes in the order that they arrive in the ready queue. The process which arrives first in ready queue is served first. It is a non-preemptive scheduling algorithm. It means processor cannot release the process before its execution is over. The FCFS scheduling is fair in the formal sense or human sense of fairness but it is unfair in the sense that long jobs make short jobs wait and unimportant jobs make important jobs wait<sup>7,8</sup>.

### 3.2 Shortest Job First (SJF)

The algorithm gives priority to shortest process available in ready queue. It works under the two schemes (preemptive and non-preemptive). The main problem with this discipline is the necessity of the previous knowledge about the time required for a process to complete. The process which has high burst Time (BT) has to suffer most in this algorithm. This type of suffering is called as 'aging'.

### 3.3 Round Robin (RR)

Scheduling is based on time sharing concept. It is basically the combination of first come first served (FCFS) scheduling algorithm and preemption among processes. To implement the RR scheduling, we keep the ready queue as FIFO queue of processes.

As new process arrives, it will be inserted in to the tail of the ready queue.

### 3.3 Min-Min

Min-min algorithm finds the task which has minimum execution time and assigns the task to the

resource that produces minimum completion time. The Min-min scheduling algorithm chooses the smaller task first. Min-min scheduling prefers the minimum completion time. Main drawback of this algorithm is unbalanced load.

### 3.4 Max-Min

The Max-min scheduling algorithm is similar to Min-min scheduling algorithm but it schedules the larger task first. Min-min and Max-min are used for small scale distributed system. Thus, Max-Min would try to schedule at the same time all the short jobs and the longest ones while Min-Min would schedule first the shortest jobs and after that the longest ones.

### 3.5 Min-Max

Min-max heuristic has two steps for assigning jobs to machines. In first step, similar to min-min method, completion time of all unassigned tasks ( $1 \leq j \leq n$ ) on all the available machines ( $1 \leq i \leq m$ ) is used to calculate the minimum completion time (MCT<sub>i</sub>) of task T<sub>i</sub> on machine M<sub>i</sub>\*. In the second step for all tasks ratio of minimum execution time (time to execute on fastest machine) to its execution time on selected machine M<sub>i</sub>\* is computed and the task which has maximum value pf it is selected for assignment.

### 3.6 Comparisons of Algorithms

FCFS scheduling algorithm is very easy to understand and it is particularly troublesome for time-sharing systems, where each user get a share of CPU at regular intervals. So, it is very unfavorable to allow one process to keep the CPU for long period. The SJF scheduling algorithm is to serve all types of job with optimum scheduling criteria. The process with less execution time is served first and the process with highest execution time is not served at all which gives minimum average waiting time and average turnaround time. But, it cannot be implemented at the level of short-term CPU scheduling. The Round Robin (RR) scheduling algorithm found as most widely adopted algorithm which may sometimes go under severe problems directly related to quantum size. The main point is that RR is more responsive than shortest job first (SJF). So, for large number of jobs, SJF gives better average waiting time than other. For small no of jobs, there is race between FCFS & SJF but still SJF is better.

## 4 CHALLENGES IN SCHEDULING

### 4.1 Type of Job

When the process is allocated to CPU, Scheduling of processes starts. At present, long term scheduler simply takes the job in ready queue & short term

scheduler selects the job from ready queue & finally job is given to CPU. But the current challenge is that before entertaining to any job by scheduler, it doesn't look for the type of job it is. Basically, there are two types of job. One is computational intensive and other is communication intensive. If the job is communication intensive then it would require higher bandwidth for the transfer of data and if it is computation intensive then it would require higher CPU speed. The computational jobs are the jobs that require processing time more than communication time. However, communicative jobs are the jobs that require communication time more than processing time. In computational intensive, job considers execution time for processing and it also takes more power.

### 4.2 Reliability

The primary concern in systems is of security and resources. A proper safety mechanism is required for grid resources, because if resource is affected by virus or some malicious code then it will not execute the application safely and degrades the performance of the system<sup>9</sup>. The reliability factor (RF) value of each system is calculated through its self-protection capability and reputation weightage obtained from user community on its past behaviour.

### 4.3 Location Dependency

In our distributed operating system, communication jobs should be submitted at nearby location. By this, there would be no network congestion problem and packet delay has dropped to considerable rate which results in low traffic. If communication jobs are to be submitted at very far location from system then it would make network congestion problem. In this, network problem increases and also increase the failure rates.

## 5. CONCLUSIONS

In this paper, we have studied the Scheduling algorithms & find the challenges encountered during the scheduling of jobs. Scheduling is a major area in the operating system. We determined that during scheduling, operating system doesn't consider the types of job it is. It simply applies the algorithm on the basis of execution time, no of processes, etc. We can minimize the average waiting time more effectively if we are known of the type of job, i.e., communication or computational. Location dependency is also one of the major factors deciding the efficiency of scheduling algorithms. The effective and efficient exploitation

of grid computing facilities needs highly advanced and protected resource management systems. Efficient resource sharing and accessing cannot go without the assurance of high trustworthiness.

### निष्कर्ष

इस पत्र में, निर्धारण एल्गोरिदम का अध्ययन किया और नौकरियों के लिए समय-निर्धारण के दौरान सामने चुनौतियों का मिल चुके हैं। निर्धारण ऑपरेटिंग सिस्टम में एक प्रमुख क्षेत्र है। हम निर्धारण के दौरान, ऑपरेटिंग सिस्टम यह है काम के प्रकार पर विचार नहीं करता कि निर्धारित। हम नौकरी यानी संचार या कम्प्यूटेशनल के प्रकार के लिए जाने जाते हैं, अगर यह बस निष्पादन समय के आधार पर एल्गोरिथ्म पर लागू होता है, प्रक्रियाओं आदि का कोई हम और अधिक प्रभावी ढंग से औसत प्रतीक्षा के समय को कम कर सकते हैं। स्थान निर्भरता भी समय-निर्धारण एल्गोरिदम की दक्षता में निर्णय लेने के प्रमुख कारकों में से एक है। ग्रिड कंप्यूटिंग सुविधाओं का प्रभावी और कुशल शोषण अत्यधिक उन्नत और संरक्षित संसाधन प्रबंधन प्रणाली की जरूरत है। कुशल संसाधन साझा करने और पहुँचने उच्च विश्वसनीयता के आश्वासन के बिना नहीं जा सकते।।

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## एफपीजीए पर बीआरएएम आधारित ऊर्जा कुशल काउंटर डिजाइन BRAM Based Energy Efficient Counter Design on FPGA

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### सारांश

इस पेपर में, चार-बिट काउंटर एक सिंक्रोनस क्लियर और क्लॉक इनबल के साथ वेरिलोग मॉड्यूल कोड का उपयोग कर जिलिक्स आईएसई 12.1 में बनाया गया है और उच्च प्रदर्शन विरटेक्स.6 और स्पार्टन-6 एफपीजीए पर कार्यान्वित किया गया है। यह दृष्टिकोण एक ऊर्जा कुशल बीआरएएम काउंटर को लागू करने के लिए प्रयोग किया गया है। बीआरएएम की ऊर्जा कुशल डिजाइन अनुकूलन की मांग करती है और इस कारण से हमने एफपीजीए की विरटेक्स.6 (45एनएम) प्रोद्योगिकी और स्पार्टन-6 (40एनएम) प्रोद्योगिकी के लिए एलवीसीएमओएस-15 और एलवीसीएमओएस-25 आईओ मानको का प्रयोग किया है। क्योंकि पावर आवृत्ति के सीधे आनुपातिक है इसलिए आवृत्ति में वृद्धि के साथ एआईओ मानको अनपेक्ष कर पावर की खपत में वृद्धि हुई है। हम जब एफपीजीए के लिए हमारे डिजाइन में सुधार करते हैं तो आईओ मानको एलवीसीएमओएस-15 सबसे निम्न पावर की खपत करता है। विश्लेषण दिखाते हैं कि आईओ मानको एलवीसीएमओएस-15 का उपयोग करके, विरटेक्स.6 एफपीजी, की तुलना में स्पार्टन-6 एफपीजीए के लिए पावर क्षमता में सुधार 10मेगा हर्ट्ज़ 100 मेगा हर्ट्ज़, 500 मेगा हर्ट्ज़, 700 मेगा हर्ट्ज़ और 1000 मेगा हर्ट्ज़ के लिए क्रमशः 98.171, 98.036, 97.099, 96.712 और 96.070 प्रतिशत हुआ है। इस प्रकार स्पार्टन-6 को आईओ मानको एलवीसीएमओएस-25 के साथ और इसके बिना उपयोग करने, विरटेक्स-6 को आईओ मानको एलवीसीएमओएस-15 और एलवीसीएमओएस-25 के साथ और इसके बिना उपयोग करने की तुलना में स्पार्टन-6 को आईओ मानको एलवीसीएमओएस-15 के साथ उपयोग करने से पावर क्षमता के लिए बेहतर परिणाम आते हैं।।

### ABSTRACT

In this paper, four-bit counter with an synchronous clear and a clock enable is designed in Xilinx ISE 12.1 using Verilog module code and implemented on high performance Virtex-6 and Spartan-6 FPGA. This approach is used to implement an energy efficient BRAM counter. Energy efficient design of BRAM demands optimization, and for the same reason we have used I/O standards LVCMOS-15 and LVCMOS-25 for Virtex-6 (45nm) technology and Spartan-6 (40nm) technology of FPGA. As Power is directly proportional to the frequency, with increase in frequency, there is an increase in power consumption irrespective of I/O standard. When we enhance our design to FPGA, the I/O standard which consumes least power is the LVCMOS-15. Analysis show that using the I/O Standard LVCMOS-15, the power efficiency for Spartan-6 FPGA is improved by 98.171 per cent, 98.036 per cent, 97.099 per cent, 96.712 per cent and 96.070 per cent for 10MHz, 100MHz, 500MHz, 700MHz and 1000MHz respectively over Virtex-6 FPGA. Thus using Spartan-6 with I/O Standard LVCMOS-15 yields better results for power efficiency than using Spartan-6 with and without I/O Standard LVCMOS-25, Virtex-6 with and without using I/O standard LVCMOS-15 and LVCMOS-25.

**Keywords:** Energy efficient design, VIRTEX-6 and SPARTAN-6 FPGA, LVCMOS15, LVCMOS25

### 1. INTRODUCTION

In order to search for energy efficient technique, we consider both synchronous, asynchronous techniques. Here we apply synchronous techniques on the counter. In a synchronous method of transmission, the design is synchronized by an external clock. Counter is frequently required in digital computers and other digital systems to record the number of events occurring in a specified interval of time. The counter must possess memory since it has to remember its past states. In

Xilinx FPGAs, a block RAM is a dedicated two port memory containing several kilobits of RAM. The FPGA contains several (or many) of these blocks. In digital logic and computing, counter is a device which stores how many number of times a particular events or process has occurred often in relationship to a clock signal. In this design of BRAM counter that is operating at different frequencies. As the frequency increases there is increase in power according to the relationship between frequency and power. Power

consumption comprises of two main components that are static and dynamic<sup>1</sup>. We are using two different I/O standards from the family of LVCMOS namely LVCMOS15 and LVCMOS25 for the 40nm FPGA and 45nm FPGA to reduce the power. LVCMOS consumes least power when used with FPGA technology<sup>2</sup>. The focus of our study is on the reduction of total power at different frequencies<sup>3</sup>.

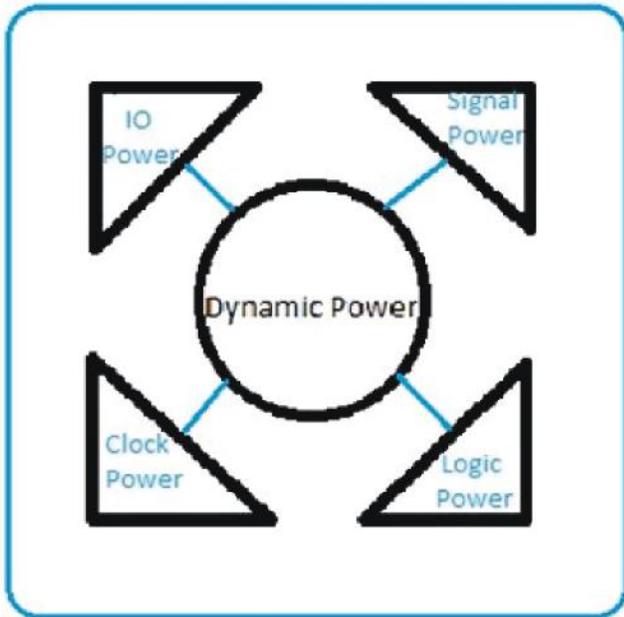


Figure 1. Components of dynamic power dissipation.

There are four different parts of dynamic power. I/O power, Signal power, Clock power and Logic power are component of dynamic power as shown in Figure1.

Figure 2 is a RTL schematic of 4-bit counter using BRAM. In this work, we are implementing this BRAM based counter on 40nm based FPGA and 45nm based

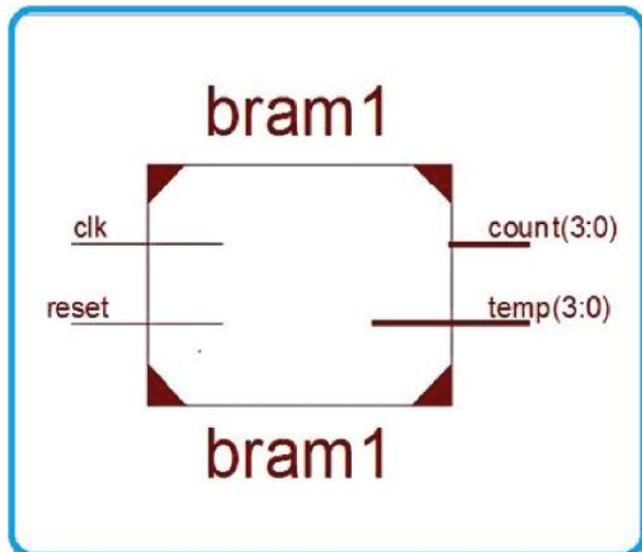


Figure 2. RTL schematic of counter with BRAM.

FPGA. In final phase, we are doing power analysis for two different IO standards i.e. LVCMOS15 and LVCMOS25. LVCMOS is an acronym for Low Voltage Complementary Metal Oxide Semiconductor.

**2. RELATED WORK**

There is an increased demand of portable design in electronic design automation and it is creating a wide scope in area of energy efficient design. The focus of Energy Efficient VLSI design of circuits is shifting towards the low power consumption and minimum delay to operate for wider range of device operating frequencies<sup>4</sup>. Leakage power and total energy is cut down up to 22 per cent-32 per cent and 18 per cent-24 per cent respectively as per the simulations shown<sup>5</sup>. B. Pandey<sup>6</sup>, UCF and NCD files are created with XPower 14.2 for analysing the energy consumed. Here, we are also creating a User Constraint File (UCF) of our design to calculate the power consumption. Power optimization is being given utmost importance in design concern, forcing EDA Personnel either process engineer or circuit designer or processor architect or software engineer to make energy efficient efforts using different optimal energy efficient techniques and tools<sup>7</sup>. The possibilities of Power Reduction and their usage in different levels of abstraction is discussed in<sup>7</sup>. Consumption of power is reduced by scaling down the voltage and frequency<sup>8</sup>. Electronic design association tools like Xilinx Power Estimator report average power consumed under toggle or enable rate and operating frequency<sup>9</sup>.

**3. POWER ANALYSIS ON SPARTAN-6 FPGA**

From Table 1, we infer that on increasing the frequency on Spartan-6 45nm FPGA there is no change in leakage power but there is an increase in clock power, BRAM power and I/O power.

Table 1. Effect of frequency (MHz) on power dissipation (W)

Frequency↓ Power→	Clock	I/Os	BRAMs	Leakage	Total
10	0	0	0	0.014	0.014
100	0.001	0	0.001	0.014	0.015
500	0.004	0.001	0.003	0.014	0.022
700	0.005	0.001	0.005	0.014	0.025
1000	0.008	0.001	0.006	0.014	0.03

When we are scaling down the frequencies from 1000MHz to 700MHz, 500MHz, 100MHz and 10MHz there is 37.5 per cent, 62.5 per cent, 87.5 per cent and 100 per cent decrease in clock power and 16.6 per cent, 50 per cent, 83.33 per cent and 100 per cent decrease in BRAM power respectively. So the

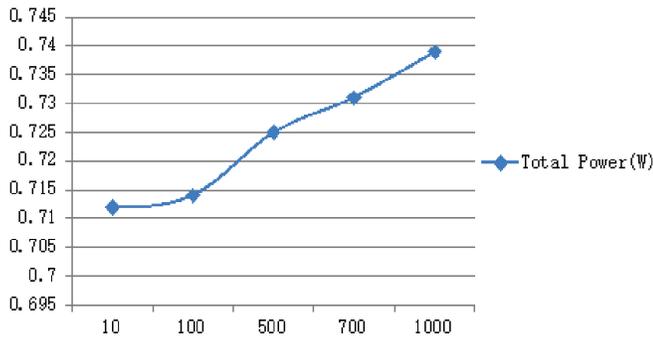


Figure 3. Power versus Frequency on 45nm FPGA.

outcome of the table reflects that the total power is decreasing by scaling down the frequency from 1000MHz to 10MHz.

#### 4. POWER ANALYSIS ON VIRTEX-6 FPGA

From Table 2, we infer that on increasing the frequency on Virtex-6 40nm FPGA there is no change in leakage power but there is an increase in clock power, BRAM power and I/O power. When we are scaling down the frequencies from 1000MHz to 700MHz, 500MHz, 100MHz and 10MHz there is 30.76per cent, 46.15 per cent, 92.30 per cent and 100 per cent decrease in clock power and 33.33 per cent, 44.44

Table 2. Effect of frequency (MHz) on power dissipation (W)

Frequency↓	Clock	I/Os	BRAMs	Leakage	Total Power→
10	0	0	0	0.712	0.712
100	0.001	0	0.001	0.712	0.714
500	0.007	0.002	0.005	0.712	0.725
700	0.009	0.003	0.006	0.712	0.731
1000	0.013	0.004	0.009	0.712	0.739

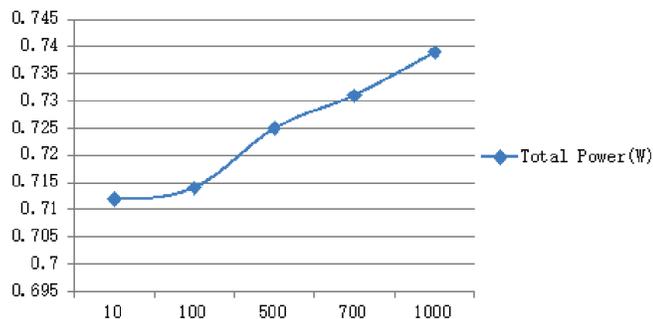


Figure 4. Power versus frequency on 45nm FPGA.

per cent, 88.88 per cent and 100 per cent decrease in BRAM power respectively. So the outcome of the table reflects that the total power is decreasing by scaling down the frequency from 1000MHz to 10MHz.

#### 5. POWER ANALYSIS USING LVCMOS-15 ON SPARTAN-6 FPGA

From Table 3, we infer that on increasing the frequency on Spartan-6 45nm FPGA using LVCMOS-15 there is no change in leakage power but there is an increase in clock power, BRAM power and I/O power. When we apply I/O standard LVCMOS-15 with Spartan-6 it reduced total power consumption by 7.142 per cent as compare to the Spartan-6 without using IO standard. When we are scaling down from 1000MHz to 700MHz, 500MHz, 100MHz and 10MHz there is 37.5 per cent, 62.5 per cent, 87.5 per cent and 100per cent decrease in clock power and 16.6 per cent, 50per cent, 83.33 per cent and 100 per cent decrease in BRAM power respectively and this

Table 3. Effect of frequency on power dissipation (W)

Frequency↓	Clock	I/Os	BRAMs	Leakage	Total Power→
10	0	0	0	0.013	0.013
100	0.001	0	0.001	0.013	0.014
500	0.004	0.001	0.003	0.013	0.021
700	0.005	0.001	0.005	0.013	0.024
1000	0.008	0.001	0.006	0.013	0.029

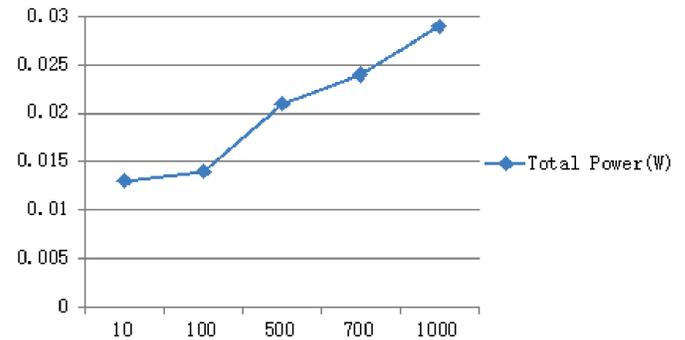


Figure 5. Power versus frequency on 45nm FPGA.

result is same as the result given by Table 1 for clock and BRAM power but the leakage power is different from the Table 1. So the outcome of the table reflects that the total power is decreasing with scaling of frequency from 1000MHz to 10MHz as compare to the Table 1.

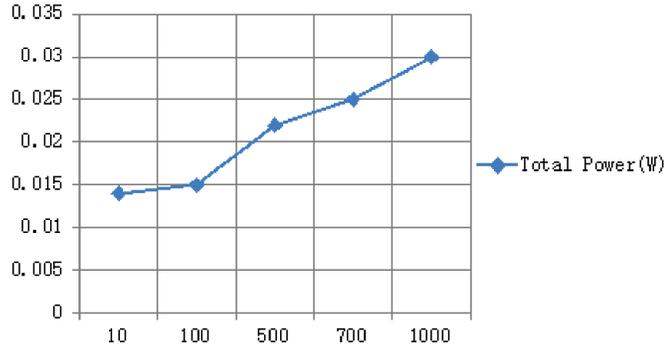
#### 6. POWER ANALYSIS USING LVCMOS-25 ON SPARTAN-6 FPGA

From Table 4, we infer that on increasing the frequency on Spartan-6 45nm FPGA using LVCMOS-25 there is no change in leakage power but there is an increase in clock power, BRAM power and I/O power.

When we apply I/O standard LVCMOS-25 with Spartan-6 there is no change in total power. When we

**Table 4. Effect of frequency on power dissipation (W)**

Frequency↓	Clock	I/Os	BRAMs	Leakage	Total Power→
10	0	0	0	0.014	0.014
100	0.001	0	0.001	0.014	0.015
500	0.004	0.001	0.003	0.014	0.022
700	0.005	0.001	0.005	0.014	0.025
1000	0.008	0.001	0.006	0.014	0.03



**Figure 6. Power versus frequency on 45nm FPGA.**

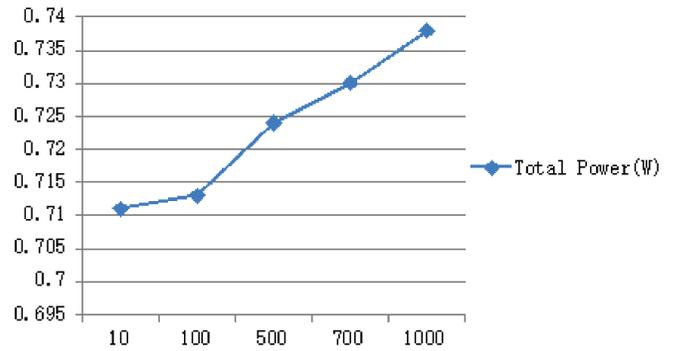
are scaling down from 1000MHz to 700MHz, 500MHz, 100MHz and 10MHz there is 37.5 per cent, 62.5 per cent, 87.5 per cent and 100 per cent decrease in clock power and 16.6 per cent, 50 per cent, 83.33 per cent and 100 per cent decrease in BRAM power respectively and leakage power will also remain same as shown in Table 1. So the analysis depicts there is no change in total power when we applied LVCMOS-25.

**7. POWER ANALYSIS USING LVCMOS-15 ON VIRTEX-6 FPGA**

From Table 5, we infer that on increasing the frequency on Virtex-6 40nm FPGA using LVCMOS-15 there is no change in leakage power but there is increase in clock power and BRAM power. When we are scaling down the frequencies from 1000MHz to 700MHz, 500MHz, 100MHz and 10MHz there is 30.76 per cent, 46.15 per cent, 92.30 per cent and 100 per cent decrease in clock power and 33.33 per

**Table 5. Effect of frequency on power dissipation (W)**

Frequency↓	Clock	I/Os	BRAMs	Leakage	Total Power→
10	0	0	0	0.711	0.711
100	0.001	0	0.001	0.711	0.713
500	0.007	0.002	0.005	0.711	0.724
700	0.009	0.003	0.006	0.711	0.73
1000	0.013	0.004	0.009	0.711	0.738



**Figure 7. Power versus frequency on 40nm FPGA.**

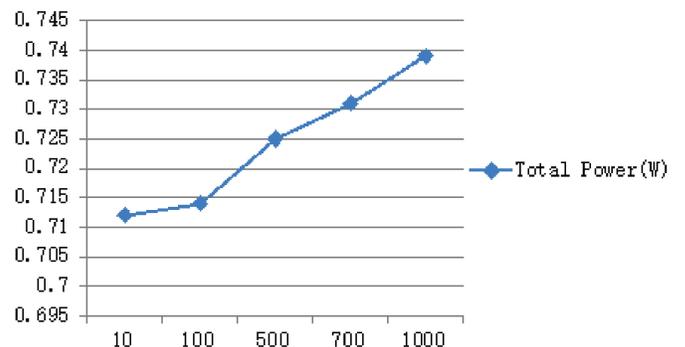
cent, 44.44 per cent, 88.88 per cent and 100 per cent decrease in BRAM power respectively. So the outcome of the table reflects that the total power is decreasing by scaling down the frequency from 1000MHz to 10MHz. When we apply I/O standard LVCMOS-15 with Virtex-6 it reduced total power by 0.14 per cent as compare to the Virtex-6 without using I/O standard.

**8. POWER ANALYSIS USING LVCMOS-25 ON VIRTEX-6 FPGA**

From Table 6, we infer that on increasing the frequency on Virtex-6 40nm FPGA using LVCMOS-25 there is no change in leakage power but there is an increase in clock power, BRAM power and I/O power. When we are scaling down the frequencies from 1000MHz to 700MHz, 500MHz, 100MHz and 10MHz there is

**Table 6. Effect of frequency on Power Dissipation (W)**

Frequency↓	Clock	I/Os	BRAMs	Leakage	Total Power→
10	0	0	0	0.712	0.712
100	0.001	0	0.001	0.712	0.714
500	0.007	0.002	0.005	0.712	0.725
700	0.009	0.003	0.006	0.712	0.731
1000	0.013	0.004	0.009	0.712	0.739



**Figure 8. Power versus Frequency on 45nm.**

10MHz there is 30.76 per cent, 46.15 per cent, 92.30 per cent and 100 per cent decrease in clock power and 33.33 per cent, 44.44 per cent, 88.88 per cent and 100 per cent decrease in BRAM power respectively. So the outcome of the table reflects that the total power is decreasing by scaling down the frequency from 1000MHz to 10MHz. When we apply I/O standard LVC MOS-25 with Virtex-6 there is no change in total power.

## 9. CONCLUSION

In this design of BRAM counter, we infer that the power efficiency for Spartan-6 FPGA is improved by 98.033 per cent, 97.899 per cent, 96.965 per cent, 96.580 per cent and 95.940 per cent for 10MHz, 100MHz, 500MHz, 700MHz and 1000MHz respectively over Virtex-6 FPGA. Further if we study the performance of Virtex-6 and Spartan-6 using the IO Standards LVC MOS-15 and LVC MOS-25 we conclude that Spartan-6 is using less power than Virtex-6. Analysis show that using the IO Standard LVC MOS15, the power efficiency for Spartan-6 FPGA is improved by 98.171 per cent, 98.036 per cent, 97.099 per cent, 96.712 per cent and 96.070 per cent for 10MHz, 100MHz, 500MHz, 700MHz and 1000MHz respectively over Virtex-6 FPGA. Similarly using the I/O Standard LVC MOS-25, the power efficiency for Spartan-6 FPGA is improved by 98.033 per cent, 97.899 per cent, 96.965 per cent, 96.580 per cent and 95.940 per cent for 10MHz, 100MHz, 500MHz, 700MHz and 1000MHz respectively over Virtex-6 FPGA. Thus using Spartan-6 with I/O Standard LVC MOS15 yields better results for power efficiency than using Spartan-6 with IO Standard LVC MOS25.

## 10. FUTURE SCOPE

This implementation is based on 40-nm Virtex-6 FPGA and 45nm Spartan-6 FPGA. There is a wide scope to implement this design for asynchronous technique and make power analysis on different FPGA like Virtex-7 and Kintex-7 FPGA device. To test this design, in term of power using other IO Standard like SSTL, HSTL and verify the low power design efficiency on the latest FPGA.

## निष्कर्ष

बीआरएएम काउंटर के डिजाइन में, हमने देखा कि विरटेक्स-6 एफपीजीए की तुलना में, स्पार्टन-6 एफपीजीए के लिए पावर क्षमता में सुधार 10मेगा हर्ट्ज, 100 मेगा हर्ट्ज, 500 मेगा हर्ट्ज, 700 मेगा हर्ट्ज और 1000 मेगा हर्ट्ज के लिए क्रमशः 98.033, 97.899, 96.965, 96.580 और 95.940 प्रतिशत हुआ है। आगे यदि हम आईओ मानक एलवीसीएमओएस-15 और एलवीसीएमओएस-25 का उपयोग विरटेक्स-6 और स्पार्टन-6 के निष्पादन का अध्ययन करते हैं तो हमने पाया कि विरटेक्स-6 की तुलना में स्पार्टन-6 कम पावर का उपयोग करता है। विश्लेषण दिखाता है कि आईओ मानक एलवीसीएमओएस-15 का उपयोग

करके, विरटेक्स-6 एफपीजीए की तुलना में, स्पार्टन-6 एफपीजीए के लिए पावर क्षमता में सुधार 10मेगा हर्ट्ज, 100 मेगा हर्ट्ज, 500 मेगा हर्ट्ज, 700 मेगा हर्ट्ज और 1000 मेगा हर्ट्ज के लिए क्रमशः 98.171, 98.036, 97.099, 96.712 और 96.070 प्रतिशत हुआ है। इसी प्रकार आईओ मानक एलवीसीएमओएस-25 का उपयोग करके विरटेक्स-6 एफपीजीए की तुलना में स्पार्टन-6 एफपीजीए के लिए पावर क्षमता में सुधार 10मेगा हर्ट्ज, 100 मेगा हर्ट्ज, 500 मेगा हर्ट्ज, 700 मेगा हर्ट्ज और 1000 मेगा हर्ट्ज के लिए क्रमशः 98.033, 97.899, 96.965, 96.580 और 95.940 प्रतिशत हुआ है। इस प्रकार स्पार्टन-6 को आईओ मानक एलवीसीएमओएस-25 के साथ उपयोग करने की तुलना में विरटेक्स-6 को आईओ मानक एलवीसीएमओएस-15 के साथ उपयोग करने से पावर क्षमता के लिए बेहतर परिणाम आते हैं।

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## 28 एनएम एफपीजीए पर अनुरूपये सन्यामयात का उपयोग कर रूट्स को खोजने के लिए डिज़ाइन गोल आधारित ऊर्जा कुशल डिजाइन Energy Efficient Design for Finding Roots Using Anurupye Sunyamayat on 28nm FPGA

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### सारांश

इस पेपर में वैदिक तकनीक अनुरूपये सन्यामयात का उपयोग कर ऊर्जा कुशल रूट्स खोजक का डिज़ाइन किया है। वैदिक गणित में 16 सूत्र होते हैं और इन सूत्रों को हमारे प्राचीन विद्वानों द्वारा तेजी से गणना करने के लिए इस्तेमाल किया जाता था जब उनके पास कोई कंप्यूटर और कलकुलेटर नहीं थे। अनुरूपये सन्यामयात एक संस्कृत शब्द है जिसका अर्थ "एक अनुपात में है, तो अन्य एक शून्य है"। आज के काम में उच्च गति दक्षता की मांग है और इसे कम समय लेना चाहिए। इन वैदिक तकनीक को लागू करके, प्रणाली की जटिलताएँ निष्पादन समय क्षेत्र, शक्ति कम होती है और ये तकनीक स्थिर है और इसलिए यह कारगर तरीका है। हमने 7 इनपुट और 2 आउटपुट के साथ अनुरूपये सन्यामयात ऊर्जा कुशल वैदिक रूट्स खोजक को बनाने की कोशिश की है। हम विभिन्न प्रकार की आवृत्तियों को लिया है और इसकी डिजाइन गोल को बार बार बदलकर पावर विप्लेषण किया है। जिलिक्स सॉफ्टवेयर में हमारे पास 5 डिज़ाइन गोल है और वे क्षेत्र में कमी, बैलेंस, न्यूनतम रनटाइम, पावर अनुकूलन, समय में सुधार कर रहे हैं। कोड जिलिक्स आईएसई डिजाइन सुइट 14.2 में लागू किया गया है और परिणाम 28 एनएम एफपीजीए प्लेटफॉर्म पर परीक्षण किये गये थे। हमारे सभी कार्य 28 एनएम एफपीजीए के किटेक्स-7 पर किये गए हैं। प्रयुक्त उपकरण एक्ससी 7 के 160 टीए प्रयुक्त पैकेज एफबीजी 676 है और यह -3 गति ग्रेड पर काम कर रहा है। अंत में हमने यह निष्कर्ष निकाला कि गोल तकनीक का उपयोग करके कुल पावर अपव्यय का 20-54 प्रतिशत की बचत हो सकती है।

### ABSTRACT

In this paper we have designed an energy efficient root finder using Anurupye Sunyamayat Vedic technique. Vedic mathematics consists of 16 sutras and these sutras were used by our ancient scholars for doing their calculations faster, when there were no computers and calculators. Anurupye Sunyamayat is a Sanskrit word meaning "If one is in the ratio, the other one is zero". In today's work, the demand is high speed, efficiency and lesser time. Applying these Vedic techniques one is able to reduce the system complexity, execution time, area, power and is stable, and hence, is efficient method. We have tried to make an energy efficient Anurupye Sunyamayat Vedic root finder with 7 inputs and 2 outputs. We have taken different set of frequencies and have done power analysis by varying its design goal. In Xilinx software we have 5 design goals and these are Area Reduction, Balanced, Minimum Runtime, Power Optimization, Timing Performance. The code has been implemented in Xilinx ISE Design Suite 14.2 and results were tested on 28nm FPGA platform. All our work is done on 28nm FPGA Kintex-7. The device used is XC7K160T, package used is FBG676 and it is working on -3 speed grade. At the end we have concluded that there can be 20-54 per cent saving of total power dissipation by using design goal technique.

**Keywords:** Anurupye Sunyamayat, vedic mathematics, FPGA, energy efficient, root finder

### 1. INTRODUCTION

Ancient mathematics is known as Vedic mathematics<sup>1,2</sup>. Vedic Mathematics is a book written by the high-ranking Hindu cleric Bharati Krishna Tirthaji and first published in 1965<sup>3</sup>. Vedic Mathematics is the ancient methodology of Indian mathematics which includes a unique technique of calculations based on 16 Sutras (formulae)<sup>4</sup>. Vedic mathematics is basically used for solving tedious problems in short duration of time.

Vedic mathematics consists of 16 sutras and these sutras were used by our ancient scholars for doing there calculation faster, when there were no computers and calculators. Nowadays with the help of calculators and computers, we are able to solve long and heavy calculations. Many researchers have worked upon Vedic mathematics on the basis of different sutras. Many papers have also been published using Vedic mathematics for different applications. An introduction to a novel

architecture using Vedic mathematics techniques for high speed multiplication<sup>5</sup>. Vedic mathematics also plays an important role in DSP (Digital Signal Processing). Reconfigurable FFT has been proposed using Vedic mathematics<sup>6</sup>. A design of an 8 bit, fixed point, asynchronous Vedic DSP processor core has also been studied<sup>7</sup>. A paper was also published which includes DSP operations based on ancient Vedic mathematics using Vedic Urdhava-Triyagbhayam multiplication sutra<sup>8</sup>. Applying these Vedic techniques one reduces the system complexity, execution time, area, power and is stable, and hence is an efficient method. In this paper we are focusing on designing a root finder device using Vedic mathematics technique “Anurupye Sunyamayat”. Meaning of Anurupye Sunyamayat is “If one is in the ratio, the other one is zero”. We use this sutra for solving simple equations in which the coefficients of ‘one’ variable are in the same ratio to each other as the independent terms are to each other. This sutra also says that the ‘other’ variable is zero if ratios are equal. In this way we are able to calculate the roots of an equation. These equations can only be solved using Anurupye Sunyamayat if a certain ratio exists between a coefficients. For example:

$$\begin{aligned} 6x + 7y &= 8 \\ 19x + 14y &= 16 \end{aligned}$$

Here the ratio of coefficients of y is the same as that of the constant terms. Therefore, the “other” is zero, i.e.,  $x = 0$ . Hence the solution of the equations is  $x = 0$  and  $y = 8/7$ .

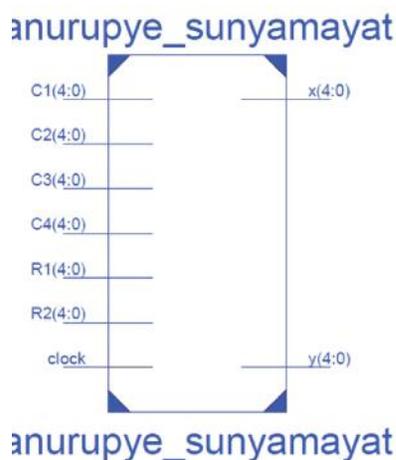


Figure 1. Symbol of anurupye sunyamayat.

Figure 1 represents the symbol of Anurupye Sunyamayat where C1, C2, C3, C4 are the coefficients of the variables and R1, R2 are the constants. These all are 4 bit numbers. And on the other side, outputs are also 4 bit numbers proving us the values of roots that are x and y. The code has been implemented in Xilinx ISE Design Suite 14.2 and results were tested on 28nm FPGA platform. All our work is done on

28nm FPGA Kintex-7. The device used is XC7K160T, package used is FBG676 and it is working on -3 speed grade. Table 1 shows different parameters in kintex-7 FPGA.

Table1. Different parameters in kintex-7 FPGA

I/O pins	676
LUT Elements	101400
Flip Flop	202800
DSPS	600
Available IOBS	400
Gb transceiver	8
Block RAM	325
GTXE2 Transceiver	8
PCI Buses	1.1
MMCMS	8
Min operating temperature	0 degree Celsius
Reference operating temperature	85 degree Celsius
Maximum operating Temperature	85 degree Celsius
Minimum operating voltage	0.97V
Reference operating Voltage	0.97V
Maximum operating Voltage	1.03V
Temperature Grade Letter	C

In this paper, we have tried to make an energy efficient Anurupye Sunyamayat Vedic root finder with 7 inputs and 2 outputs. We have taken different sets of frequencies mentioned in Table 2 and have done power analysis by varying its design goal. Now in Xilinx software we have 5 design goals and these are Area Reduction, Balanced, Minimum Run time, Power Optimization, Timing Performance shown in Fig. 2. These design goals play a vital role when we analyse power in our circuit or design. In this paper, power analysis is our main concern and we have studied about the power analysis in this paper at different frequencies keeping the temperature constant at 25 degree Celsius and maintaining the constant air flow.

Power is also of two types: (i) Static (ii) Dynamic. In this research work we have focused on the dynamic power and it includes clock power, logic power, signal power, I/Os power, and leakage power. The sum of all these gives us the total power involved in the

Table 2. Set of frequencies taken in consideration

Frequency	Mobile set
1400MHz	Nokia Lumia 710
1.2GHz	Samsung Galaxy Core
2100MHz	I phone6
1700MHz	HTC/T
1800MHz	Micromax X091
2.2GHz	Sony Xperia Z1

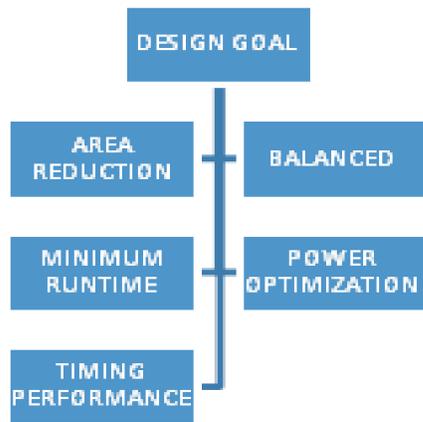


Figure 2. Types of design goal.

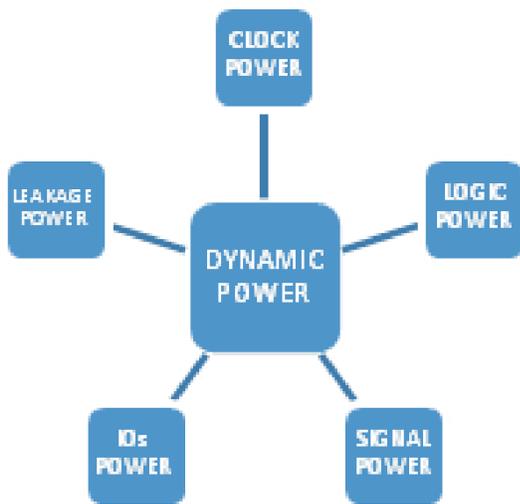


Figure 3. Components of dynamic power.

designed. Fig. 3 shows the components of power. Our main aim is to make it energy efficient that’s why the testing has been done at different frequencies and different design goals.

**2. POWER ANALYSES**

**2.1 Power Analysis at 1400 MHz**

There is 36.36per cent saving in clock power dissipation with area reduction design goal, 18.18 per cent saving in clock power dissipation with power optimization design goal in comparison to power dissipation with balanced, minimum run time, and timing performance design goal. There is 49.29

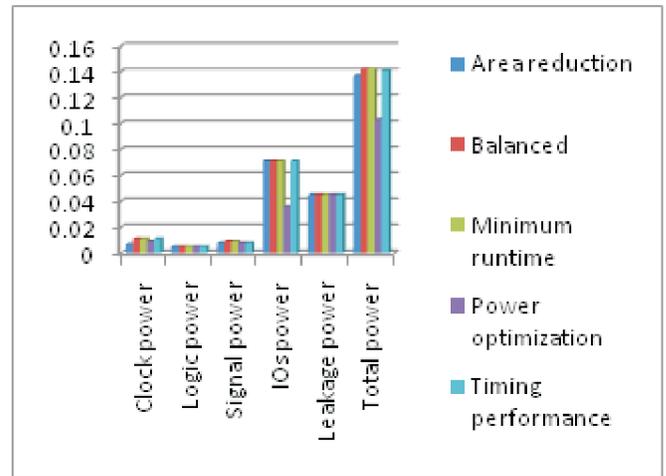


Figure 4. Power dissipation at 1400 MHz.

per cent reduction in I/O power dissipation with power optimization design goal in comparison to all other different design goals. There is no change in logic power and leakage power. There is 11.11 per cent saving in signal power dissipation with area reduction, power optimization, and timing performance when compared with power dissipation of balanced and minimum run time. There is 27.46 per cent saving in total power dissipation with power optimization when compared with balanced and minimum run time design goal’s power dissipation as shown in Table 3 and Fig. 4.

**2.2 Power Analysis at 1.2GHz**

There is 40 per cent saving in clock power dissipation with area reduction design goal,30 per cent saving in clock power dissipation with power optimization design goal in comparison to power dissipation with balanced, minimum run time, and timing performance design goal. There is 41.50 per cent reduction in I/O power dissipation with power optimization design goal in comparison to all other different design goals. There is no change in logic power and leakage power. There is 12.5 per cent saving in signal power dissipation with area reduction, power optimization, timing performance, and balanced when compared with power dissipation of minimum run time. There is 20.83 per cent saving in total power dissipation with power optimization when compared with balanced, minimum run time and timing performance design goal’s power dissipation, as shown in Table 4 and Fig. 5.

Table 3. Power analysis at 1400 MHz

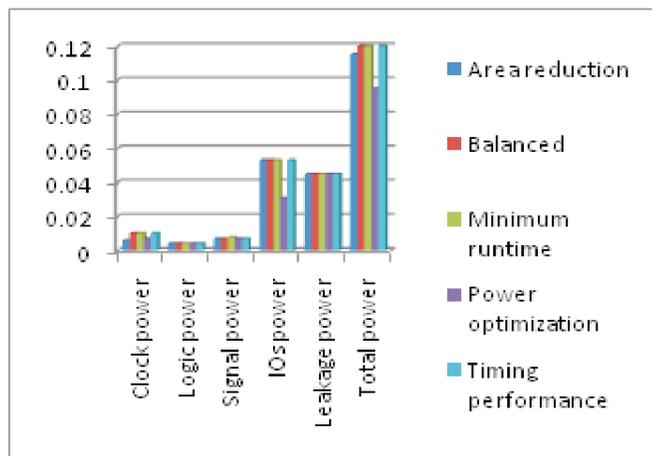
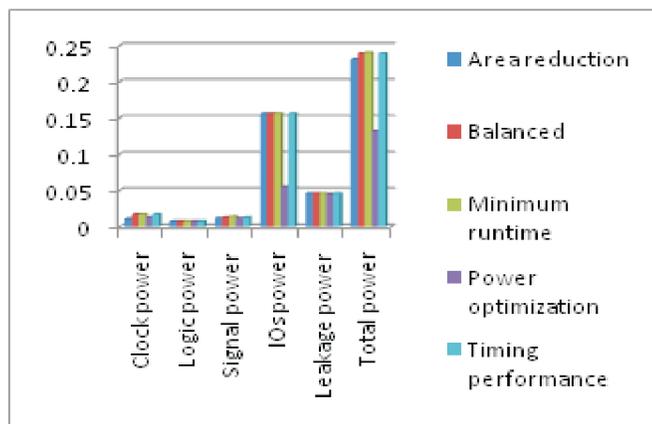
Design goal	Clock power	Logic power	Signal power	I/Os power	Leakage power	Total power
Area reduction	0.007	0.005	0.008	0.071	0.045	0.137
Balanced	0.011	0.005	0.009	0.071	0.045	0.142
Minimum runtime	0.011	0.005	0.009	0.071	0.045	0.142
Power optimization	0.009	0.005	0.008	0.036	0.045	0.103
Timing performance	0.011	0.005	0.008	0.071	0.045	0.141

**Table 4. Power analysis at 1.2GHz**

Design goal	Clock power	Logic power	Signal power	I/Os power	Leakage power	Total power
Area reduction	0.006	0.004	0.007	0.053	0.045	0.115
Balanced	0.010	0.004	0.007	0.053	0.045	0.120
Minimum runtime	0.010	0.004	0.008	0.053	0.045	0.120
Power optimization	0.007	0.004	0.007	0.031	0.045	0.095
Timing performance	0.010	0.004	0.007	0.053	0.045	0.120

**Table 5. Power analysis at 2100 MHz**

Design goal	Clock power	Logic power	Signal power	I/Os power	Leakage power	Total power
Area reduction	0.011	0.008	0.012	0.156	0.046	0.231
Balanced	0.017	0.008	0.013	0.156	0.046	0.239
Minimum runtime	0.017	0.008	0.014	0.156	0.046	0.240
Power optimization	0.013	0.008	0.012	0.055	0.045	0.132
Timing performance	0.017	0.008	0.013	0.156	0.046	0.239

**Figure 5. Power dissipation at 1.2 GHz.****Figure 6. Power dissipation at 2100 MHz.**

### 2.3 Power Analysis at 2100 MHz

There is 35.29 per cent saving in clock power dissipation with area reduction design goal, 23.52 per cent saving in clock power dissipation with power optimization design goal in compare to power

dissipation with balanced, minimum run time, and timing performance design goal. There is 64.74 per cent reduction in I/O power dissipation with power optimization design goal in comparison to all other different design goals. There is no change in logic power and leakage power. There is 14.28 per cent saving in signal power dissipation with area reduction, power optimization when compared with power dissipation of minimum runtime. There is 7.14 per cent saving in signal power with balanced when compared with minimum run time. There is 45 per cent saving in total power dissipation with power optimization when compared with minimum runtime design goal's power dissipation, as shown in Table 5 and Fig. 6.

### 2.4 Power Analysis at 1700MHz

There is 50 per cent saving in clock power dissipation with area reduction design goal, 28.57 per cent saving in clock power dissipation with power optimization design goal in compare to power dissipation with balanced, minimum run time, and timing performance design goal. There is 57.28 per cent reduction in I/O power dissipation with power optimization design goal in compare to all other different design goals. There is no change in logic power and leakage power. There is 9.09 per cent saving in signal power dissipation with area reduction, power optimization, and timing when compared with power dissipation of minimum run time and balanced. There is 35.55 per cent saving in total power dissipation with power optimization when compared with balanced design goal's power dissipation, as shown in Table 6 and Fig 7.

### 2.5 Power Analysis at 1800MHz

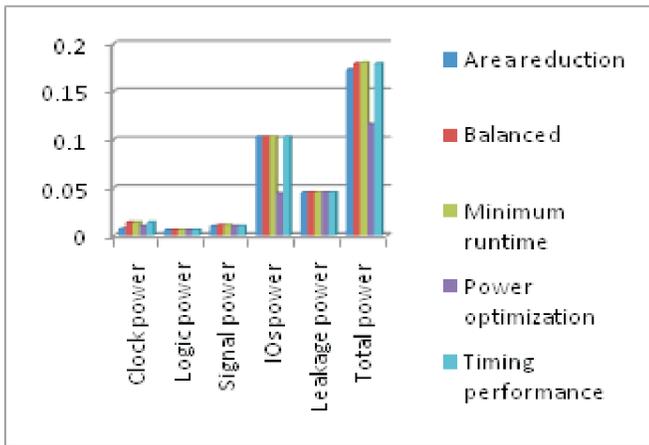
There is 40 per cent saving in clock power dissipation with area reduction design goal, 26.66 per cent saving

**Table 6. Power analysis at 1700MHz**

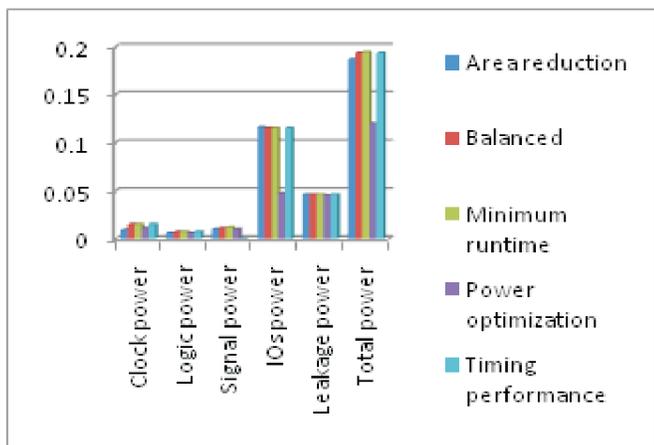
Design goal	Clock power	Logic power	Signal power	I/Os power	Leakage power	Total power
Area reduction	0.007	0.006	0.010	0.103	0.045	0.173
Balanced	0.014	0.006	0.011	0.103	0.045	0.179
Minimum runtime	0.014	0.006	0.011	0.103	0.045	0.180
Power optimization	0.010	0.006	0.010	0.044	0.045	0.116
Timing performance	0.014	0.006	0.010	0.103	0.045	0.179

**Table 7. Power analysis at 1800 MHz**

Design goal	Clock power	Logic power	Signal power	I/Os power	Leakage power	Total power
Area reduction	0.009	0.006	0.010	0.116	0.046	0.187
Balanced	0.015	0.007	0.011	0.115	0.046	0.193
Minimum runtime	0.015	0.007	0.012	0.115	0.046	0.194
Power optimization	0.011	0.006	0.010	0.047	0.046	0.120
Timing performance	0.015	0.007	0.011	0.115	0.046	0.193



**Figure 7. Power dissipation at 1700 MHz.**



**Figure 8. Power dissipation at 1800 MHz.**

in clock power dissipation with power optimization design goal in comparison to power dissipation with balanced, minimum run time, and timing performance design goal. There is 0.8 per cent saving in I/O power dissipation with to balanced, minimum runtime and timing performance and 59.48 per cent saving in

I/O power dissipation with power optimization design goal in comparison with area reduction design goal. There is no change in leakage power. There is 16.66 per cent saving in signal power dissipation with area reduction, power optimization and 8.33 per cent saving in signal power dissipation with balanced and timing performance when compared with power dissipation of minimum runtime. There is 38.14 per cent saving in total power dissipation with power optimization when compared with minimum runtime design goal's power dissipation, as shown in Table 7 and Fig. 8.

**2.6 Power Analysis at 2.2 GHz**

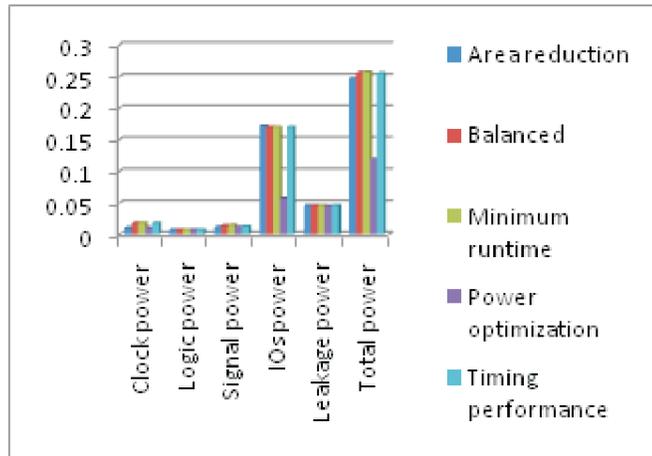
There is 38.88 per cent saving in clock power dissipation with area reduction and power optimization design goal in compare to power dissipation with balanced, minimum run time, and timing performance design goal. There is 66.66 per cent saving in I/O power dissipation with power optimization and 0.58 per cent saving in I/O power dissipation with balanced, minimum runtime and timing performance design goal in compare to area reduction design goal. There is no change in logic power and leakage power. There is 20 per cent saving in signal power dissipation with area reduction, power optimization, and 13.33 per cent saving in signal power dissipation with balanced and timing performance when compared with power dissipation of minimum runtime. There is 53.30 per cent saving in total power dissipation with power optimization when compared with balanced, minimum run time and timing performance design goal's power dissipation, as shown in Table 8 and Fig. 9.

**3. CONCLUSION**

The design is low power energy efficient and the code has been implemented in Xilinx ISE Design Suite 14.2 and results were tested on 28nm FPGA platform

**Table 8. Power analysis at 2.2 GHz**

Design goal	Clock power	Logic power	Signal power	I/Os power	Leakage power	Total power
Area reduction	0.011	0.008	0.012	0.171	0.046	0.247
Balanced	0.018	0.008	0.013	0.170	0.046	0.256
Minimum runtime	0.018	0.008	0.015	0.170	0.046	0.257
Power optimization	0.011	0.008	0.012	0.057	0.046	0.120
Timing performance	0.018	0.008	0.013	0.170	0.046	0.255

**Figure 9. Power Dissipation at 2.2 GHz.**

using Kintex-7 FPGA family. The device is designed to find the roots of an equation using the Vedic technique called Anurupye Sunyamayat. This Vedic root finder consists of 7 inputs and 2 outputs. One input is the clock pulse and other 4 inputs are the coefficients of the variables and remaining two are the constants of an equation. Output is the values of variables present in the equations. The inputs and the outputs all are 4 bit numbers. The design is tested by varying frequency at constant temperatures that is 25 °C and also keeping air flow constant. We can conclude that there can be 20-54 per cent saving of total power dissipation by using design goal technique.

#### 4 FUTURE SCOPE

The future scope of “Design Goal Based Energy Efficient Design for Finding Roots Using Anurupye Sunyamayat on 28nm FPGA” is that we can also implement this design on 22nm or 18 nm FPGA. We can also use different FPGA families like automotive Artix7, automotive Coolrunner2, automotive Spartan, automotive Spartan-3A DSP, automotive Spartan 3A, automotive Spartan 3E, automotive Spartan6, Spartan3, Spartan3E. Here, we are using design goal techniques in which we are changing the design goal and analyzing its power. We can redesign this Vedic root finder with other energy efficient technique like capacitance scaling, thermal scaling, clock gating, frequency scaling and impedance matching with different logic family, and mapping. Analysis has been done with different

frequencies like 1400 MHz, 1.2 GHz, 2100 MHz, 1700MHz, 1800MHz, 2.2GHz. We can use any other frequency range and test our design on that also. The temperature has been kept constant, that is 25 degree Celsius, So if needed it can also be varied. Air flow can also be varied.

#### निष्कर्ष

डिजाइन कम पावर ऊर्जा कुशल है और कोड जिलिक्स आईएसई डिजाइन सुइट 14.2 में लागू किया गया है और परिणाम 28एनएम एफपीजीए प्लेटफॉर्म पर 28एनएम एफपीजीए के किंटेक्स-7 वर्ग का उपयोग कर परीक्षण किये गये थे। डिवाइस वैदिक तकनीक अनुरूपये सन्यामयात का उपयोग कर एक समीकरण के रूट्स को खोजने के लिए बनाया गया है। इस वैदिक रूट खोजक में 7 इनपुट और 2 आउटपुट है। एक इनपुट क्लॉक पल्स है और 4 इनपुट चर के गुणांक है और बाकी दो समीकरण के कॉन्स्टंट्स है। आउटपुट समीकरणों में मौजूद चर के मान है। सभी इनपुट और आउटपुट 4 बिट नंबर है। यह डिजाइन विभिन्न आवृत्ति पर 25 डिग्री सेल्सियस के स्थिर तापमान पर परीक्षण किया गया है और हवा के प्रवाह को भी स्थिर रखा गया है। हमने यह निष्कर्ष निकाला सकते है कि गोल तकनीक का उपयोग करके कुल पावर अपव्यय का 20-54 प्रतिशत की बचत हो सकती है।

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## एफपीजीए पर बीआरएएम और एल्यूटी आधारित क्षेत्र और ऊर्जा कुशल साइन अप काउंटर डिजाइन BRAM and LUTs Based Area and Energy Efficient Signed Up Counter Design on FPGA

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### सारांश

इस कार्य में 4-बिट साइन अप काउंटर को जिलिक्स 14.6 का एक सिमुलेटर के रूप में उपयोग कर डिजाइन किया गया है। वेरीलोग सत्यापन भाषा के रूप में और एक्सपावर ऊर्जा की खपत के आकलनकर्ता के रूप में प्रयोग किया गया है। इस डिजाइन को विरटेक्स-4 और डिवाइस एक्ससी4वीएफएक्स12 पर कार्यान्वित किया गया है। एलवीसीएमओएस25 आईओ मानक को डिजाइन के कार्यान्वयन में इस्तेमाल किया है। वोल्टेज स्केलिंग तकनीक सर्किट डिजाइन के लिए प्रयोग की गई है। बीआरएएम के साथ सर्किट डिजाइन के लिए हम जब वोल्टेज को 1.5वी से 0.5वी नीचे करते हैं तब यह आलेख 65.95, 90.90, 86.90 और 86.11 प्रतिशत कमी क्रमशः क्लॉक पावर, बीआरएएम पावर, रिसाव पावर और कुल पावर में प्राप्त करता है। बीआरएएम के बिना सर्किट डिजाइन के लिए इसमें 66.66, 86.95 और 84.49 प्रतिशत की कमी क्रमशः क्लॉक पावर, रिसाव पावर और कुल पावर में होती है जब वोल्टेज को 1.5वी से 0.5वी नीचे करते हैं। बीआरएएम के बिना डिजाइन की तुलना में बीआरएएम के साथ सर्किट डिजाइन के लिए इस्तेमाल किया घटकों की संख्या 50 प्रतिशत से भी कम है।

### ABSTRACT

In this work, 4-bit signed up counter is designed using Xilinx 14.6 as a simulator. Verilog is used as verification language and XPower is the power consumption estimator. This design is implemented on Virtex-4 and device XC4VFX12. The IO standard used in the implementation of design is LVCMOS25. Voltage scaling technique is used for the circuit design. This paper achieves 65.95%, 90.90%, 86.90% and 86.11% reduction in clock power, BRAM power, leakage power and total power, respectively for the circuit design with BRAM, when we scale down voltage from 1.5V to 0.5V. For the circuit design without BRAM, there is a reduction of 66.66%, 86.95% and 84.49% in clock power, leakage power, and total power, respectively, when we scale down voltage from 1.5V to 0.5V. The number of components used for the circuit design with BRAM is 50% less as compared to design without BRAM.

**Keywords:** 4-bit signed up counter, LUT, BRAM, voltage scaling management

## 1. INTRODUCTION

The 4-bit signed up counter with asynchronous counter has C (Positive-Edge Clock) and CLR (Asynchronous Reset) as the input pins and Q (Data Output) as the output pin. LUT(Lookup Table) is an array in which runtime computation is replaced with a simpler array indexing operation<sup>8</sup>. There is significant saving of processing time. This is so because retrieving a value from memory is faster than undergoing an expensive computation. In case of digital logic, an n-bit LUT can be implemented with a multiplexer and the select lines of MUX forms the inputs of LUT.

BRAM is a block of random access memory. BRAM consists of a memory cell array and control logic which can be configured to select one of the write modes to access the memory cell array<sup>6</sup>. The control logic selects the write mode on the basis of configuration

**Table 1. I/O Pin description of 4-bit signed up counter**

I/O Pins	Description
C	Positive-Edge Clock
CLR	Asynchronous Reset (Active High)
Q	Data Output

bits stored in the corresponding configuration memory cells of the programmable logic device(PLD). The figures Fig.1 and Fig.3 shows the top level schematic of the circuit with and without BRAM, respectively and Fig.2 and Fig.4 show the RTL schematic of the circuit with and without BRAM, respectively.

Zhong, X., *et al*<sup>1</sup> presents high speed and low power consumption design of BRAM-based FIFO in FPGA. The design is improved with optimized cycle latency. A new way of utilization of the RAM block

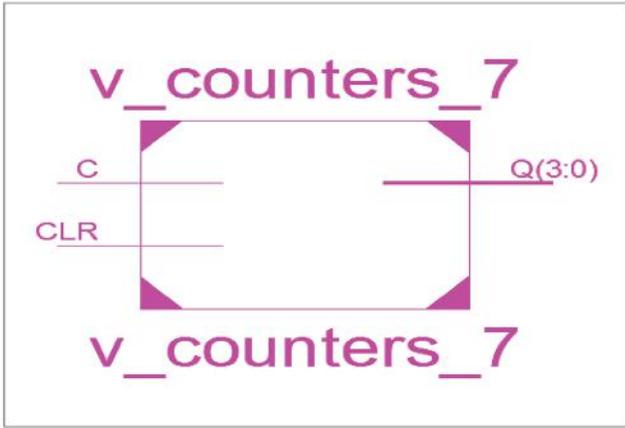


Figure 1. Top level schematic of 4-bit counter without BRAM.

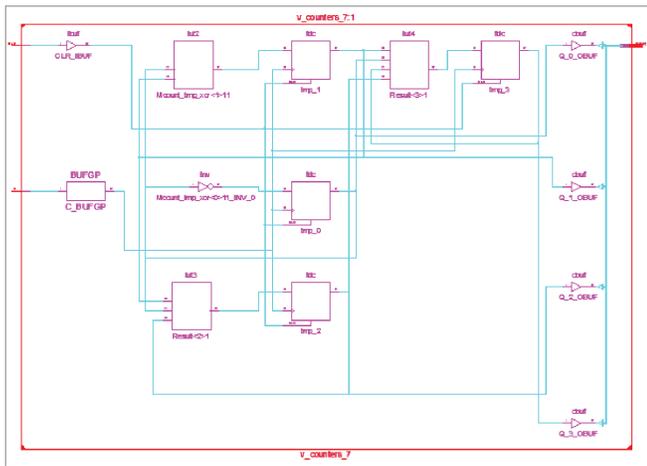


Figure 2. RTL schematic of 4-bit counter without BRAM.

(BRAM) is presented for the delay fault detection purposes Pfeifer,P<sup>2</sup>. Vasijevic, J.<sup>3</sup>, introduces a two low-level pragmas that specifies information about memory access patterns which results in improved on-chip memory utilization up to 22%.

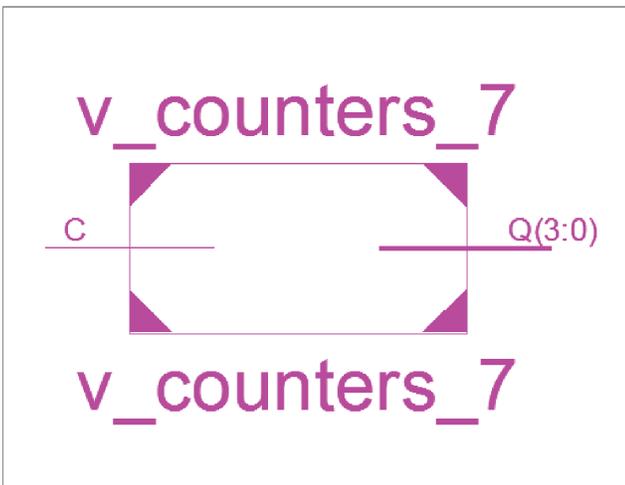


Figure 3. Top level schematic of 4-bit counter with BRAM.

Gupta, V.<sup>4</sup>, voltage scaling technique is used for conserving energy in asynchronous systems. It achieved dynamic energy savings up to 85% and throughput degradation of less than 10%. Islam, S.M.<sup>5</sup> presents voltage scaling based design of Mobile battery charge controller sensor. According to this reference, there is a reduction of 92.72%, 87.50%, 98.77% and 68.24% in Clock Power, Logic Power, Signal Power and I/O Power respectively on 1 THz operating frequency when voltage is scaled down from 1V to 0.1V.

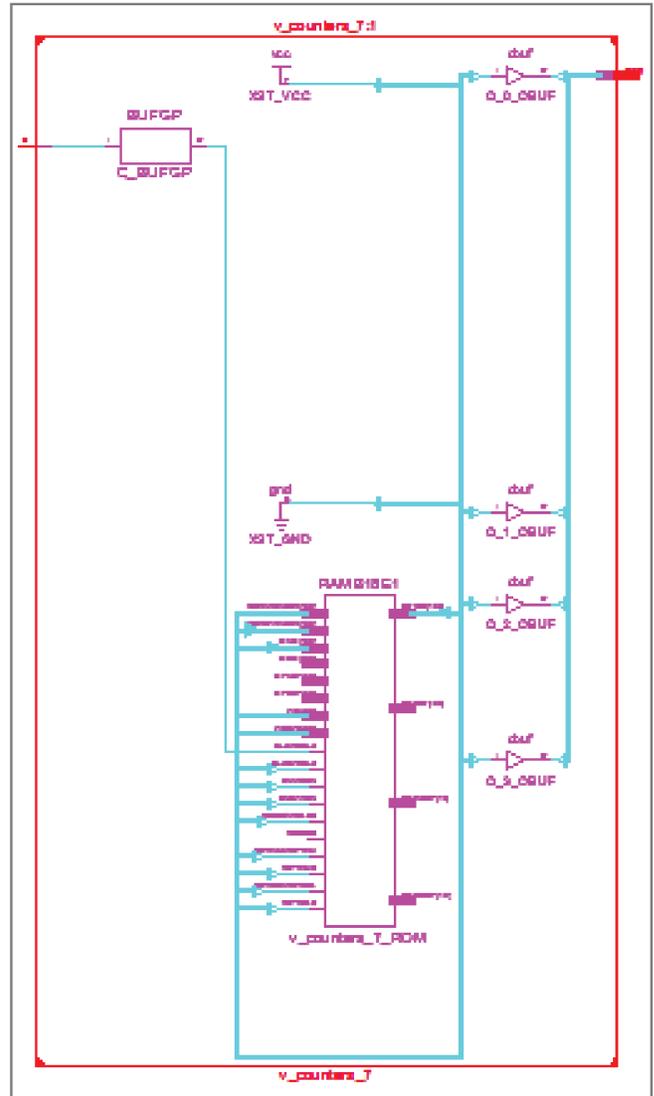


Figure 4. RTL schematic of 4-bit counter with BRAM.

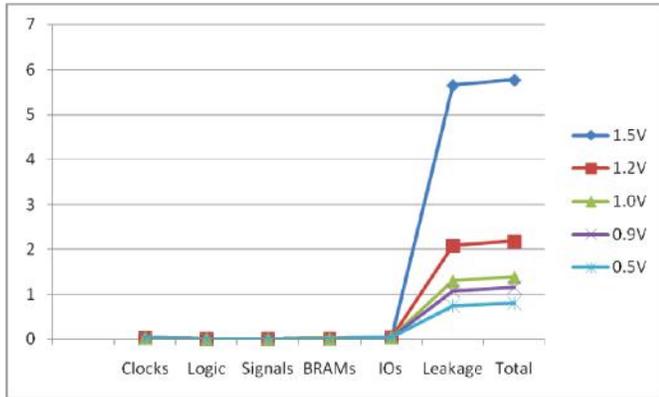
## 2. RESULTS

### 2.1 Power Dissipation for 4-bit Signed Up Counter with BRAM

According to the Table 2 for 4-bit signed up counter with BRAM, there is a reduction of 65.95% in clock power as we scale down the voltage from 1.5V to 0.5V. There is no reduction in logic power as we scale down the voltage from 1.5V to 0.5V. The signal power reduction is 1% on scaling down the voltage from 1.5V to 0.5V. There is a reduction of

**Table 2. Power dissipation for 4-bit Signed Up counter with BRAM**

Voltage Power	1.5V	1.2V	1.0V	0.9V	0.5V
Clocks	0.047	0.038	0.031	0.028	0.016
Logic	0.000	0.000	0.000	0.000	0.000
Signals	0.002	0.002	0.001	0.001	0.000
BRAMs	0.022	0.014	0.010	0.008	0.002
IOs	0.047	0.046	0.045	0.045	0.043
Leakage	5.649	2.083	1.295	1.083	0.740
Total	5.767	2.182	1.382	1.164	0.801



**Figure 5. Power Dissipation 4-bit Signed Up Counter with BRAM.**

90.90% in BRAM power on scaling down the voltage from 1.5V to 0.5V.

There is a reduction of 8.51% in I/O power as we scale down the voltage from 1.5V to 0.5V. The leakage power reduction is 86.90% as we scale down the voltage from 1.5V to 0.5V. The total power reduction is 86.11% as we scale down the voltage from 1.5V to 0.5V.

**2.2 Power Dissipation 4-bit Signed Up Counter without BRAM**

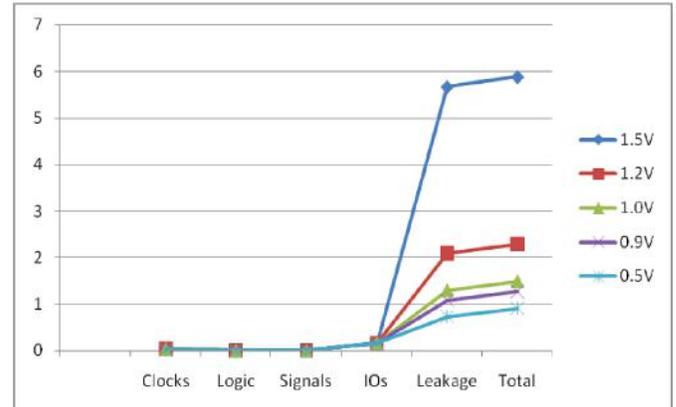
As per the Table 3, for 4-bit signed up counter without BRAM, there is a reduction of 66.66% in clock power as we scale down the voltage from 1.5V to 0.5V. There is a reduction of 1% in logic power and signal power as we scale down the voltage from 1.5V to 0.5V.

**Table 3. Power dissipation for 4-bit signed up counter BRAM.**

Voltage Power	1.5V	1.2V	1.0V	0.9V	0.5V
Clocks	0.048	0.038	0.032	0.028	0.016
Logic	0.001	0.000	0.000	0.000	0.000
Signals	0.004	0.002	0.002	0.001	0.000
IOs	0.161	0.160	0.159	0.158	0.156
Leakage	5.669	2.088	1.297	1.084	0.740
Total	5.882	2.288	1.489	1.272	0.912

**2.3 Design Summary for 4-bit Signed Up Counter with BRAM**

Table 4 design summary for 4-bit signed up counter with BRAM.



**Figure 6. Power dissipation for 4-bit signed Up counter without BRAM.**

The Table 4 shows the design summary for 4-bit signed up counter with BRAM. As seen clearly, there are 2 BELS, 1 RAM, 1 Clock Buffer and 4 Output Buffers.

**Table 4. Design Summary for 4-bit signed up counter with BRAM**

Device	Number
BELS	2
GND	1
VCC	1
RAMS	1
RAMB18E1	1
Clock Buffers	1
BUFGP	1
IO Buffers	4
OBUF	4

**2.4 Design Summary for 4-bit Signed Up Counter without BRAM**

The above table shows the design summary of the 4-bit signed up counter without BRAM. According to this table, there are 4 BELS, 4 Flip-Flops, 1 Clock Buffer, 1 Input Buffer and 4 Output buffers.

**2.5 Comparison of Design Summary for circuit design of 4-bit Signed Up Counter**

According to the above table, the circuit designed with BRAM is taking 2 BELS and that designed without BRAM is taking 4 BELS. Therefore the circuit designed using BRAM uses less area than the other. Hence area optimization is achieved using this design

**Table 5. Design summary for 4-bit signed up counter without BRAM**

Device	Number
BELS	4
INV	1
LUT2	1
LUT3	1
LUT4	1
Flip-Flops/Latches	4
FDC	4
Clock Buffers	1
BUFGP	1
IO Buffers	5
IBUF	1
OBUF	4

**Table 6. Comparison of design summary for the circuit design**

Device	With BRAM	Without BRAM
BELS	2	4
Clock Buffers	1	1
IO Buffers	4	5

### 3. POWER ANALYSIS

#### 3.1 Clock Power Dissipation for 4-bit Signed Up Counter

According to the Table 6, there is not much difference in the clock power dissipation for the 4-bit signed up counter in both the configurations; with BRAM and without BRAM. There is a reduction of 65.95% and 66.66% in clock power dissipation for the circuit design with BRAM and without BRAM respectively on account of voltage scaling from 1.5V to 0.5V.

**Table 7. Clock power dissipation for 4-bit signed up counter**

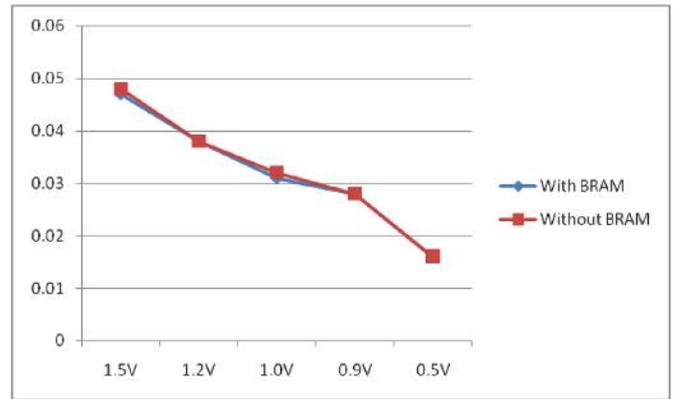
Circuit Configuration	1.5V	1.2V	1.0V	0.9V	0.5V
With BRAM	0.047	0.038	0.031	0.028	0.016
Without BRAM	0.048	0.038	0.032	0.028	0.016

#### 3.2 Signal Power Dissipation for 4-bit Signed Up Counter

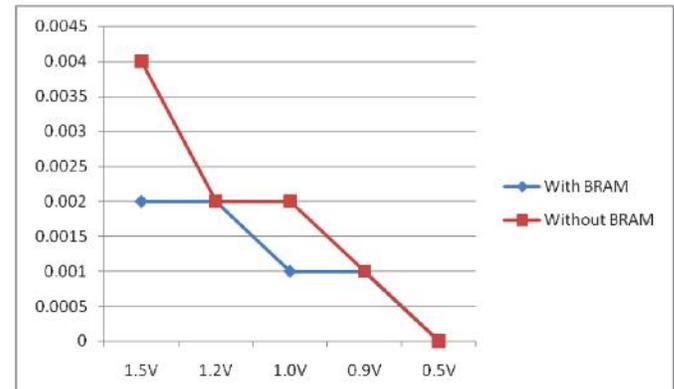
According to the Table 7, for the design of counter there is a reduction of 1% in signal power for both with BRAM and without BRAM configurations as we scale down the voltage from 1.5V and 0.5V.

**Table 8. Signal power dissipation for 4-bit signed up counter**

Circuit Configuration	1.5V	1.2V	1.0V	0.9V	0.5V
With BRAM	0.002	0.002	0.001	0.001	0.000
Without BRAM	0.004	0.002	0.002	0.001	0.000



**Figure 7. Clock power dissipation for 4-bit signed up counter.**



**Figure 8. Signal power dissipation for 4-bit signed up counter.**

#### 3.3 I/O Power Dissipation for 4-bit Signed Up Counter

According to the Table 8, for the design of 4-bit signed up counter there is a reduction of 8.51% and 3.11% in I/O power as we scale down the voltage from 1.5V to 0.5V for configuration with BRAM and without BRAM respectively.

**Table 9. I/O power dissipation for 4-bit signed up counter**

Circuit Configuration	1.5V	1.2V	1.0V	0.9V	0.5V
With BRAM	0.047	0.046	0.045	0.045	0.043
Without BRAM	0.161	0.160	0.159	0.158	0.156

#### 3.4 Leakage Power Dissipation for 4-bit Signed Up Counter

According to the above table, there is a reduction of 86.90% and 86.95% in leakage power dissipation for the circuit design with BRAM and without BRAM respectively on account of voltage scaling from 1.5V to 0.5V.

#### 3.5 Total Power Dissipation for 4-bit Signed Up Counter

According to the Table 10, for the design of 4-bit signed up counter there is a reduction of 86.11% and 84.49% in total power as we scale down the voltage from 1.5V to 0.5V for with BRAM and without BRAM configurations respectively.

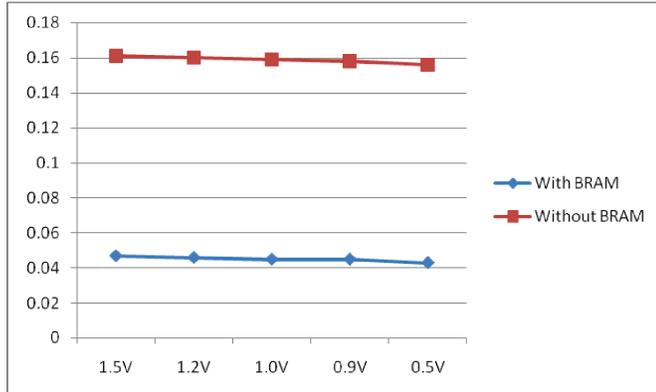


Figure 9. I/O power dissipation for 4-bit signed up counter

Table 10. Leakage power dissipation for 4-bit signed up counter

Circuit Configuration	1.5V	1.2V	1.0V	0.9V	0.5V
With BRAM	5.649	2.083	1.295	1.083	0.740
Without BRAM	5.669	2.088	1.297	1.084	0.740

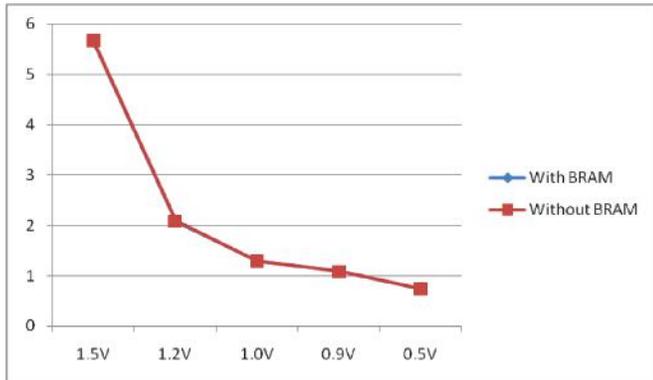


Figure 10. Leakage power dissipation for 4-bit signed up counter.

Table 11: Total power dissipation for 4-bit signed up counter

Circuit Configuration	1.5V	1.2V	1.0V	0.9V	0.5V
With BRAM	5.767	2.182	1.382	1.164	0.801
Without BRAM	5.882	2.288	1.489	1.272	0.912

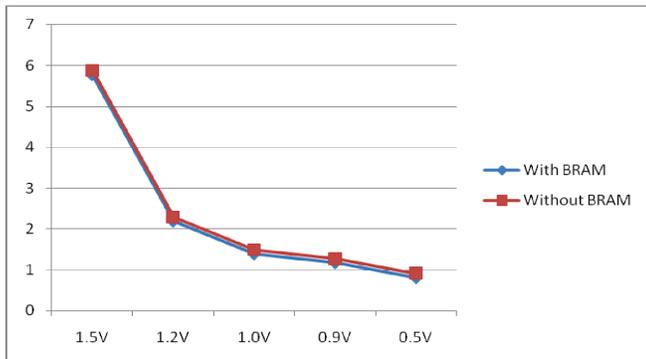


Figure 11. I/O power dissipation for 4-bit signed up counter.

#### 4. CONCLUSION

For the circuit design without BRAM, there is a reduction of 66.66%, 86.95% and 84.49% in clock power, leakage power and total power respectively as we scale down the voltage from 1.5V to 0.5V. On account of voltage scaling from 1.5V to 0.5V, there is a reduction of 65.95%, 90.90%, 86.90% and 86.11% in clock power, BRAM power, leakage power and total power respectively for the circuit design with BRAM. The circuit designed using BRAM uses less number of components than the circuit designed without BRAM. The circuit designed with BRAM achieves more reduction in total power as compared to the design without BRAM. Hence area optimization is achieved in this work in addition to power optimization.

#### 5. FUTURE SCOPE

This circuit design is implemented on Virtex-4 FPGA. It can be redesigned on Virtex-5, Virtex-6, Virtex-7 and Airtex-7 FPGA. This technique can be used to design other circuits having asynchronous reset like latch, flip-flops, adders, and accumulator. This work is implemented on LVCMOS I/O standard. There is a scope to implement this design using other I/O standards. The voltage scaling technique is used in this work. It can also be designed using frequency scaling or capacitance scaling methods

#### निष्कर्ष

बीआरएएम के बिना सर्किट डिजाइन के लिए इसमें 66.66, 86.95 और 84.49 प्रतिशत की कमी क्रमशः क्लॉक पावर, रिसाव पावर और कुल पावर में होती है, जब वोल्टेज को 1.5वी से 0.5वी नीचे करते हैं। वोल्टेज स्केलिंग 1.5वी से 0.5वी के बाद भी बीआरएएम के साथ सर्किट डिजाइन के लिए इसमें 65.95, 90.90, 86.90 और 86.11 प्रतिशत कमी क्रमशः क्लॉक पावर, बीआरएएम पावर, रिसाव पावर और कुल पावर में हुई है। बीआरएएम के बिना डिजाइन की तुलना में बीआरएएम के साथ सर्किट डिजाइन के लिए इस्तेमाल किया घटकों की संख्या 50 प्रतिशत से भी कम है। बीआरएएम के बिना डिजाइन की तुलना में बीआरएएम के साथ सर्किट डिजाइन कुल पावर में और अधिक कमी को प्राप्त करता है। इसलिए इस काम में क्षेत्र अनुकूलन के साथ पावर अनुकूलन भी प्राप्त हुआ है।

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## एफपीजीए पर जीपीएचएल आईओ मानक आधारित थर्मल अवेयर निम्न पावर वैदिक गुणक डिजाइन GPHL I/O Standard Based Thermal Aware Low Power Vedic Multiplier Design on FPGA

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### सारांश

जीपीएचएल 4 निम्न पावर आईओ मानकों का समूह है। जी जीटीएल को, पी पीसीआई को, एच एचएसयूएल को और एल एलवीटीटीएल आईओ मानकों को प्रदर्शित करता है। जीटीएल गनिंग ट्रांसीवर लॉजिक है, पीसीआई परिधीय घटक इंटरफेस है एचएसयूएल उच्च गति का न समाप्त होने वाला लॉजिक है और एलवीटीटीएल निम्न वोल्टेज ट्रांजिस्टर ट्रांजिस्टर लॉजिक है। इस कार्य में, हम जीपीएचएल आईओ मानकों के साथ वेरीलोग एचडीएलए जिलिक्स सिम्युलेटर 90एनएम वरटेक्स-4 एफपीजीए और कंटेक्स-7 एफपीजीए आधारित 28एनएम प्रौद्योगिकी का उपयोग थर्मल अवेयर और निम्न पावर वैदिक गुणक के डिजाइन के लिए किया जा रहा है। आईओ मानकों का चुनाव एफपीजीए पर शक्ति के अपव्यय में एक महत्वपूर्ण भूमिका निभाता है। इस कार्य में हम अपने निम्न पावर वैदिक गुणक डिजाइन के लिए इन 4 आईओ मानकों में से निम्न पावर कंज्यूमर आईओ मानक को ले रहे हैं। जब हम जीटीएलपीए जीटीएलपी-डीसीआई और जीटीएल-डीसीआई आईओ मानकों के स्थान पर जीटीएल का उपयोग करते हैं, तब 53.50 डिग्री सेल्सियस परिवेश तापमान पर आईओ पावर अपव्यय में क्रमशः 36.76, 82.66, और 72.78 प्रतिशत की कमी है। जब हमने परिवेश तापमान को 56.7 डिग्री सेल्सियस से 53.5, 40 और 21 डिग्री सेल्सियस कम किया तब इसमें पीसीआई आईओ मानक वर्ग के लिए लीकेज पावर में 2.83, 12.43 और 23.16 प्रतिशत क्रमशः की कमी और एचएसयूएल आईओ मानक वर्ग के लिए लीकेज पावर में 10.9, 40.9 और 23.16 प्रतिशत क्रमशः की कमी हुई है। एलवीटीटीएल आईओ मानक वर्ग के लिए जब हमने परिवेश तापमान को 56.7 डिग्री सेल्सियस से 53.5, 40 और 21 डिग्री सेल्सियस कम किया, तब इसमें लीकेज पावर और कुल पावर दोनों में 2.83, 12.43 और 23.16 प्रतिशत क्रमशः की कमी हुई है।

### ABSTRACT

GPHL is group of 4 low powers I/O standards. G stands for GTL, P is PCI, H means HSUL and L is LVTTL I/O Standards. GTL is gunning transceiver logic, PCI is peripheral component interface, HSUL is high speed unterminated logic and LVTTL is Low Voltage Transistor Transistor Logic. In this work, we are going to design both thermal aware and low power Vedic multiplier using Verilog HDL, Xilinx Simulator, 90nm Virtex-4 FPGA and 28nm technology based Kintex-7 FPGA along with GPHL I/O standard. Selection of I/O standards plays a significant role in power dissipation on FPGA. In this work, we are selecting the least power consumer I/O Standards among these 4 I/O standards for our low power Vedic multiplier design. When we are using GTL in place of GTLP, GTLP\_DCI, and GTL\_DCI I/O standards, then there is 36.76 per cent, 82.66 per cent, and 72.78 per cent reduction in I/O power dissipation respectively at 53.5° C ambient temperature. When we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 2.83 per cent, 12.43 per cent, and 23.16 per cent reduction in leakage power respectively for PCI I/O standards family and there is 10.9 per cent, 40.9 per cent, and 62.73 per cent reduction in leakage power respectively for HSUL I/O standard family. For LVTTL I/O standards family, when we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 2.83 per cent, 12.43 per cent, and 23.16 per cent reduction respectively in both leakage and total power.

**Keywords:** GTL, PCI, HSUL, Mobile DDR, I/O standards, low power, VLSI design, vedic multiplier, FPGA

### 1. INTRODUCTION

In our Vedic multiplier<sup>1-3, 6-8</sup> design, we are using the efficiency of 'Urdhva Tiryagbhyam' to achieve performance because it enables parallel generation of intermediate products. We are using 90-nm technology based FPGA<sup>4</sup>, 28-nm technology based FPGA<sup>5</sup> along with I/O Standards for both energy efficient and

thermal aware Vedic multiplier design.

. Previous work on energy efficient Vedic multiplier was based on LVDCI<sup>1</sup>, LVCMOS<sup>2,3</sup> and HSTL<sup>3</sup> I/O standards. In this work, we are extending that work to GPHM group of I/O standard. G stands for GTL, P is PCI, H means HSUL and M is Mobile DDR I/O Standards. GTL is gunning transceiver logic, PCI is

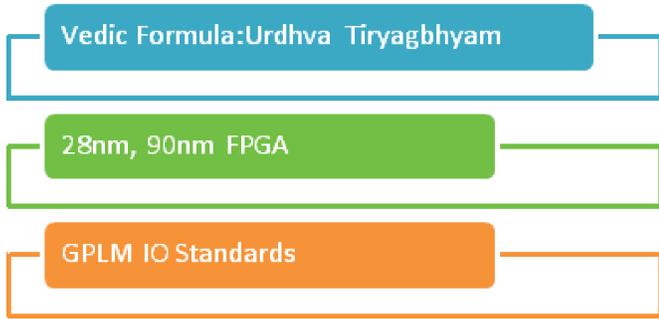


Figure 1. Techniques used in thermal aware low power vedic multiplier.

peripheral component interface, HSUL is high speed unterminated logic and DDR is double data rate.

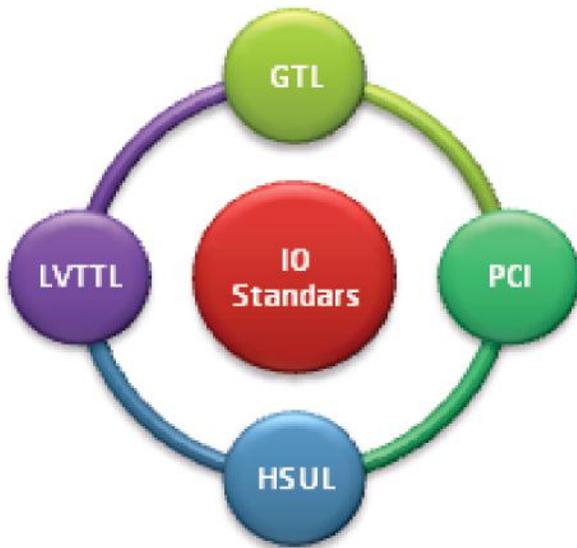


Figure 2. GPLM I/O standard family.

The design of low power and high performance multiplier is so important because speed of arithmetic logic unit (ALU) depends greatly on the multiplier. Speed of Math Co-processor design is directly proportional to speed of ALU. Similarly, the speed of processor is depending on speed of math co-processor. Xerox develops high speed bus standards and called it Gunning Transceiver Logic (GTL) I/O standard<sup>4</sup>. In our work, we are using 4 different GTL I/O standards for energy efficient design of Vedic Multiplier. GTL has both differential amplifier input buffer and Open Drain output buffer<sup>4</sup>. Peripheral Component Interface (PCI) I/O standard uses an LVTTTL input buffer and a Push-Pull output buffer<sup>4</sup>. This standard has not reference voltage (VREF) and board termination voltage (VTT). It has 3.3V output source voltage (VCCO)<sup>4</sup>. HSUL<sub>12</sub> has both unidirectional and bidirectional board topology<sup>5</sup>.

Mobile DDR is a 1.8V single-ended I/O standard that eliminates the need for VREF and VTT voltage

Table 1. Reference, output source and board termination voltage

I/O Standard	Input Reference Voltage (VREF)	Output Source Voltage (VCCO)	Board Termination Voltage (VTT)
GTL	0.8	N/A	1.2
GTL+	1.0	N/A	1.5
PCI	N/A	3.3	N/A
HSUL	0.6		
MOBILE	N/A	1.8	N/A
DDR			
LVTTTL	N/A	3.3	N/A
LVC MOS25	N/A	2.5	N/A

supplies<sup>5</sup>. FPGA and ASIC Implementation of 16-Bit Vedic Multiplier is using Urdhva Tiryagbhyam Sutra<sup>6</sup>. VHDL Implementation of Complex Number Multiplier using Vedic Mathematics is discussed<sup>7</sup>. The helps us to select the formula (Urdhva Tiryagbhyam)<sup>6</sup> and HDL (VHDL) for our Vedic multiplier design<sup>7</sup>. In our work, we are extending these existing works and techniques with GPHM I/O standards, and thermal scaling<sup>9,10</sup> to design thermal aware Vedic multiplier.

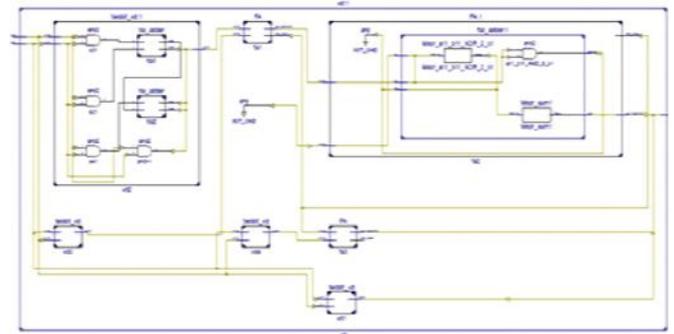


Figure 3. Schematic of vedic multiplier.

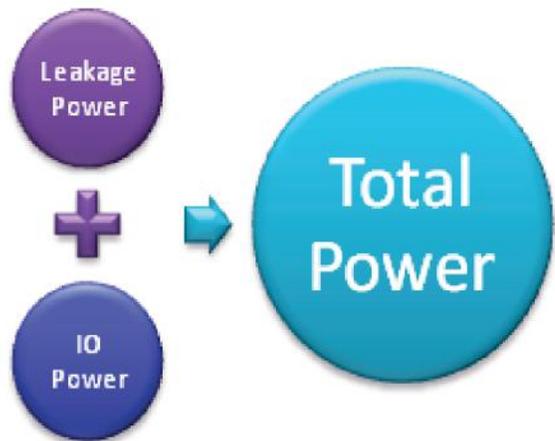


Figure 4. Relation between leakage, I/O and total power dissipation.

This schematic of Vedic multiplier is using 8 look up table in Virtex-6 as shown in Fig. 1. Out of 8 lookup table, it has two LUT2 and six LUT4. There are eight input buffers and eight output buffer also.

## 2. GUNNING TRANSCEIVER LOGIC I/O STANDARD

**Table 2. Total power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
GTL	0.218	0.213	0.196	0.177
GTLP	0.244	0.239	0.222	0.203
GTLP_DCI	0.428	0.423	0.405	0.385
GTL_DCI	0.335	0.331	0.313	0.293

When we are using GTL in place of GTLP, GTLP\_DCI, and GTL\_DCI IO standards, then there is 10.66%, 49.06%, and 34.93% reduction respectively at 56.70C ambient temperature as shown in Table 2 and Figure 4.

**Table 3. Leakage power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
GTL	0.175	0.170	0.153	0.134
GTLP	0.176	0.171	0.154	0.135
GTLP_DCI	0.180	0.175	0.157	0.137
GTL_DCI	0.178	0.173	0.155	0.136

When we scale down ambient temperature from 56.7°C to 21°C, then there is 23.43%, 23.3%, 23.89% and 23.59% reduction for using GTL, GTLP, GTLP\_DCI, and GTL\_DCI I/O standards respectively as shown in Table 3.

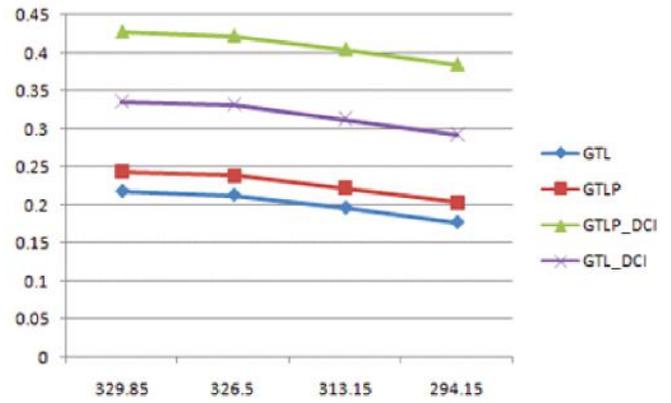
**Table 4. I/O power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
GTL	0.043	0.043	0.043	0.043
GTLP	0.068	0.068	0.068	0.068
GTLP_DCI	0.248	0.248	0.248	0.248
GTL_DCI	0.158	0.158	0.158	0.158

When we are using GTL in place of GTLP, GTLP\_DCI, and GTL\_DCI I/O standards, then there is 36.76%, 82.66%, and 72.78% reduction in I/O power dissipation, respectively at 53.5 °C ambient temperature, as shown in Table 4.

## 3. PERIPHERAL COMPONENT INTERFACE I/O STANDARD

When we are using any I/O standards of PCI family, then there is no change in either leakage



**Figure 5. Total power dissipation in vedic multiplier using GTL.**

**Table 5. Total power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
PCI33_3	0.177	0.172	0.155	0.136
PCI66_3	0.177	0.172	0.155	0.136
PCIX	0.177	0.172	0.155	0.136

power or total power as shown in Tables 5-6. When we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 2.83 per cent, 12.43 per cent, and 23.16 per cent reduction in leakage power respectively as shown in Table 6.

**Table 6. Leakage power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
PCI33_3	0.177	0.172	0.155	0.136
PCI66_3	0.177	0.172	0.155	0.136
PCIX	0.177	0.172	0.155	0.136

## 4. HIGH SPEED UNTERMINATED LOGIC I/O STANDARD

When we are using HSUL\_12 in place of HSUL\_12\_DCI, then there is 13.04 per cent, 14 per cent, 17.24 per cent, and 21.74 per cent reduction, respectively at 56.7 °C, 53.5 °C, 40 °C, and 21 °C ambient temperature as shown in Table 7.

**Table 7. Total power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
HSUL_12	0.140	0.129	0.096	0.072
HSUL_12_DCI	0.161	0.150	0.116	0.092

When we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 10.9 per cent, 40.9 per cent, and 62.73 per cent reduction in leakage power respectively for HSUL I/O standard family, as shown in Table 8.

**Table 8. Leakage power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
HSUL_12	0.110	0.098	0.065	0.041
HSUL_12_DCI	0.110	0.099	0.065	0.041

When we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is no change in I/O power for HSUL I/O standard family as shown in Table 9.

**Table 9. I/O power dissipation in thermal aware vedic**

	56.7 °C	53.5 °C	40 °C	21 °C
HSUL_12	0.031	0.031	0.031	0.031
HSUL_12_DCI	0.051	0.051	0.051	0.051

**5. LVTTL I/O STANDARD**

For LVTTL I/O standards family, when we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 2.83 per cent, 12.43 per cent, and 23.16 per cent reduction respectively in both leakage and total power as shown in Table 10.

**Table 10. Power dissipation in thermal aware vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
Total	0.177	0.172	0.155	0.136
Leakage	0.177	0.172	0.155	0.136

**6. MOBILE DDR I/O STANDARD**

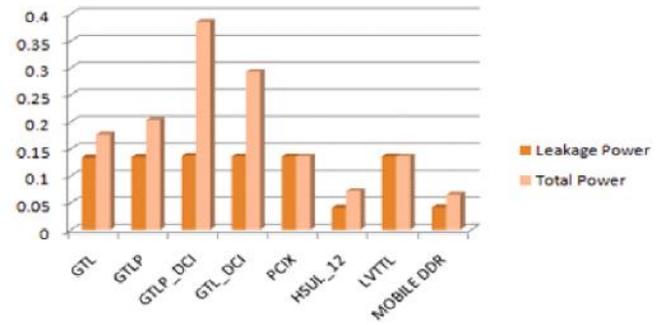
For Mobile DDR I/O standards family, when we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 8.27 per cent, 33.08 per cent, and 51.13 per cent reduction respectively in total power as shown in Table 11. For similar thermal scaling, there is no change in I/O power for HSUL I/O standard family as shown in Table 11.

**Table 11. Power dissipation in thermal aware Vedic multiplier**

	56.7 °C	53.5 °C	40 °C	21 °C
Total	0.133	0.122	0.089	0.065
Leakage	0.110	0.099	0.066	0.042
I/O	0.023	0.023	0.023	0.023

**7. THERMAL ANALYSIS ON STANDARD ROOM TEMPERATURE**

As shown in Fig. 6 and Table 12, HSUL\_12 is minimum leakage power consumer whereas GTLP\_DCI is maximum leakage power consumer. If we consider total power dissipation, then Mobile DDR is the minimum and GTLP\_DCI is maximum power consumer I/O standards among GPHL family.



**Figure 6. Leakage and total power analysis of vedic multiplier.**

**Table 12. Thermal analysis of vedic multiplier**

	Leakage Power	Total Power
GTL	0.134	0.177
GTLP	0.135	0.203
GTLP_DCI	0.137	0.385
GTL_DCI	0.136	0.293
PCIX	0.136	0.136
HSUL_12	0.041	0.072
LVTTL	0.136	0.136
MOBILE DDR	0.042	0.065

**8. CONCLUSION**

Power analysis is that HSUL\_12 is minimum leakage power consumer whereas GTLP\_DCI is maximum leakage power consumer. If we consider total power dissipation, then Mobile DDR is the minimum and GTLP\_DCI is maximum power dissipater I/O standards among GPHL family. When we scale down ambient temperature from 56.7 °C to 53.5 °C, 40 °C and 21 °C, then there is 8.27 per cent, 33.08 per cent, and 51.13per cent reduction for Mobile DDR I/O standard family, 2.83 per cent, 12.43 per cent, and 23.16per cent reduction for LVTTL I/O standard family, 13.04per cent, 14 per cent, 17.24 per cent, and 21.74per cent reduction for HSUL I/O standard family, and 2.83 per cent, 12.43per cent, and 23.16 per cent reduction for PCI I/O standard family in leakage power dissipation. When we are using GTL in place of GTLP, GTLP\_DCI, and GTL\_DCI I/O standards, then there is 10.66%, 49.06%, and 34.93% reduction in total power dissipation respectively.

**9. FUTURE SCOPE**

In this work, we are using GPHL I/O standards family available on 90nm technology based Virtex-4 and 28nm technology based Kintex-7 FPGA. In future, we can design Vedic multiplier using other I/O standards like LVC MOS, HSTL, SSTL, and LVDCI and so on. For energy efficient design of Vedic multiplier, we can go for energy efficient technique like clock gating,

clock enable, thermal scaling, capacitance scaling, dynamic frequency scaling, voltage scaling and many more. Here, our target design is Vedic multiplier based on Urdhva Tiryagbhyam. In future, we can go for design of Vedic multiplier with remaining 15 Vedic formulas. In future, there is also open scope to design Vedic ALU, Vedic math co-processor and a complete Vedic processor.

## निष्कर्ष

हमारे पावर विश्लेषण का निष्कर्ष है कि एचएसयूएल-12 निम्न पावर कंज्यूमर है और जीटीएलपी-डीसीआई अधिकतम पावर कंज्यूमर है। यदि हम कुल पावर अपव्यय को देखें, तो जीपीएचएल वर्ग में मोबाइल डीडीआर निम्न और जीटीएलपी-डीसीआई अधिकतम पावर उत्सर्जक आईओ मानक है। जब हमने परिवेश तापमान को 56.7 डिग्री सेल्सियस से 53.5, 40 और 21 डिग्री सेल्सियस कम किया तब इसमें मोबाइल डीडीआर आईओ मानक वर्ग के लिए लीकेज पावर में 8.27, 33.08, और 51.13 प्रतिशत की कमी एलवीटीटीएल आईओ मानक वर्ग के लिए 2.83, 12.43 और 23.16 प्रतिशत की कमी, एचएसयूएल आईओ मानक वर्ग के लिए 13.04, 14, 17.24, और 21.74 प्रतिशत की कमी, और पीसीआई आईओ मानक वर्ग के लिए 2.83, 12.43 और 23.16 प्रतिशत क्रमशः की कमी हुई है। जब हम जीटीएलपीए जीटीएलपी-डीसीआई और जीटीएल-डीसीआई आईओ मानकों के स्थान पर जीटीएल का उपयोग कर रहे हैं, तब कुल पावर अपव्यय में क्रमशः 10.66, 49.06, और 34.93 प्रतिशत की कमी हुई है।

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# एलवीसीमोस निवेश निर्गम मानक आधारित निम्न शक्ति देवनागरी यूनिकोड रीडर का एफपीजीए पर कार्यान्वयन

## LVCMOS I/O Standard Based Low Power Devanagari Unicode Reader on FPGA

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### सारांश

हमारे भारतीय संविधान में बड़ी संख्या में उपभाषाएँ और लिपियाँ हैं, जिनमें देवनागरी लिपि प्राथमिक और सब लिपियों से अधिकाधिक प्रयोग में आने वाली लिपि है। यंत्रोपदान अभिकल्प में संचरण लाइन की परावर्तन समस्या को संचरण प्रतिभाधा, पोर्ट और उपकरण को सकते हैं। हमारे शोध पत्र में हमने कोड को जाईलिंग्स आइ.एस.आई. साफ्टवेयर 12.1 पर कार्यान्वित किया है और परिणाम का परीक्षण 40 नैनो मीटर एफ.पी.जी.ए. पर किया है। देवनागरी यूनिकोड रीडर को ऊर्जा दक्ष बनाने के लिए विभिन्न आवृत्तियों पर शक्ति का विश्लेषण किया गया है। हमने सी मोस के विविध निम्न वोल्टेज एल.वी.सी.मोस. (निम्न वोल्टेज कॉम्प्लिमेंट्री मेटल ऑक्साइड सेमीकंडक्टर) निवेश निर्गम मानकों को लिया है। यह प्रारूप 2 मेगाहर्ट्ज, 6 मेगाहर्ट्ज, 8 मेगाहर्ट्ज, 100 मेगाहर्ट्ज, 300 मेगाहर्ट्ज और 3 गीगाहर्ट्ज की प्रचालन आवृत्ति और एल.वी.सी.मोस. के चार विभिन्न निवेश निर्गम मानक जो कि एल.वी.सी.मोस. 12, एल.वी.सी.मोस. 15, एल.वी.सी.मोस. 18, एल.वी.सी.मोस. 25 के साथ कार्य करता है। प्रचालन आवृत्ति 3 गीगाहर्ट्ज पर एल.वी.सी.मोस. 25 की अपेक्षा एल.वी.सी.मोस.12 में निवेश निर्गम शक्ति में 61.58 प्रतिशत की कमी आई है। निवेश निर्गम मानक बदलने पर निर्देश शक्ति एवं कालद शक्ति में कोई बदलाव नहीं हुआ। निर्देश शक्ति एवं कालद शक्ति आवृत्ति के साथ परिवर्तित होती है। एल.वी.सी.मोस.12 के लिए आवृत्ति को 3 गीगाहर्ट्ज से 100 मेगाहर्ट्ज करने पर निवेश निर्गम शक्ति में 97.05: प्रतिशत की कमी होती है।।

### BSTRACT

Our Indian constitution has a large number of dialects and scripts with the Devanagari script being the primary and most widely used among all the scripts. Impedances of transmission line, port and device should be equal so as to avoid reflection in transmission line which is a usual problem in hardware design. In our paper, we have implemented our code on Xilinx ISE Design Suite 12.1 and for testing of results, we were using 40nm FPGA platform. Power analyses have done by varying frequencies to make our Devanagari Unicode Reader energy efficient. We are using low voltage variants of CMOS: LVCMOS (Low Voltage Complementary Metal oxide Semiconductor) I/O standards. This design is tested on 2MHz, 6MHz, 8MHz, 100MHz, 300MHz and 3GHz operating frequency with four different LVCMOSes which are LVCMOS12, LVCMOS15, LVCMOS18 and LVCMOS25. Reduction of I/O power is of 61.58% with LVCMOS12 in comparison to LVCMOS25 at 3 GHz operating frequency. There is no change in the clock power when we change I/O standards. Clock power changes with change in frequency. There is 97.05% reduction in I/O power when we scale down frequency from 3GHz to 100MHz for LVCMOS12.

**Keywords:** Devanagari Unicode Reader, LVCMOSes, I/O standards, FPGA, energy efficient

## 1. INTRODUCTION

Devanagari is coalition of 'deva' and 'nagari'. It is written from left to right. Devanagari is originated from Gupta script. In former times, it was used to write the Gujrati script but nowadays, it is used to write Sindi, Sanskrit, Maithili, Konkani, Nepali and Marathi. This makes it the most espoused writing script of the world<sup>1</sup>. Automatic character recognition is

a grueling task. Research has been done on character detection of Indian script by Chaudary along with Pal<sup>2</sup>. OCR is urbanized by them to read two Indian language scripts: Devanagari and Bengali<sup>2</sup>. In order to evade transmission line reflection and to perceive the most energy efficient IO standard and to design, low voltage variants of complementary metal oxide semiconductor (LVCMOS)<sup>3,5</sup> were considered ranging

from low frequency to microwave frequencies. The implemented design of Devanagari Unicode reader reads the Devanagari and it displays how many vowels, consonants, digits are in the text when it is used with the counter. Text can also be read if the Unicode is mapped with their vocable.

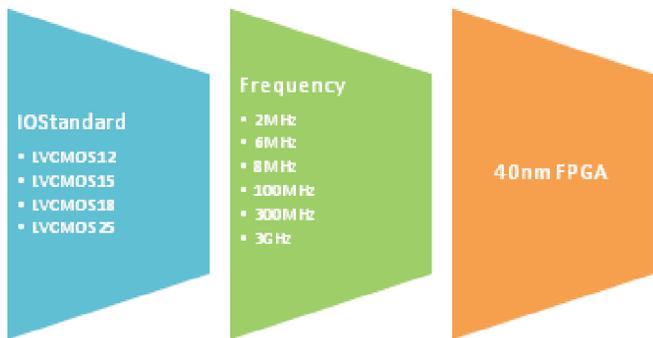
For example: 0915 is Devanagari consonant (क), 0940- is dependent vowel sign of I (ी), 0909 is independent vowel sign of U (उ), 090E is independent vowel sign of Ai (ऐ), 0912 is independent vowel sign of O (ओ) as shown in Table 1.

**Table 1. Range of Devanagari Unicode scripts**

Character Type (o/p port)	Unicode Range
Vowels	0904-0914,093E-094C
Consonants	0915-0939,0958-095F
Digits Sign	0966-096F
Reserved and Other signs	0951-0954, 094D-097D,0973-097C, 097E,097F

**2. EXPERIMENTAL SETUP**

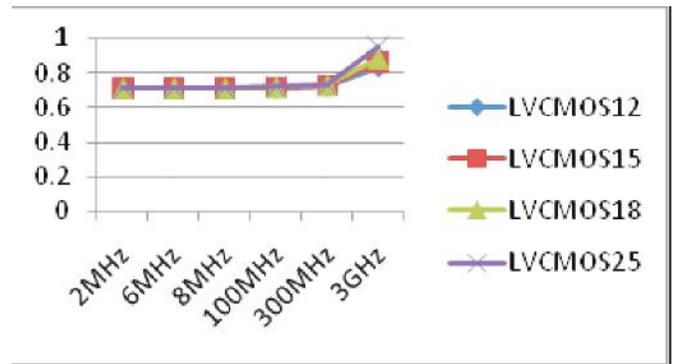
LVC MOS is used to design an energy efficient Devanagari Unicode reader. The experimental setup of this reader is that we have used Verilog as a hardware description language. Virtex6 FPGA was selected and XPower analyzer was used for calculating the power. Four different LVC MOS I/O Standards are used i.e. LVC MOS12, LVC MOS15, LVC MOS18, LVC MOS25 at six different frequencies of 2MHz, 6MHz, 8MHz, 100MHz, 300MHz and 3GHz as shown in Fig.1. The four mention voltages at which LVC MOSes are working is 1.2V, 1.5V, 1.8V and 2.5V.



**Figure 1. Specification of Devanagari Unicode Reader.**

**3. RESULTS USING LVC MOS IO STANDARDS**

In Fig. 2, the power consumption is least by using LVC MOS12 and highest at LVC MOS25 I/O Standard. We are analyzing power in terms of clock power, I/O power, leakage power and total power. We are operating our unicode reader with different frequencies of 2MHz, 6MHz, 100MHz, 300MHz, and 3 GHz. There is no change in the clock power when we change I/O standards. Clock power changes with



**Figure 2. Different LVC MOS showing different frequencies.**

change in frequency. There is 97.05% reduction in I/O power when we scale down frequency from 3GHz to 100MHz for LVC MOS12. There is 96.77% reduction in I/O power when we scale down frequency from 3GHz to 100MHz for LVC MOS25.

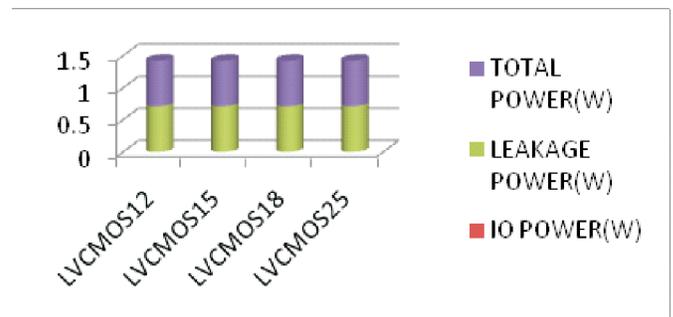
In Table 2 and Fig. 3, there is no change in the clock power and I/O power and the leakage power and total power remains the same in case of LVC MOS12, 15, 18 but there is a slight change in LVC MOS25 of Devanagari Unicode Reader.

Table 3 and Fig. 4, shows the power dissipation at frequency 6MHz and the decrease of power is of 0.14% between LVC MOS12 and LVC MOS25. On the other side, there is no change in the clock power and I/O power.

Table 4 and Fig. 5, show the power dissipation at frequency 100MHz and the decrease of I/O power

**Table 2. Power Dissipation when operating at 2MHz**

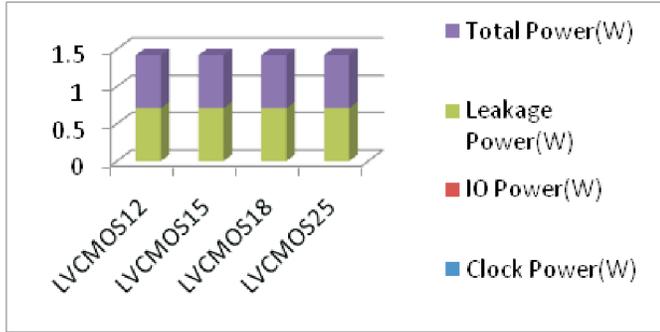
	LVC MOS12	LVC MOS15	LVC MOS18	LVC MOS25
Clock Power (W)	0.000	0.000	0.000	0.000
IO Power (W)	0.000	0.000	0.000	0.000
Leakage Power (W)	0.711	0.711	0.711	0.712
Total Power (W)	0.711	0.711	0.711	0.712



**Figure 3. Total and I/O power using different LVC MOSes on 2MHz.**

**Table 3. Power dissipation when operating at 6MHz**

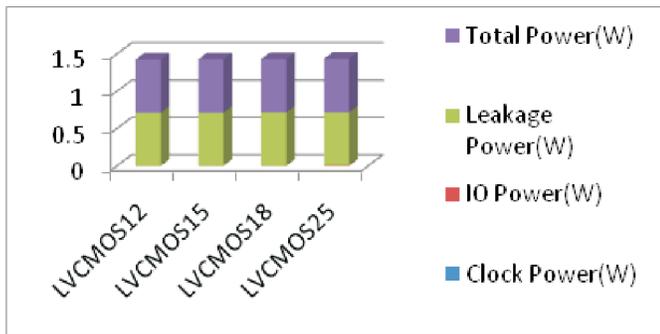
	LVCM OS12	LVCM OS15	LVCM OS18	LVCM OS25
Clock Power(W)	0.000	0.000	0.000	0.000
IO Power(W)	0.000	0.000	0.000	0.000
Leakage Power(W)	0.711	0.711	0.711	0.712
Total Power(W)	0.711	0.711	0.711	0.712



**Figure 4. Total and I/O power using different LVC MOSes on 6MHz.**

**Table 4. Power dissipation when operating at 100MHz**

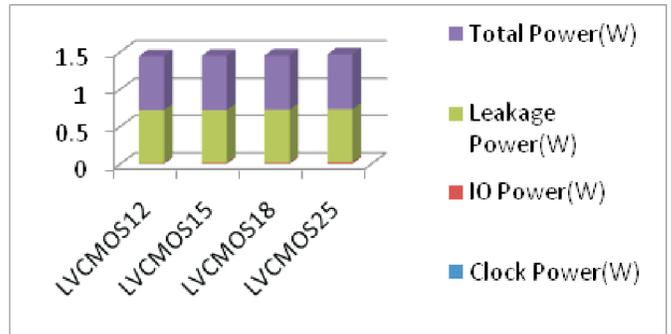
	LVCM OS12	LVCM OS15	LVCM OS18	LVCM OS25
Clock Power(W)	0.002	0.002	0.002	0.002
I/O Power(W)	0.002	0.003	0.004	0.006
Leakage Power(W)	0.711	0.711	0.711	0.712
Total Power(W)	0.714	0.716	0.717	0.719



**Figure 5. Total and I/O power using different LVC MOSes on 100MHz.**

**Table 5. Power dissipation when operating at 300MHz**

	LVCM OS12	LVCM OS15	LVCM OS18	LVCM OS25
Clock Power(W)	0.005	0.005	0.005	0.005
I/O Power(W)	0.007	0.009	0.012	0.018
Leakage Power(W)	0.711	0.711	0.711	0.712
Total Power(W)	0.723	0.726	0.728	0.735



**Figure 6. Total and I/O power using different LVC MOSes on 300MHz.**

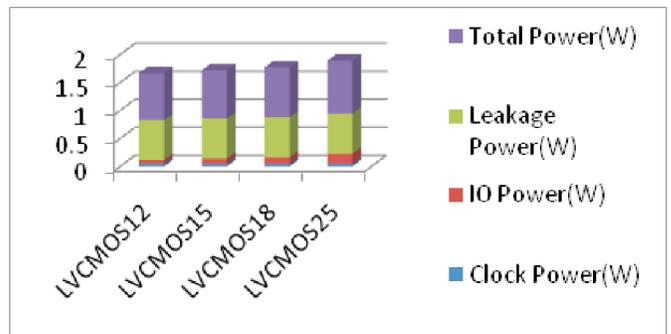
is of 66.66% between LVC MOS12 and LVC MOS25. On the other side, there is no change in the clock power.

Table 5 and Fig. 6, shows the power dissipation at frequency 300MHz and the decrease of I/O power is of 61.11% when we use LVC MOS12 in place of LVC MOS25. On the other side, there is no change in the clock power.

Table 6 and Fig. 7, show the power dissipation at frequency 3GHz and the decrease of I/O power is of 61.58% between LVC MOS12 and LVC MOS25. On the other side, there is no change in the clock power.

**Table 6. Power dissipation when operating at 3GHz**

	LVCM OS12	LVCM OS15	LVCM OS18	LVCM OS25
Clock Power(W)	0.049	0.049	0.049	0.049
I/O Power(W)	0.068	0.093	0.116	0.177
Leakage Power(W)	0.713	0.714	0.715	0.717
Total Power(W)	0.836	0.862	0.886	0.949



**Figure 7. Total and I/O power using different LVC MOSes on 100MHz.**

#### 4. CONCLUSION

The reduction in power dissipation at different frequency using different I/O standards was noticed during the experiment. LVC MOS12 operating at 1.2V gave the highest power reduction on different frequency using virtex-6 FPGA. This shows that the energy efficient Devanagari is varied at different frequencies starting from the minimum to highest and

the power dissipation is calculated using different LVC MOSes.

## 5. FUTURE SCOPE

The Devanagari Unicode reader is implemented on Virtex-6 i.e., 40nm FPGA, so this reader can be implemented on 28nm FPGA. The coverage at 22 different languages than Devanagari Unicode reader can be implemented using different FPGA. Here, we are using 40nm; we can implement using Silicon Blue's iCE 65 FPGA; Cyclone Series FPGA, and other Xilinx FPGA Families.

## निष्कर्ष

इस परीक्षण में विभिन्न आवृत्तियों पर विभिन्न निवेश निर्गम मानकों का प्रयोग करने पर शक्ति अपव्यय में कमी देखी गयी है। सबसे अधिक शक्ति अपव्यय में कमी वर्टेक्स-6 एफ.पी.जी.ए. पर उपलब्ध 1.2 वॉल्ट प्रचालन वोल्टेज के एल० वी० सी० मोस 12 निवेश निर्गम मानक के उपयोग करने से हुई है। ऊर्जा दक्ष देवनागरी की शक्ति अपव्यय में कमी तब भी देखी गयी है जब हम प्रचालन आवृत्तियों को उच्चतम से निम्न की ओर ले जाते हैं और एल० वी० सी० मोस० निवेश निर्गम मानकों में कोई परिवर्तन नहीं करते हैं।

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# निवेश निर्गम मानक आधारित ऊर्जा दक्ष देवनागरी यूनिकोड रीडर 28 एन एम एफ.पी.जी.ए. पर कार्यान्वयन I/O Standard Based Energy Efficient Devanagari Unicode Reader on 28nm FPGA

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## सारांश

इस शोध पत्र में हमने निवेश निर्गम आधारित ऊर्जा दक्ष देवनागरी कोड का निर्माण किया है। भारत देश में हिन्दी भाषा को लिखने के लिए देवनागरी का प्रयोग किया जाता है। प्रत्येक लिपि द्वारा सुस्पष्ट कहावतों का सतत प्रयोग उसे अनूठापन प्रदान करता है। इस शोध पत्र में हम जाईलिंग्स आइ.एस.आई. साफ्टवेयर 14.2 को उपयोग में लाकर देवनागरी यूनिकोड का निर्माण कर रहे हैं और परिणाम को 28 नैनो मीटर एफ.पी.जी.ए. प्लेटफॉर्म पर जांचा है। हमने शक्ति का विश्लेषण 300 मेगा हर्ट्ज, 1 गिगा हर्ट्ज और 3 गिगा हर्ट्ज आवृत्तियों का विभिन्न एल.वी.सी.मोस. (लो वोल्टेज कॉम्प्लैटरी मेटल ऑक्साइड सेमीकंडक्टर) निवेश निर्गममानकों का प्रयोग करके किया है। हमारा लक्ष्य कीनेटेक्स-7 है। कुल शक्ति अपव्यय में कमी 300 मेगा हर्ट्ज और 1 गिगा हर्ट्ज, 3 गिगा हर्ट्ज के संदर्भ में एल.वी.सी.मोस. 15 का प्रयोग करके 46.15% और 60% की है। विभिन्न एल.वी.सी.मोस. निवेश निर्गम मानकों पर संधिस्थल तापमान कम होता है।

## ABSTRACT

In our paper, we have designed an I/O Standard based Energy Efficient Devanagari Unicode Reader. Devanagari is used for writing the Hindi language in India. As each script, has peculiarities of its own, which every now and then require an unambiguous 'idiom' for the particular script. In this paper we have implemented our Devanagari Unicode Reader code on Xilinx ISE Design Suite 14.2 and the results were tested using 28nm FPGA platform. We have done the power analyses using 300MHz, 1GHz, and 3GHz frequencies at different LVC MOS (Low Voltage Complementary Metal Oxide Semiconductor). Our target FPGA is Kintex-7 FPGA. The total power reduction at frequency 300MHz and 1 GHz with respect to 3GHz and by using I/O standard LVC MOS15 is 46.15% and 60% respectively. The junction temperature reduces at different LVC MOSes.

**Keywords:** I/O standard, FPGA, LVC MOS, Devanagari unicode reader, leakage power, energy efficient

## 1. INTRODUCTION

Low power Unicode reader outline is gaining special consideration in Devanagari natural language processing. Research has previously been done on power efficient Bengali Unicode Reader based on thermal alert techniques<sup>1</sup>. These days with the advancement in Information Technology, in India where the majority of people are Hindi language speaking, a ideal Devnagari Spell Checker is required for word dispensation of articles in Hindi language<sup>2</sup>. Devanagari being the official script of India, spoken by more than 500 million people should be given added interest so that document recovery and analysis of rich olden and modern Indian text can be efficiently finished<sup>3</sup>. Previously Devanagari was used as script of Gujrati but presently, it is used to write Hindi, Sanskrit, Marathi, Sindhi, Maithili, Konkani and Nepali, that makes it one of the most adopted scripts of the world<sup>1</sup>. In this work, a low power Devanagari

Unicoder is designed using different LVC MOSes. The Devanagari Unicode involves different 16-bit hexadecimal code for independent vowels, dependent vowels, consonants, and different signs. LVC MOS15, LVC MOS18, LVC MOS25 takes 1.2V, 1.8V, and 2.5V as driver voltages, respectively. Interior supply voltage of FPGA is 1.2V and supplementary supply voltage is 2.5V<sup>4</sup>. Power reduction, by tradition relegate to the synthesis and circuit level, now is shifted to the System Level and Register-Transfer-Level<sup>5</sup>. The block diagram of Devnagari Unicode reader is shown in Fig.1.

With thermal scale, there is no transform in clock power, logic power, signal power and I/O Power<sup>6</sup>.

We have studied different 90nm FPGA, 65nm FPGA, 40nm FPGA and 28nm FPGA. We are working on 28nm technology based KIntex-7 FPGA. As shown in Fig.1, this Unicode reader takes 16-bit inputs and specifies whether the input is consonant, vowel, digit or other sign.

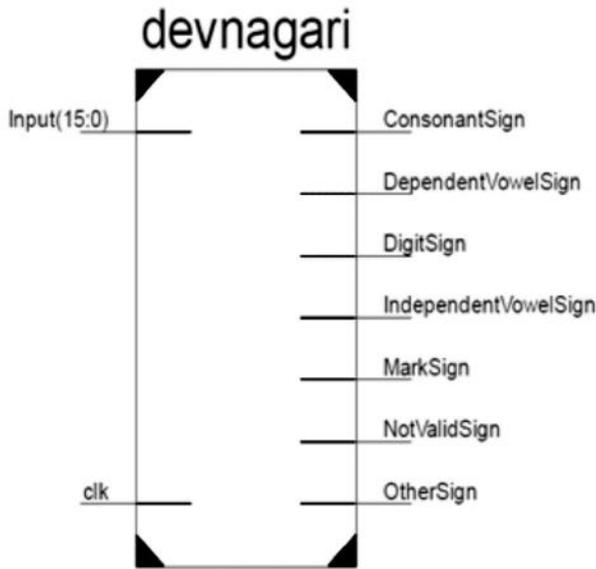


Figure 1. Schematic of Devanagari Unicode Reader (DUR).

Operating Frequency: 300MHz, 1GHz and 3GHz

IO Standards: LVC MOS15, LVC MOS18, LVC MOS25

Technology: 28nm FPGA

Figure 2. Specification of energy efficient DUR.

## 2. EXPERIMENTAL SETUP

An energy efficient Devanagari Unicode reader is designed using different LVC MOSes. The experimental arrangement of this reader is that verilog language is as the hardware description language. Kintex-7 FPGA is preferred and XPower analyzer is used to calculate the power. Three different LVC MOS IO standards are used i.e. LVC MOS15, LVC MOS18, LVC MOS25 at three different frequencies of 300MHz, 1GHz and 3GHz. The three position voltages at which LVC MOSes will be working are 1.5V, 1.8V and 2.5V.

## 3. RESULTS USING LVC MOS I/O STANDARD

In Fig.1, the total power consumption is least by using I/O standard LVC MOS15 and highest at LVC MOS25. There is 60% reduction in total power when we range down frequency from 3GHz to 300MHz for LVC MOS15.

In Fig.4 and Table1, the power dissipation is calculated at 300MHz. There is no modification in the clock power. The I/O power and leakage power decreases from LVC MOS25 to LVC MOS15. The power reduction in total power dissipation is of 11% but the junction temperature the remains same at all LVC MOSes.

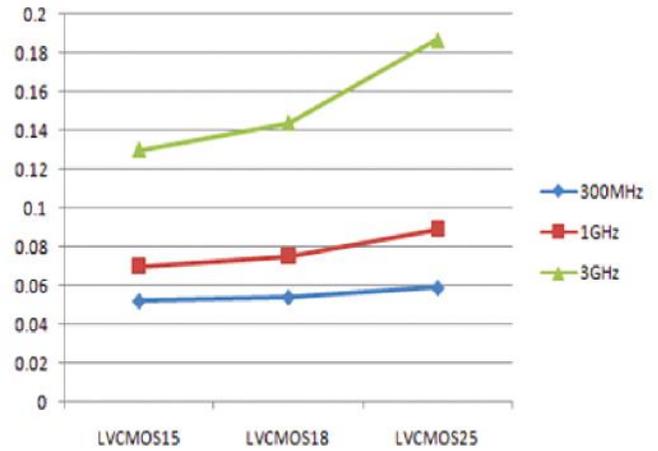


Figure 3. Different LVC MOS showing different frequencies.

Table 1. Power Dissipation when Operating at 300MHz

	LVC MOS15	LVC MOS18	LVC MOS25
Clock Power(W)	0.002	0.002	0.002
I/O Power(W)	0.005	0.006	0.010
Leakage Power(W)	0.045	0.045	0.046
Total Power(W)	0.052	0.054	0.059
Junction Temperature (°C)	25.1	25.1	25.1

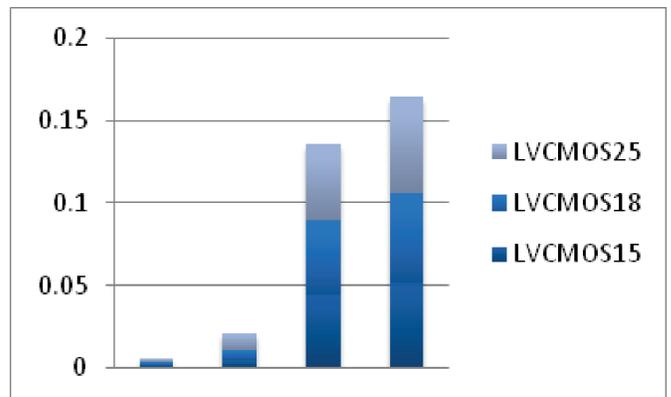


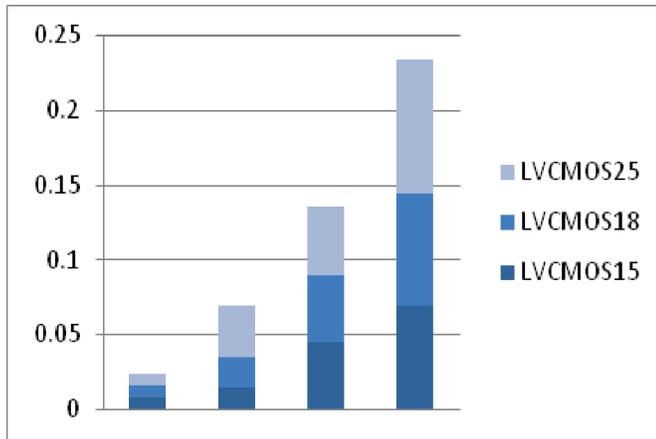
Figure 4. I/O power with different LVC MOSes on 300MHz.

In Table 2 and Fig.5, the power dissipation is calculated at 1GHz. There is no modification in the clock power. The IO power and leakage power decreases from LVC MOS25 to LVC MOS15. The power reduction in total power dissipation is of 21% but the junction temperature decrease at LVC MOS15.

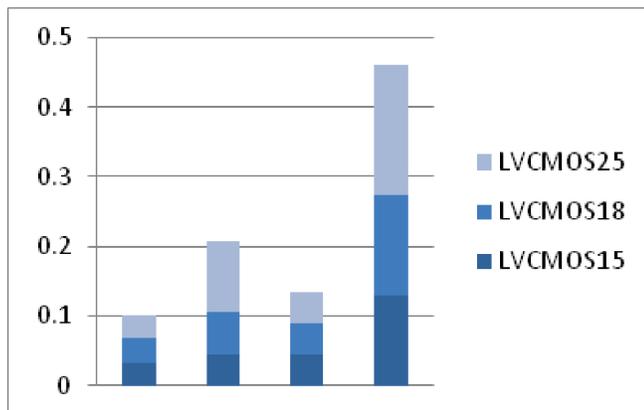
In Table 3 and Fig. 6, the power dissipation is calculated at 3GHz. There is no modification in the clock power. The IO power and leakage power decreases from LVC MOS25 to LVC MOS15. The power reduction in total power dissipation is of 30% but the junction temperature decreases at LVC MOS15 and LVC MOS18.

**Table 2. Power dissipation when operating at 1GHz**

	LVC MOS15	LVC MOS18	LVC MOS25
Clock Power(W)	0.008	0.008	0.008
IO Power(W)	0.015	0.020	0.034
Leakage Power(W)	0.045	0.045	0.046
Total Power(W)	0.070	0.075	0.089
Junction Temperature(°C)	25.1	25.2	25.2

**Figure 5. I/O Power with different LVC MOSes on 1GHz.****Table 3. Power dissipation when operating at 3GHz**

	LVC MOS15	LVC MOS18	LVC MOS25
Clock Power(W)	0.034	0.034	0.034
IO Power(W)	0.046	0.060	0.102
Leakage Power(W)	0.045	0.045	0.046
Total Power (W)	0.130	0.144	0.187
Junction Temperature (°C)	25.3	25.3	23.4

**Figure 6. I/O Power with different LVC MOSes on 3GHz.**

#### 4. CONCLUSION

The reduction in power dissipation at different frequencies using different I/O standard were noticed during the experiment. LVC MOS15 operating at 1.5V gave the utmost power reduction on different frequencies using virtex-6 FPGA. This shows that the energy efficient Devnagari is varied at different frequencies i.e., 300MHz, 1GHz and 3GHz the power dissipation is calculated using different LVC MOSes.

#### निष्कर्ष

इससे हम इस निष्कर्ष पर पहुँचते हैं कि परीक्षण में विभिन्न निवेश निर्गम मानकों पर विभिन्न आवृत्तियों पर शक्ति के अपव्यय में कमी होती है। सबसे अधिक शक्ति अपव्यय में कमी विभिन्न आवृत्तियों का एल० वी० सी० मोस 15 का प्रचालन 1.5 वॉल्ट पर एफ.पी.जी.ए. वरटैक्स-6 पर कार्यान्वयन करके होती है। ऊर्जा दक्ष देवनागरी की शक्ति अपव्यय परिकलित का विभिन्न आवृत्तियों जैसे 300 मेगा हर्ट्ज, 1 गिगा हर्ट्ज और 3 गिगा हर्ट्ज का विभिन्न एल० वी० सी० मोस० निवेश निर्गम मानकों के साथ किया गया है।

#### 5. FUTURE SCOPE

The Devnagari Unicode reader is implemented on 28nm FPGA, so this reader can be implemented on 20nm FPGA, 14nm FPGA, 3D ICs and System on Chip (SoC). Here, we are using Xilinx 7 series FPGA; we can implement Unicode reader on Silicon Blue's iCE 65 FPGA; Cyclone Series FPGA, and other Xilinx FPGA families. This Unicode reader is designed for Devnagari. In future, we can go for 22 official languages of India and more than 1000 languages of the world for which Unicode consortium has allocated Unicode range.

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# एफपीजीए पर पर आवृत्ति और वोल्टेज स्केलिंग आधारित ऊर्जा कुशल थर्मल अवेयर इमेज एएलयू डिजाइन Frequency and Voltage Scaling Based Energy Efficient Thermal Aware Image ALU Design on 28nm FPGA

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## सारांश

इस कार्य में 25 डिग्री सेल्सियस परिवेश तापमान पर 28 एनएम किंटेक्स-7 से ऊर्जा कुशल और थर्मल अवेयर इमेज एएलयू को डिजाइन किया गया। जिलिक्स 14.2 आईएसई डिजाइन टूल है। शक्ति और तापमान अनुकूलित इमेज एएलयू होना बहुत जरूरी है इसलिए हम वोल्टेज और आवृत्ति स्केलिंग दृष्टिकोण का उपयोग कर रहे हैं। हम 1 गीगा हर्ट्ज से 35 गीगा हर्ट्ज आवृत्ति और 2 वोल्ट से 1.2 वोल्ट की वोल्टेज स्केलिंग कर रहे हैं और इमेज एएलयू का लीकेज पावर कुल पावर और जंक्शन तापमान की जांच कर रहे हैं। आवृत्ति स्केलिंग तकनीक 1 गीगा हर्ट्ज आवृत्ति और आगे की आवृत्ति के लिए लीकेज पावर खपत को 88.8 से 44.8 प्रतिशत रेंज में कुल पावर खपत को 46.8 से 21.36 प्रतिशत रेंज में और जंक्शन तापमान को 4.982 से 2.13 प्रतिशत रेंज में कम करने में सक्षम है जबकि वोल्टेज स्केलिंग तकनीक 2 वोल्ट और आगे की वोल्टेज पर लीकेज पावर खपत को 96.4 से 66 प्रतिशत रेंज में, कुल पावर खपत को 97.1 से 40.5 प्रतिशत रेंज में और जंक्शन तापमान को 77.6 से 27.5 प्रतिशत रेंज में कम करने में सक्षम है जो इमेज एएलयू (अर्थमेटिक लॉजिक यूनिट) ऊर्जा कुशल थर्मल अवेयर बनाता है।

## ABSTRACT

In this work, energy efficient and thermal aware image arithmetic logic unit (ALU) is designed using 28 nm Kintex-7 at ambient temperature of 25 °C. Xilinx 14.2 ISE is the design tool. It is important to have power and temperature optimised Image ALU for this reason voltage and frequency scaling approach is used. Voltage values are scaled from 2 V to 1.2 V and frequency from 1GHZ to 35 GHz and examining the leakage power, total power and Junction temperature of Image ALU. Frequency scaling technique is able to reduce leakage power consumption in the range of 88.8 per cent to 44.8 per cent, total power consumption in the range 46.8 per cent to 21.36 per cent and Junction temperature range from 4.982 per cent to 2.13 per cent for 1GHz frequency and so on, whereas voltage scaling technique is able to reduce leakage power consumption in the range of 96.4 per cent to 66 per cent, total power consumption in the range 97.1 per cent to 40.5 per cent and Junction temperature range from 77.6 per cent to 27.5 per cent at 2 Volts and so on, which makes Image ALU energy efficient and thermal aware.

**Keywords:** Image ALU, low power, frequency optimisation, voltage optimisation, power optimisation, FPGA

## 1. INTRODUCTION

ImageALU is an Arithmetical and Logical data processing processor which is reliable in energy efficiency<sup>1</sup> perspective, for this purpose 28 nm technology<sup>1</sup> based FPGA is utilised. Arithmetic operations such as addition, subtraction, multiplication, division, so on and logical operations such as NOT, OR, AND, XOR and so on are performed. The decrease in power dissipation and junction temperature is analyzed in ImageALU design. In an Image ALU we are taking two images of 16 bits and performed various arithmetic

and logic operations. Block diagram of Image ALU is shown in Fig.1. In this work we optimized frequency and voltage in Image ALU design to save power and junction temperature<sup>1</sup>. The decrease in power dissipation is analyzed with equation 1.

$$\text{Power} = \text{Capacitance} * \text{Voltage}^2 * \text{Frequency} \quad (1)$$

The dynamic power is directly proportional to the square of the voltage and frequency. Hence with the help of frequency and voltage optimization leakage power, total power and the junction temperature are reduced.

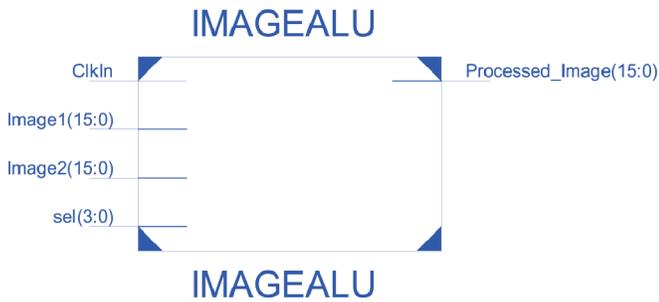


Figure 1. Block diagram image ALU.

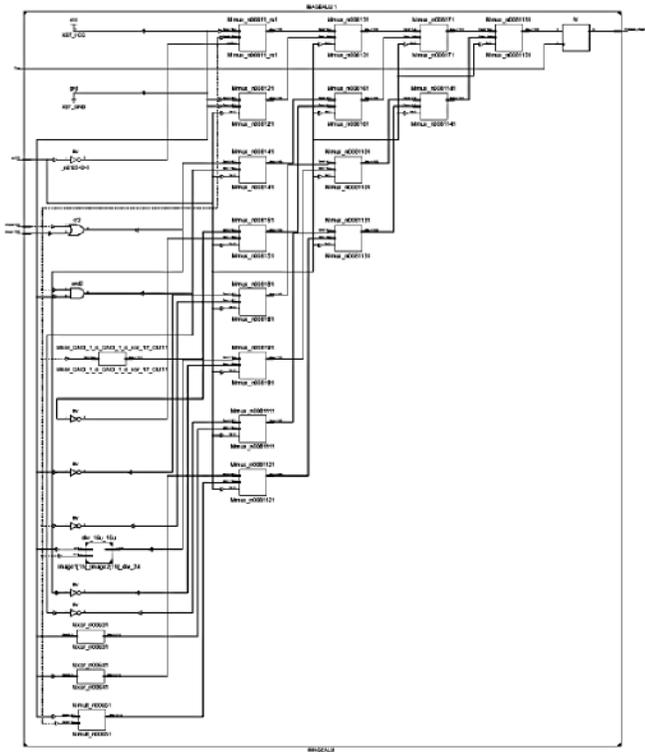


Figure 2. RTL schematic of image ALU.

**2. LITERATURE REVIEW**

Technology scaling is advancing from 40nm to 28 nm, Pandey<sup>1</sup> *et al.* apply voltage optimization to reduce dynamic power in both 28nm and 40nm technologies and concluded that 28nm Technology based FPGA is more power effective FPGA in comparison to 40nm technology based FPGA Artix7, hence we apply frequency and voltage optimization on ImageALU to reduce the power on 28nm technology using Kintex-7. In Paper by Pandey<sup>2</sup> *et al.* energy Efficient ALU Design and Implementation is done on 28nm FPGA using IO standards LVCMOS. In this paper, Image ALU is designed using Kintex-7 to achieve low power. In Paper by Das<sup>3</sup> *et al.* capacitance scaling and frequency scaling is done in order to make energy efficient Image Inverter design. In Paper by Kumar<sup>4</sup> *et al.* frequency scaling results variations in power

consumption and the Junction temperature of Image Inverter, In Islam<sup>5</sup> *et al.* voltage Scaling of Mobile Battery Charge Controller Sensor is implemented Paper is based on energy efficient FIR filter for digital signal processing is designed using 28nm Kintex-7<sup>6</sup>. Present paper also follows energy efficient design using 28nm Kintex-7. Frequency and Voltage scaling results in change in leakage power, total power as well as the Junction temperature of Image ALU design. Chow<sup>4</sup> *et al.* describes the voltage scaling of commercial FPGAs. In Asano<sup>8</sup> *et al.* has done comparison to FPGA with GPU and CPU in image processing focuses on Dynamic Power Reduction of ALU using LVCMOS<sup>9</sup>. ALU design and implementation is done on 28nm FPGA using voltage optimization is done by Satyn<sup>10</sup>. et al. In<sup>11</sup> capacitive Scaling is implemented on low power ALU. In Paper<sup>12</sup> Green ImageALU is designed on different FPGA using SSTL technique. In this paper Kintex-7 FPGA is used to design ImageALU so as to make it Energy efficient and thermal aware. Paper by Bansal<sup>13</sup> *et al.* is based on low power design of ROM, present work is also based on low power design of Image ALU. Paper by Tuan-Tim<sup>14</sup> *et al.* and Kumar<sup>15</sup> *et al.* are also based on 90nm low power design of FPGA and energy efficient design on ultra-scale FPGA. This paper also focuses on low power energy aware image ALU design.

**3. RESULTS OF FREQUENCY SCALING**

Kintex-7 FPGA is based on 28nm technology. It is effective to reduce effective and total power dissipation and junction temperature of target design. We are operating ALU with different frequency of 1GHz, 5GHz, 15GHz, 25GHz and 35GHz. Frequency scaling<sup>3</sup> results are as follows:

**3.1 ALU Operating Frequency 1GHz**

With 28nm technology and 1GHz operating frequency, there is 44.8%, 68.9%, 81.9% and 88.9% reduction in leakage power, 21.36%, 33.99%, 41.81% and 46.8% reduction in Total Power<sup>4</sup>, 2.13%, 3.558%, 4.626% and 4.982% reduction in junction temprature<sup>5</sup>, when the range of voltage is 2V-1.2V with step size of 0.2V.

Table 1. Operating frequency 1GHz on 28nm FPGA

Frequency (F) = 1GHz			
Voltage (V) volts	Leakage Power (LP) watts	Total Power (TP)watts	Junction Temperature (JT)degree C
2	0.625	1.521	28.1
1.8	0.345	1.196	27.5
1.6	0.194	1.004	27.1
1.4	0.113	0.885	26.8
1.2	0.07	0.808	26.7

change in leakage power of 0.555W, total power of 0.713W and junction temperature of 1.4 °C is possible with voltage reduction of 1.2 V as shown in Table 1 and Fig. 3.

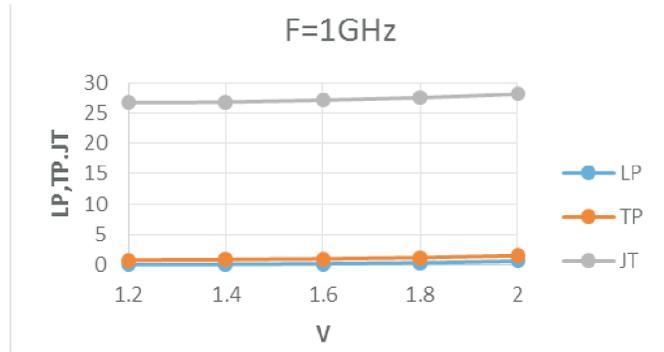


Figure 3. Power and Junction Temperature at F = 1GHz.

### 3.2 ALU Operating Frequency 5GHz

When 5 GHz is operating frequency and FPGA is 28nm [6], there is 46.3%, 70.78%, 83.5% and 90.4% reduction in leakage power, 9.72%, 16.0%, 20.5% and 23.85% reduction in total power, 3.37%, 5.71%, 7.27% and 8.31% reduction in junction temperature when range of voltage is 2V-1.2V with step size of 0.2V. Highest change in leakage power of 0.848W, total power of 1.561W and junction temperature of 3.2 °C is possible when voltage reduces to 1.2V as shown in Table 2 and Fig. 4.

Table 2. Operating frequency 5 GHz on 28nm FPGA  
Frequency(F) = 5GHz

Voltage (V) volts	Leakage Power (LP) watts	Total Power (TP)watts	Junction Temperature (JT) °C
2	0.938	6.57	38.5
1.8	0.503	5.931	37.2
1.6	0.274	5.513	36.3
1.4	0.154	5.221	35.7
1.2	0.09	5.003	35.3

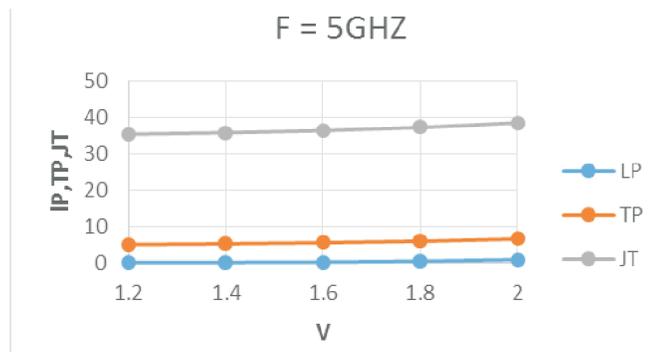


Figure 4. Power and junction temperature at F = 5GHz

### 3.3 ALU Operating Frequency 15 GHz

On 15 GHz operating frequency and 28nm FPGA, there is 49.1%, 73.6%, 86.1% and 92.4% reduction

in leakage power, 8.58%, 13.8%, 17.38% and 19.99% reduction in total power, 5.78%, 8.19%, 10.28% and 11.89% reduction in junction temperature when range of voltage is 2V-1.2V with step size of 0.2V. The magnitude of leakage power reduction is 2.156W, total power reduction is 3.63W and junction temperature reduction is 7.4 °C when voltage reduces from 2V to 1.2V as shown in Table 3 and Fig. 5.

Table 3. Operating frequency 15 GHz on 28nm FPGA

Frequency(F) = 15GHz

Voltage(V) volts	Leakage Power(LP) watts	Total Power(TP) watts	Junction Temperature (JT)degree C
2	2.332	18.159	62.2
1.8	1.185	16.6	59
1.6	0.615	15.646	57.1
1.4	0.324	15.002	55.8
1.2	0.176	14.528	54.8

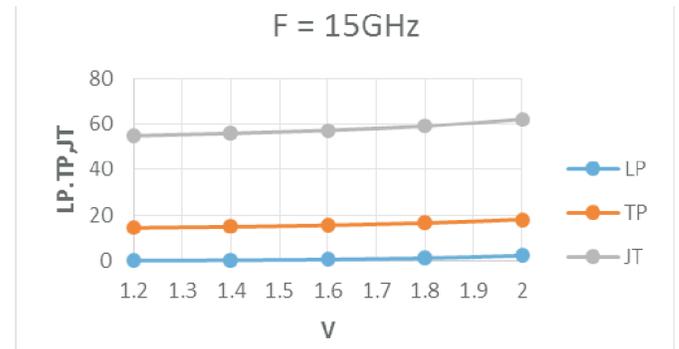


Figure 5. Power and junction temperature at F = 15GHz

### 3.4 ALU Operating Frequency 25 GHz

When ALU operate with 25 GHz frequency on 28nm FPGA, there is 53.19%, 76.94%, 88.35% and 93.98% reduction in leakage power, 11.8%, 18.1%, 21.9% and 24.5% reduction in total power, 8.6%, 13.1%, 15.8% and 17.7% reduction in junction temperature when range of voltage is 2V-1.2V with step size of 0.2V. 5.64W leakage power, 7.83W of total power and 16.1 °C can save when we scale voltage from 2 V to 1.2V as shown in Table 4 and Fig. 6.

Table 4. Operating frequency 25 GHz on 28nm FPGA

Frequency(F) = 25GHz

Voltage(V) volts	Leakage Power(LP) watts	Total Power(TP) watts	Junction Temperature (JT)degree C
2	6.002	31.974	90.6
1.8	2.809	28.172	82.8
1.6	1.384	26.178	78.7
1.4	0.699	24.964	76.2
1.2	0.361	24.136	74.5

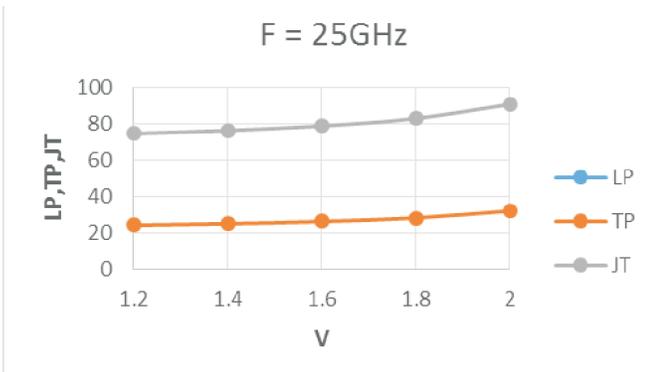


Figure 6. Power and junction temperature at F = 25GHz

### 3.5 ALU Operating Frequency 35GHz

When ALU operates on the highest possible 35Hz frequency on 28nm Kintex-7 FPGA, there is 62.7%, 82.9%, 91.7%, 95.9% reduction in leakage power, 22.0%, 30.1%, 34.3% and 36.9% reduction in total power and 11.28%, 18.4%, 22.0% and 24.3% reduction in junction temperature, when range of voltage is 2V-1.2V with step size of 0.2V as shown in Table 5 and Fig. 7.

Table 5. Operating frequency is 35GHz on 28nm FPGA

Frequency(F) = 35GHz			
Voltage(V) volts	Leakage Power(LP) watts	Total Power(TP) watts	Junction Temperature (JT)degree C
2	17.664	53.778	125
1.8	6.588	41.896	110.9
1.6	3.008	37.561	102
1.4	1.455	35.304	97.4
1.2	0.724	33.92	94.6

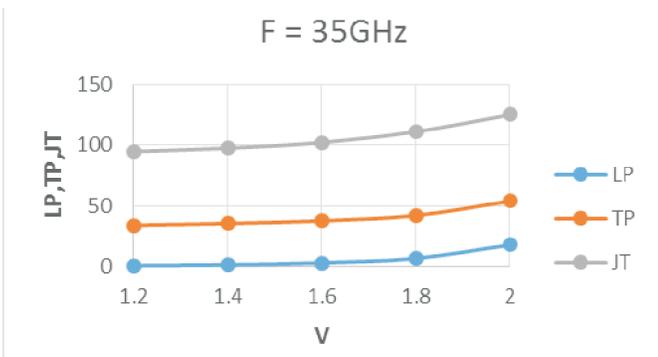


Figure 7. Power and junction temperature at F = 35GHz

## 4. RESULTS OF FREQUENCY SCALING

### 4.1 ALU Operating Voltage 2 V

When ALU operates at 2 volts on 28nm Kintex-7 FPGA, there is total of 96.4% reduction of leakage power, 97.1% reduction of total power and 77.5% reduction of junction temperature as shown in Table 6 and Fig. 8.

Table 6. Operating voltage 2V on 28nm FPGA

Voltage(V) = 2Volts			
Frequency(F) GHz	Leakage Power(LP) watts	Total Power(TP) watts	Junction Temperature (JT)degree C
1	0.625	1.521	28.1
5	0.938	6.57	38.5
15	2.332	18.159	62.2
25	6.002	31.974	90.6
35	17.664	53.778	125

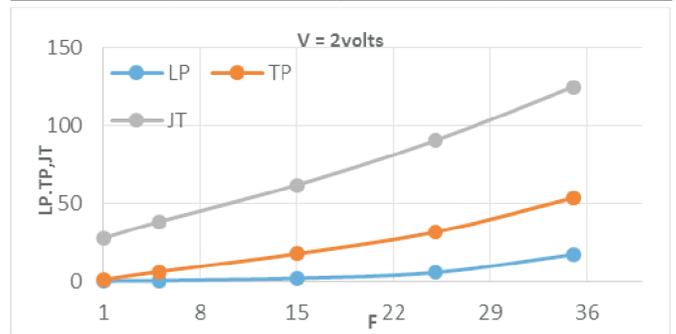


Figure 8. Power and junction temperature at V = 2Volts

### 4.2 ALU Operating Voltage is 1.8 Volts.

When ALU operates at 1.8 volts on 28nm Kintex-7 FPGA, there is total of 94.7% reduction of leakage power, 97.1% reduction of total power and 7775.2% reduction of junction temperature as shown in Table 7 and Fig. 9.

Table 7. Operating voltage is 1.8volts on 28nm FPGA

Voltage(V) = 1.8Volts			
Frequency(F) GHz	Leakage Power (LP) watts	Total Power (TP)watts	Junction Temperature (JT) °C
1	0.345	1.196	27.5
5	0.503	5.931	37.2
15	1.185	16.6	59
25	2.809	28.172	82.8
35	6.588	41.896	110.9

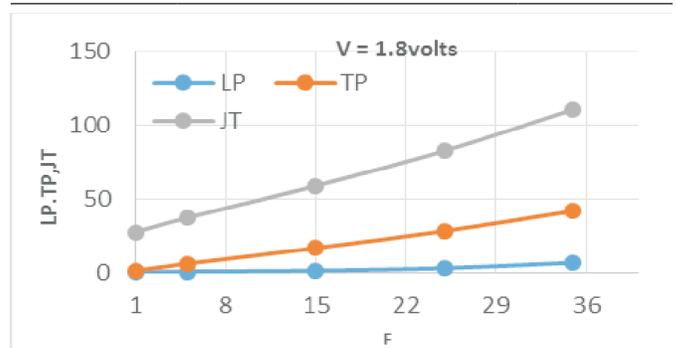


Figure 9. Power and junction temperature at V = 1.8Volts.

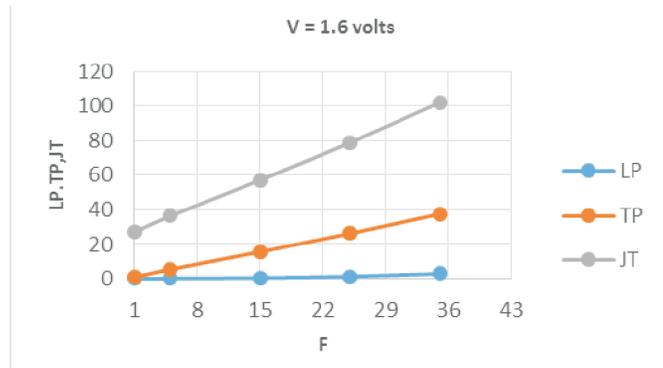
### 4.3 ALU Operating Voltage 1.6 Volts.

When ALU operates at 1.6 volts on 28nm Kintex-7 FPGA, there is total of 93.5% reduction of leakage power, 97.3% reduction of total power and 73.4%

reduction of junction temperature as shown in Table 8 and Fig. 10.

**Table 8. Operating voltage 1.6 V on 28nm FPGA**

Voltage(V) = 1.6Volts			
Frequency(F) GHz	Leakage Power (LP) watts	Total Power (TP)watts	Junction Temperature (JT) °C
1	0.194	1.004	27.1
5	0.274	5.513	36.3
15	0.615	15.646	57.1
25	1.384	26.178	78.7
35	3.008	37.561	102



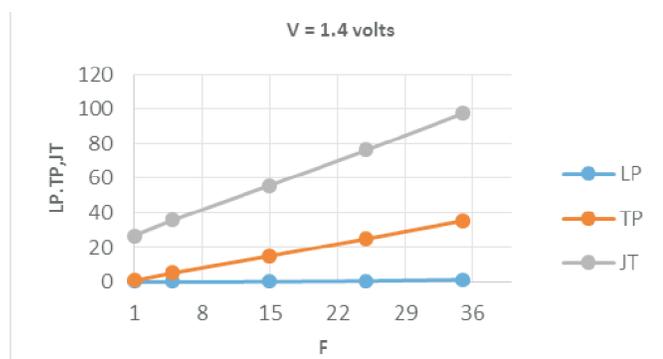
**Figure 10. Power and junction temperature at V = 1.6Volts**

**4.4 ALU Operating Voltage is 1.4 Volts**

When ALU operates at 1.4 volts on 28nm Kintex-7 FPGA, there is total of 92.2% reduction of leakage power, 97.4% reduction of total power and 72.4% reduction of junction temperature as shown in Table 9 and Fig. 11.

**Table 9. Operating Voltage 1.4volts on 28nm FPGA**

Voltage(V) = 1.4Volts			
Frequency (F) GHz	Leakage Power (LP) watts	Total Power (TP)watts	Junction Temperature (JT) °C
1	0.113	0.885	26.8
5	0.154	5.221	35.7
15	0.324	15.002	55.8
25	0.699	24.964	76.2
35	1.455	35.304	97.4



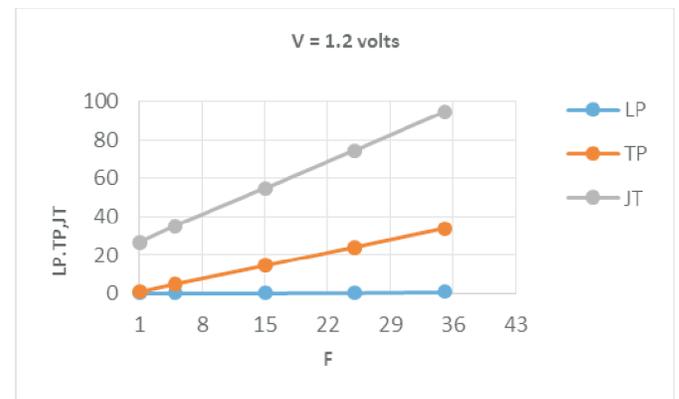
**Figure 11. Power and junction temperature at V =1. 4Volts**

**4.5 ALU Operating Voltage 1.2 Volts**

When ALU operates at 1.2 volts on 28nm Kintex-7 FPGA, there is total of 90.33% reduction of leakage power, 97.6% reduction of total power and 71.77% reduction of junction temperature as shown in Table 10 and Fig. 12.

**Table 10. Operating voltage 1.6 Volts on 28nm FPGA**

Voltage(V) = 1.2Volts			
Frequency (F) GHz	Leakage Power (LP) watts	Total Power (TP)watts	Junction Temperature (JT) °C
1	0.07	0.808	26.7
5	0.09	5.003	35.3
15	0.176	14.528	54.8
25	0.361	24.136	74.5
35	0.724	33.92	94.6



**Figure 12: Power and junction temperature at V =1. 2Volts**

**5. CONCLUSIONS**

28nm Technology based FPGA is power and energy aware FPGA. With Frequency scaling, as the frequency decreases from 35GHz to 1GHz the reduction in leakage power is 96.4% at 2 V, 94.7% at 1.8 V, 93.5% at 1.6 V, 92.2% at 1.4 V and 90.3% at 1.2 V. Similarly, the reduction in total power is 97.17% at 2 V, 97.14% at 1.8 V, 97.3% at 1.6 Volts, 97.4% at 1.4 Volts and 97.6% at 1.2 V. The reduction in junction temperature is 77.5% at 2 V, 75.2% at 1.8 V, 73.4% at 1.6 V, 72.4% at 1.4 Volts and 71.7% at 1.2 V. With voltage scaling, as the voltage decreases from 2 V to 1.2 V the reduction in leakage power is 88.8% at 1GHZ, 90.4% at 5GHZ, 92.4% at 15GHZ, 93.98% at 25GHZ and 95.9% at 35GHZ. Similarly the reduction in junction temperature is 4.98% at 1GHZ, 8.3% at 5GHZ, 11.8% at 15GHZ, 17.7% at 25GHZ and 24.3% at 35GHZ.

**6. FUTURE SCOPE**

There is an open scope to implement 20nm FPGA, 14nm FPGA, 3D IC, and System on chip for Digital Image Processing. In future we can go for 32 bit, 64 bit ImageALU architecture. There is a wide scope to

re-implement the above said work on 16nm and 7nm depending on availability of future FPGA.

## निष्कर्ष

28एनएम प्रौद्योगिकी आधारित एफपीजीए पावर और ऊर्जा अवेयर एफपीजीए है। आवृत्ति स्केलिंग के साथए जैसे ही आवृत्ति में 35 गीगा हर्ट्ज़ से 1 गीगा हर्ट्ज़ की कमी करते है तो लीकेज पावर में 2 वोल्ट पर 96.4 प्रतिशत, 1.8 वोल्ट पर 94.7 प्रतिशत, 1.6 वोल्ट पर 93.5 प्रतिशत, 1.4 वोल्ट पर 92.2 प्रतिशत और 1.2 वोल्ट पर 90.3 प्रतिशत की कमी होती है। इसी तरह से, कुल पावर में 2 वोल्ट पर 97.17 प्रतिशत, 1.8 वोल्ट पर 97.14 प्रतिशत, 1.6 वोल्ट पर 97.3 प्रतिशत, 1.4 वोल्ट पर 97.4 प्रतिशत और 1.2 वोल्ट पर 97.6 प्रतिशत की कमी होती है।

जंक्शन तापमान में 2 वोल्ट पर 77.5 प्रतिशत, 1.8 वोल्ट पर 75.2 प्रतिशत, 1.6 वोल्ट पर 73.4 प्रतिशत, 1.4 वोल्ट पर 72.4 प्रतिशत और 1.2 वोल्ट पर 71.7 प्रतिशत की कमी होती है। वोल्टेज स्केलिंग के साथ, जैसे ही वोल्टेज में 2 वोल्ट से 1.2 वोल्ट की कमी करते है तो लीकेज पावर में 1 गीगा हर्ट्ज़ पर 88.8 प्रतिशत, 5 गीगा हर्ट्ज़ पर 90.4 प्रतिशत, 15 गीगा हर्ट्ज़ पर 92.4 प्रतिशत, 25 गीगा हर्ट्ज़ पर 93.98 प्रतिशत और 35 गीगा हर्ट्ज़ पर 95.9 प्रतिशत की कमी होती है। इसी तरह से, जंक्शन तापमान में 1 गीगा हर्ट्ज़ पर 4.98 प्रतिशत, 5 गीगा हर्ट्ज़ पर 8.3 प्रतिशत, 15 गीगा हर्ट्ज़ पर 11.8 प्रतिशत, 25 गीगा हर्ट्ज़ पर 17.7 प्रतिशत और 35 गीगा हर्ट्ज़ पर 24.3 प्रतिशत की कमी होती है।

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# एस एस टी एल आधारित (इंटरनेट आफ थिंग्स) अनेबल प्रोसेसर स्पेसिफिक रैम का 40 नैनोमीटर एफ पी जी ए पर डिजाइन SSTL-based Internet of Things Enable Processor Specific RAM Design on 40nm FPGA

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## सारांश

इस कार्य में, हम ऊर्जा दक्ष इंटरनेट आफ थिंग्स (आई ओ टी) सक्षम रैम को बनाते हैं। इसे ऊर्जा दक्ष बनाने के क्रम में, हम सटब सीरीज टर्मिनेटिड लोजिक (एस एस टी एल) निवेश-निर्गम मानको का उपयोग करेंगे। हम एस एस टी एल निवेश-निर्गम मानक परिवार के 5 विभिन्न सदस्यों का उपयोग करेंगे और इनमें से बेहतर ऊर्जा दक्ष सदस्य की खोज करेंगे। हम रैम में 128 बीट अड्रेस डालकर इसे इंटरनेट आफ थिंग्स सक्षम रैम बनाएंगे। अन्त में, हम अपनी सक्षम की इंटरनेट बनाने के लिए रैम में 128 बिट आईपी पते डालने हैं। अंत में, हम (आईओटी) सक्षम रैम को विभिन्न कार्यित आवृत्तियों 13, 15, 17, मोटो-ई और मोटो एक्स पर काम करेंगे। हम पाते हैं कि 1.7 गीगाहर्ज आवृत्ति पर निवेश-निर्गम में ऊर्जा खपत 78.14% कम हो जाती है जब हम एसएसटीएल II डीसीआई के स्थान एसएसटीएल2-I का उपयोग करते हैं और 79.23% कम हो जाती है जब हम एसएसटीएल18-1 के स्थान एसएसटीएल II डीसीआई का उपयोग करते हैं। रिसाव खपत में एक छोटी कमी को भी अनुभव किया गया है।

## ABSTRACT

In this work, energy-efficient Internet of Things (IoTs)-enable RAM is made. To make it energy efficient, we are using Stub Series Terminated Logic (SSTL) IO standards. We are using the 5 different members of SSTL IO standards family and searching the most energy efficient among them. We are inserting 128-bit IP address in RAM to make internet of things enable RAM. Finally, we are operating our IoTs Enable RAM with different operating frequency of I3, I5, I7, Moto-E and Moto-X. We find out that on 1.7 GHz operating frequency, there is maximum reduction of 78.14% in I/O when we use SSTL2\_I instead of SSTL\_II\_DCI and 79.23% reduction in I/O power when we use SSTL18\_I instead of SSTL\_II\_DCI. A small amount of reduction in leakage power is also observed.

**Keywords:** RAM, internet of things, FPGA, SSTL\_2,SSTL\_18 thermal aware design, energy efficient design

## 1. INTRODUCTION

Internet of Things (IoTs)<sup>[1]</sup> is a concept in which objects, people or everything around is provided with a unique id. It is the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. By inserting short range mobile transceivers into a large number of gadgets and daily items, it is enabling new forms of communication. We are using IPv6 for IoTs enable design of RAM as shown in Fig. 1 and Fig. 3. IPv6 address is 128 bits long. So, we can assign 100 addresses to every atom on the surface of the earth. Therefore, we have plenty of IPv6 address, which we can assign for every RAM<sup>[2]</sup> and make it internet of things (IoTs) enable RAM.

SSTL for 1.8V (SSTL\_18) - SSTL (Stub Series

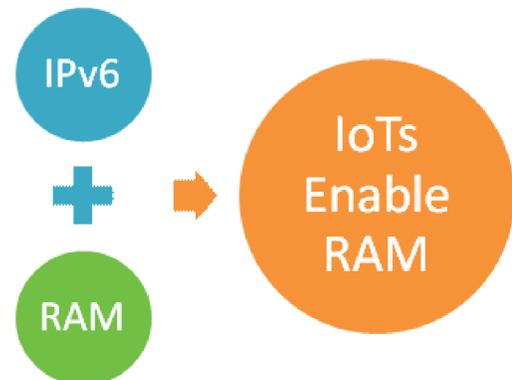


Figure 1. Internet of things enable RAM.

Terminated Logic) is an electrical interface commonly used with DDR (Double Data Rate) DRAM memory ICs and memory modules. This standard defines the

input, output specifications and ac test conditions for devices that are designed to operate in the SSTL\_18 logic switching range, nominally 0 V to 1.8 V. The standard maybe applied to ICs operating with separate VDD and VDDQ supply voltages. Prime focus of this standard is to improve operation of RAM in such

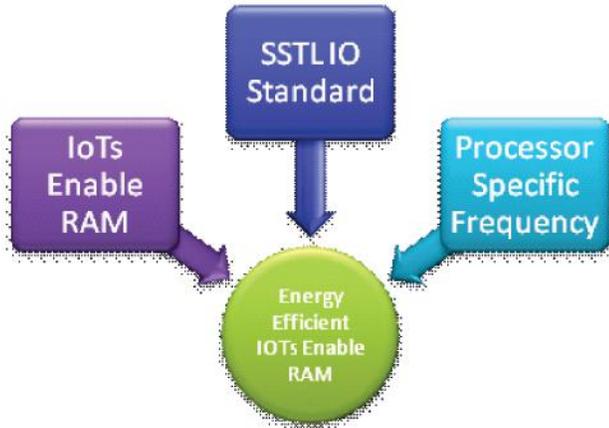


Figure 2. Components of energy efficient IoTs enable RAM.

situations where buses must be relatively isolated from large stubs.. We have enabled a RAM with IP address (IPV6) and tested different I/O standards (SSTL\_2, SSTL\_18) with different frequencies on it.

We are operating our IOTs Enable RAM with different operating frequency of I3, I5, I7, Moto-E and Moto-X. And, we are analyzing energy efficiency in respect of different SSTL IO standard used in IoTs Enable RAM. SSTL standard is defined in four clauses: The first clause defines pertinent supply voltage requirements common to all compliant ICs. The second clause defines the minimum dc and ac input parametric requirements and ac test conditions for inputs on compliant devices. The third clause specifies the minimum required output characteristics of, and ac test conditions for, compliant outputs targeted for various application environments. The fourth clause specifies requirements for differential signaling isolated from relatively large stubs. SSTL for 2.5V(SSTL\_2) - This standard defines the input, output specifications and ac test conditions for devices

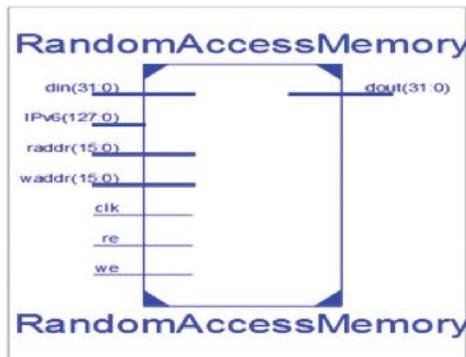


Figure 3. IoTs enable RAM.

that operates in the SSTL\_2 logic switching range, nominally 0 V to 2.5 V. Earlier, SSTL was used to design energy efficient parallel integrator [3], ROM [4] and Image ALU[5].

Table 1. Operating frequency of different processor

Processor	Frequency (GHz)
I3	2.5
I5	3.6
I7	3.0
Moto-E	1.2
Moto-X	1.7

Table 2. Power dissipation by different I/O standards at 1.2GHz

	Clocks	Signals	IOs	BRAMs	Leakage	Total
SSTL2_I	0.058	0.063	1	2.927	0.815	4.863
SSTL2_II	0.058	0.063	1.071	2.927	0.817	4.936
SSTL2_II_						
DCI	0.057	0.063	4.16	2.927	0.922	8.58
SSTL18_I	0.058	0.063	0.946	2.927	0.813	4.807
SSTL18_II	0.058	0.063	1.003	2.927	0.814	4.866

2. THERMAL AND POWER ANALYSIS

We design an IOT enable RAM with an IP version 6 addresses (IPV6). Then we took out power readings using different processor frequencies namely (I3, I5, I7, and Motorola) as shown in Table 1.

On 1.2GHz operating frequency, there is 78.1 percent reduction in I/O when we use SSTL2\_I instead of SSTL\_II\_DCI and 77.26percent reduction in I/O power when we use SSTL18\_I instead of SSTL\_II\_DCI as shown in Table 2.

Variation in IO Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, and leakage power dissipation as shown in Table 2.

On 1.7 GHz operating frequency, there is 78.14 percent reduction in I/O when we use SSTL2\_I instead of SSTL\_II\_DCI and 79.23 percent reduction in I/O power when we use SSTL18\_I instead of SSTL\_II\_DCI as shown in Table 3.

Variation in IO Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 11.93 percent reduction in leakage power dissipation as shown in Table 3.

On 2.5 GHz operating frequency, there is 77.88 percent reduction in I/O when we use SSTL2\_I instead of SSTL\_II\_DCI and 79.07 percent reduction in I/O power when we use SSTL18\_I instead of SSTL\_II\_DCI as shown in Table 4.

Variation in IO Standard do not play significant

**Table 3. Power dissipation by different I/O standards at 1.7GHz**

	Clocks	Signals	IOs	BRAMs	Leakage	Total
SSTL2_I	0.083	0.087	1.01	4.147	0.851	6.179
SSTL2_II	0.083	0.087	1.08	4.147	0.853	6.251
SSTL2_II_						
DCI	0.08	0.093	4.619	4.147	0.964	9.904
SSTL18_I	0.083	0.087	0.955	4.147	0.849	6.122
SSTL18_II	0.083	0.087	1.013	4.147	0.85	6.181

role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 11.47 percent reduction in leakage power dissipation as shown in Table 4.

**Table 4. Power dissipation by different I/O standards at 2.5GHz**

	Clock	Signal	IOs	BRAMs	Leakage	Total
SSTL2_I	0.123	0.133	1.025	6.098	0.913	8.293
SSTL2_II	0.2123	0.133	1.095	6.098	0.915	8.365
SSTL2_II_						
DCI	0.122	0.133	4.634	6.098	1.029	12.017
SSTL18_I	0.123	0.133	0.97	6.098	0.911	8.236
SSTL18_II	0.123	0.133	1.028	6.098	0.913	8.295

On 3 GHz operating frequency, there is 77.73 percent reduction in I/O when we use SSTL2\_I instead of SSTL\_II\_DCI and 78.9 percent reduction in I/O power when we use SSTL18\_I instead of SSTL\_II\_DCI as shown in Table 5.

Variation in IO Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 7.48 percent reduction in leakage power dissipation as shown in Table 5.

**Table 5. Power dissipation by different I/O standards at 3GHz**

	Clocks	Signals	IOs	BRAMs	Leakage	Total
SSTL2_I	0.147	0.159	1.034	7.318	0.955	9.614
SSTL2_II	0.147	0.159	1.105	7.318	0.957	9.687
SSTL2_II_						
DCI	0.146	0.16	4.644	7.318	1.029	13.29
SSTL18_I	0.147	0.159	0.98	7.318	0.952	9.557
SSTL18_II	0.147	0.159	1.037	7.318	0.954	9.617

**Table 6. Power dissipation by different I/O standards at 3.6 GHz.**

	Clocks	Signals	IOs	BRAMs	Leakage	Total
SSTL2_I	0.177	0.191	1.045	8.782	1.007	11.203
SSTL2_II	0.177	0.191	1.116	8.782	1.01	11.276
SSTL2_						
II_DCI	0.176	0.192	4.655	8.782	1.029	14.834
SSTL18_I	0.177	0.191	0.991	8.782	1.005	11.146
SSTL18_						
II	0.177	0.191	1.049	8.782	1.007	11.206

On 3.6 GHz operating frequency, there is 77.55 percent reduction in I/O when we use SSTL2\_I instead of SSTL\_II\_DCI and 78.7 percent reduction in I/O power when we use SSTL18\_I instead of SSTL\_II\_DCI as shown in Table 6.

Variation in IO Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 7.48 percent reduction in leakage power dissipation as shown in Table 6.

### 3. CONCLUSION

We observed that when we use SSTL2\_I instead of SSTL\_II\_DCI there is a significant reduction of 77.73percent in I/O power on an operating frequency of 3GHz and a small reduction of 7.48percent in leakage power as well. We also observed that when we use SSTL\_18\_I instead of SSTL\_II\_DCI there is a reduction of 78.95percent in I/O power. So we can conclude that SSTL\_II\_DCI I/O standard is least efficient and SSTL\_18\_I I/O standard is most efficient to design an energy efficient Internet of Things enabled RAM on FPGA.

### 4. FUTURE SCOPE

Like SSTL\_2 and SSTL\_18 I/O standard we can use HSTL,GTL,P,PCIX,PCI33,PCI66 and many more I/O standards for making an energy efficient RAM. We can use FPGA Vertex 4 ,Vertex 5 instead of vertex 6 as well. We can test these I/O standards on different frequencies .So there are many I/O standards and FPGA's by which we can design an energy efficient Internet of Things enabled RAM.

### निष्कर्ष

हमने पाया है कि जब हम एसएसटीएल\_II\_डीसीआई के स्थान पर एसएसटीएल2\_I का उपयोग करते हैं तो 3 गीगाहर्ट्ज का एक कार्यित आवृत्ति पर निवेश-निर्गम ऊर्जा में 77-73percent की एक महत्वपूर्ण कमी होती है और रिसाव खपत में 7-48percent की एक छोटी सी कमी होती है। हम यह भी पाते हैं जब हम एसएसटीएल\_II\_डीसीआई के स्थान पर एसएसटीएल\_18\_I का उपयोग करते हैं तो निवेश-निर्गम में 78.95 percent की ऊर्जा खपत की कमी पाते हैं। इस प्रकार हम इस निष्कर्ष पर पहुँचते हैं एसएसटीएल\_II\_डीसीआई निवेश-निर्गम मानक कम कुशल हैं और एसएसटीएल\_18\_I निवेश-निर्गम मानक ऊर्जादक्ष इंटरनेट आफ थिंग्स सक्षम रैम डिजाइन में सबसे अधिक कुशल हैं।

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## हाई स्पीड ट्रांसीवर तर्क आधारित सामान के अन्तरजाल पर 40 एनएम एफपीजीए पर ऊर्जा कुशल रैम डिजाइन सक्षमता

### High Speed Transceiver Logic-Based Internet of Things Enable Energy Efficient RAM Design on 40 nm FPGA

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#### सारांश

इस कार्य में, हम ऊर्जा कुशल सामान के अन्तरजाल (आईओटी) योग्य रैम बना रहे हैं। इसे ऊर्जा कुशल बनाने के लिए, हम हाई स्पीड ट्रांसीवर तर्क (एचएसटीएल) आईओ मानक का उपयोग कर रहे हैं। हम एचएसटीएल आईओ मानक वर्ग के 5 विभिन्न सदस्यों के प्रयोग कर रहे हैं और उनमें से सबसे अधिक ऊर्जा कुशल को खोज रहे हैं। हम सामान के अन्तरजाल सक्षम रैम बनाने के लिए हम 128-बिट आईपी एड्रेस अन्तर्निदिष्ट कर रहे हैं। अंततः हम अपने आईओटी आधारित रैम को आई3, आई5, आई7, मोटो-ई और मोटो-एक्स जैसी विभिन्न ऑपरेटिंग आवृत्तियों पर संचालन कर रहे हैं। हमने यह पाया कि 1.7 गीगा हर्ट्ज ऑपरेटिंग आवृत्ति पर आई/ओ में 8.38 प्रतिशत की कमी हुई जब हमने एचएसटीएल\_आई\_18 की बजाए एचएसटीएल\_III का प्रयोग किया और आई/ओ में 7.64 प्रतिशत की कमी हुई जब हमने एचएसटीएल\_आई\_18 की बजाए एचएसटीएल\_III-18 का प्रयोग किया। इसमें ऊर्जा रिसाव में भी थोड़ी कमी है।

#### ABSTRACT

In this work, we are making energy efficient internet of things (IoT) enable RAM. In order to make it energy efficient, we are using high speed transceiver logic (HSTL) I/O standards. We are using 5 different members of HSTL I/O standards family and searching the most energy efficient among these. We are inserting 128-bit IP address in RAM to make internet of things enable RAM. Finally, we are operating our IOTs Enable RAM with different operating frequencies of I3, I5, I7, Moto-E and Moto-X. we find that on 1.7GHz operating frequency, there is 8.38 per cent reduction in I/O when we use HSTL\_III instead of HSTL\_I\_18 and 7.64 per cent reduction in I/O power when we use HSTL\_III\_18 instead of HSTL\_I\_18. There is a small reduction in leakage power as well.

**Keywords:** RAM, internet of things, FPGA, HSTL, thermal aware design, energy efficient design

## 1. INTRODUCTION

High Speed Transceiver Logic (HSTL) standard defines the input and output specifications and test conditions for devices that are designed to operate in the HSTL switching logic range nominally 0V to 1.5V, and signals either single-ended or differential ended. HSTL I/O standards are designed for operation beyond 180 MHz<sup>4</sup>. The output specifications of HSTL are divided into 4 different classes (Class I through Class IV) depending upon output drive voltage (VCCO) as shown in Fig.1.

The Internet of Things (IoT) refers to network of physical objects<sup>1</sup>, where, each object has a characteristic feature of an IP address for internet connectivity. Finally, communication takes place between these objects and other Internet-enabled devices. To enable these new

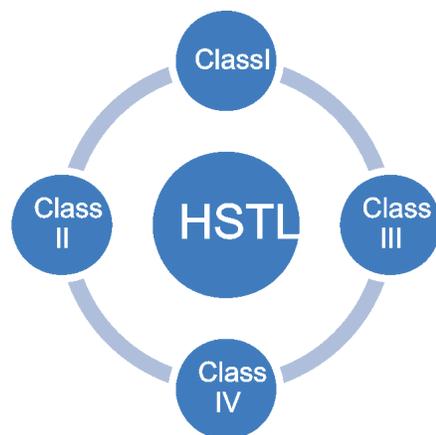


Figure 1. Different HSTL I/O standards.

forms of communication, we require transceivers and IPv6 Address. We are using IPv6 in RAM for IoTs enable design of RAM as shown in Figures 2 and 4. IPv6 address is 128 bits long. So, we can assign 100 addresses to every atom on the surface of the earth. Therefore, we have plenty of IPv6 address, which we can assign for every RAM<sup>2</sup> and make it internet of things (IoT)s-enable RAM.

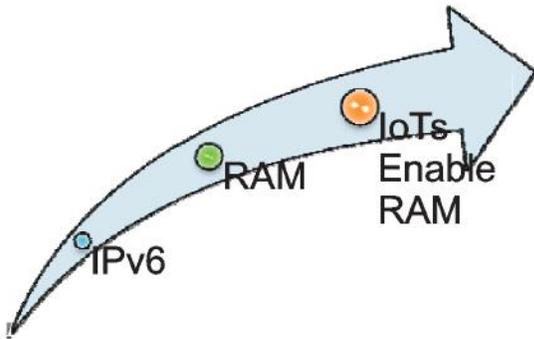


Figure 2. Internet of things enable RAM.

We have embedded an IP address (IPV6) in RAM and test that RAM using I/O standard (HSTL). And, finally we operate our IoTs-enable design with different frequencies. We are operating our IoTs-enable RAM with different operating frequencies of I3, I5, I7, Moto-E and Moto-X. And, we are analyzing energy efficiency in respect of different HSTL I/O standard used in IoTs-enable RAM as shown in Fig.3. Frame Buffer is a memory that is used to store frame of image for multimedia specific application. In this work, we are not designing application specific memory, but we are going to design general purpose RAM with 128-bit IP address embedded in it. HSLVDCI is used to design energy efficient design of frame buffer<sup>5</sup>. In this work, we are extending our work from HSLVDCI to HSTL. Dabbas, S.<sup>6</sup> HSTL was used to design energy efficient memory design. We are extending that work of general memory into IoTs-enable memory. Kumar, T.<sup>7</sup> HSTL was used to design energy efficient frame buffer.



Figure 3. Components of energy efficient IoTs-enable RAM.

As shown in Fig. 4, RAM has 32-bit data input along with 16-bit write address and 16-bit read address. In case of read operation, the data stored in RAM at particular location defined by read address will go

to data output port. In case of write operation, the data received at input port will be stored in RAM at particular location defined by write address.

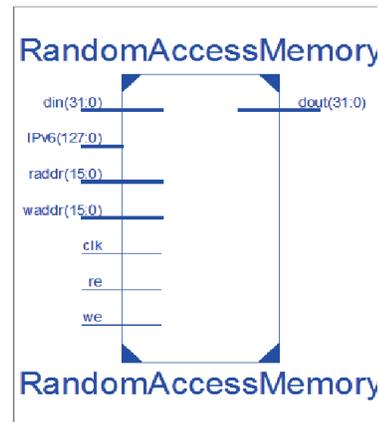


Figure 4. IoTs-enable RAM.

## 2. THERMAL AND POWER ANALYSES

We design an IOT-enable RAM with an IP version 6 addresses (IPV6). Then we took out power readings using different processor frequencies namely (I3, I5, I7, and Motorola), as shown in Table 1.

Table 1. Operating frequency of different processor

Processor	Frequency (GHz)
I3	2.5
I5	3.6
I7	3.0
Moto-E	1.2
Moto-X	1.7

On 1.2GHz operating frequency, there is 8.4 per cent reduction in I/O when we use HSTL\_III instead of HSTL\_I\_18 and 7.7 per cent reduction in I/O power when we use HSTL\_III\_18 instead of HSTL\_I\_18, as shown in Fig. 4 and Table 2.

Variation in I/O Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, and leakage power dissipation as shown in Fig. 5 and Table 2.

Table 2. Power dissipation by different I/O standards at 1.2GHz

	Clocks	Signals	I/Os	BRAMs	Leakage	Total
HSTL_I	0.058	0.063	0.933	2.927	0.812	4.793
HSTL_III	0.058	0.063	0.854	2.927	0.81	4.712
HSTL_I-18	0.058	0.063	0.933	2.927	0.812	4.793
HSTL_I_12	0.058	0.063	0.895	2.927	0.811	4.753
HSTL_III_18	0.058	0.063	0.861	2.927	0.81	4.719

On 1.7GHz operating frequency, there is 8.38 per cent reduction in I/O when we use HSTL\_III instead of HSTL\_I\_18 and 7.64 per cent reduction in I/O power when we use HSTL\_III\_18, instead of HSTL\_I\_18 as shown in Fig. 6 and Table 3.

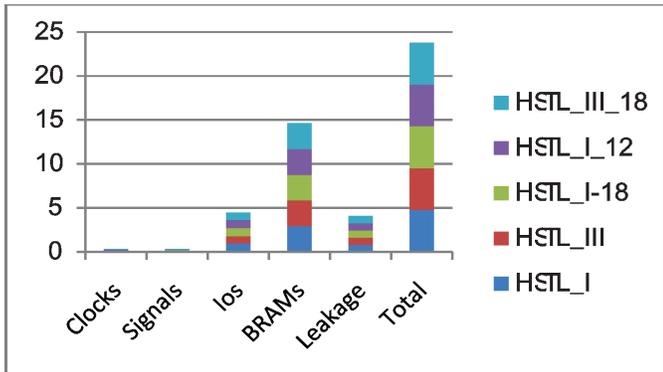


Figure 5. Power dissipation in IoTs-enabled RAM on 1.2GHz.

Table 3. Power dissipation by different I/O standards at 1.7GHz.

	Clocks	Signals	Ios	BRAMs	Leakage	Total
HSTL_I	0.083	0.087	0.942	4.147	0.848	6.109
HSTL_III	0.083	0.087	0.863	4.147	0.846	6.027
HSTL_I-18	0.083	0.087	0.942	4.147	0.848	6.109
HSTL_I_12	0.083	0.087	0.904	4.147	0.847	6.069
HSTL_III_18	0.083	0.087	0.87	4.147	0.846	6.034

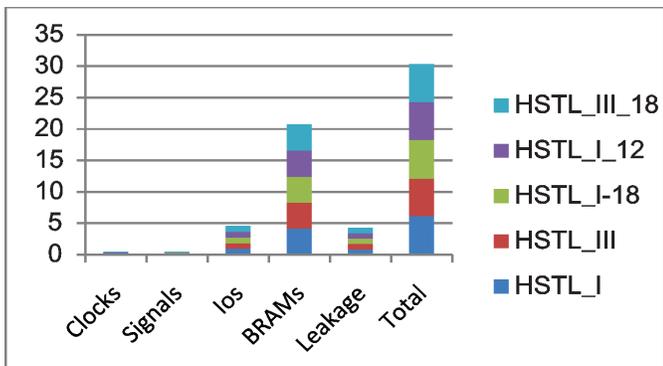


Figure 6. Power dissipation in IoTs-enabled RAM on 1.7GHz.

Variation in I/O standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 0.23 per cent reduction in leakage power dissipation as shown in Fig. 5 and Table 3.

On 2.5 GHz operating frequency, there is 8.35per cent reduction in I/O when we use HSTL\_III instead of HSTL\_I\_18 and 7.6 per cent reduction in I/O power when we use HSTL\_III\_18 instead of HSTL\_I\_18, as shown in Fig. 7 and Table 4.

Variation in I/O Standards do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 0.21 per cent reduction in leakage power dissipation as shown in Fig. 6 and Table 4.

On 3.0 GHz operating frequency, there is 8.16 per cent reduction in I/O when we use HSTL\_III instead of HSTL\_I\_18 and 7.44 % reduction in I/O power when we use HSTL\_III\_18 instead of HSTL\_I\_18, as shown in Fig. 8 and Table 5.

Table 4. Power dissipation by different I/O standards at 2.5GHz

	Clocks	Signals	Ios	BRAMs	Leakage	Total
HSTL_I	0.123	0.133	0.958	6.098	0.91	8.222
HSTLc_III	0.123	0.133	0.878	6.098	0.908	8.14
HSTL_I-18	0.123	0.133	0.958	6.098	0.91	8.222
HSTL_I_12	0.123	0.133	0.919	6.098	0.909	8.182
HSTL_III_18	0.123	0.133	0.885	6.098	0.908	8.148

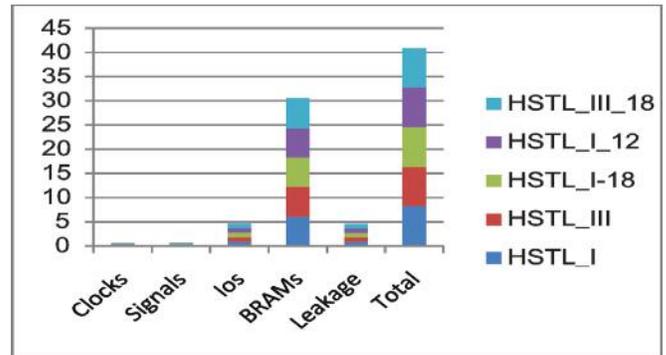


Figure 6. Power dissipation in IoTs-enabled RAM on 2.5GHz.

Variation in I/O Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 0.31 per cent reduction in leakage power dissipation as shown in Fig.7 and Table 5.

On 3.6 GHz operating frequency, there is 8.07 per cent reduction in I/O when we use HSTL\_III instead of HSTL\_I\_18 and 7.36 per cent reduction in I/O power when we use HSTL\_III\_18 instead of HSTL\_I\_18 as shown in Fig. 9 and Table 6.

Variation in I/O Standard do not play significant role in change in clock power dissipation, signals power dissipation, BRAM power dissipation, but there is 0.199 per cent reduction in leakage power dissipation as shown in Fig. 8 and Table 6.

Table 5. Power dissipation by different I/O standards at 3GHz

	Clocks	Signals	Ios	BRAMs	Leakage	Total
HSTL_I	0.147	0.159	0.967	7.318	0.951	9.544
HSTL_III	0.147	0.159	0.888	7.318	0.949	9.462
HSTL_I-18	0.147	0.159	0.967	7.318	0.952	9.544
HSTL_I_12	0.147	0.159	0.929	7.318	0.95	9.504
HSTL_III_18	0.147	0.159	0.895	7.318	0.949	9.469

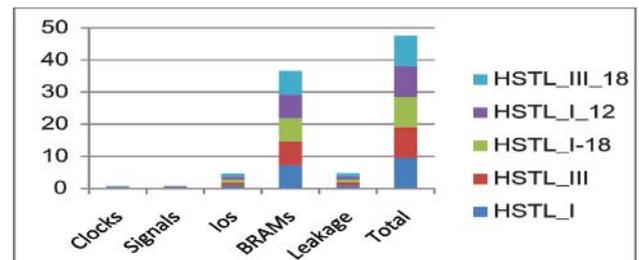
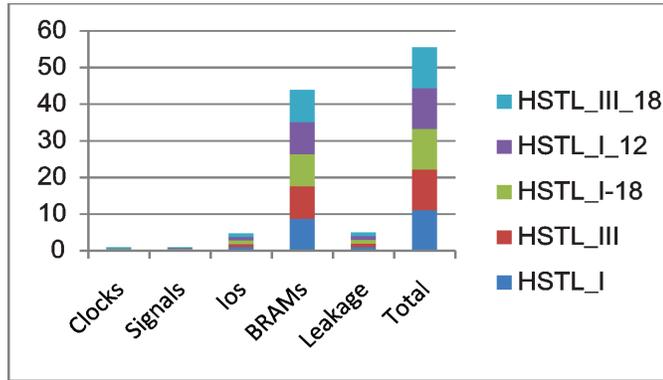


Figure 8. Power dissipation in IoTs-enabled RAM on 3 GHz.

**Table 6. Power dissipation by different I/O standards at 3.6 GHz**

	Clocks	Signals	Ios	BRAMs	Leakage	Total
HSTL_I	0.177	0.191	0.978	8.782	1.004	11.133
HSTL_III	0.177	0.191	0.899	8.782	1.001	11.051
HSTL_I-18	0.177	0.191	0.978	8.782	1.004	11.133
HSTL_I_12	0.177	0.191	0.94	8.782	1.002	11.093
HSTL_III_18	0.177	0.191	0.906	8.782	1.002	11.058

**Figure 9. Power dissipation in IoTs-enabled RAM on 3.6 GHz.**

### 3. CONCLUSION

We observed that when we use HSTL\_III instead of HSTL\_I\_18, there is a significant reduction of 8.07 per cent in I/O power on an operating frequency of 3.6 GHz and a very small reduction of 0.199 per cent in leakage power as well. We also observed that when we use HSTL\_III\_18 instead of HSTL\_I\_18, there is a reduction of 7.36 per cent in I/O power. So we can conclude that HSTL\_I\_18, I/O standard is least efficient and HSTL\_III I/O standard is most efficient to design an energy efficient Internet of Things enabled RAM on FPGA.

### निष्कर्ष

हमने यह देखा कि जब हम एचएसटीएल\_I\_18 की बजाए एचएसटीएल\_III का उपयोग करते हैं तब 3.6 गीगा हर्ट्ज ऑपरेटिंग आवृत्ति पर आई/ओ में 8.07 प्रतिशत की कमी हुई और ऊर्जा रिसाव में 0.199 प्रतिशत भी थोड़ी कमी हुई। हमने यह भी देखा कि जब हम एचएसटीएल\_I\_18 की बजाए एचएसटीएल\_III\_18 का उपयोग करते हैं तब आई/ओ में 7.36 प्रतिशत की कमी हुई। इसलिए हम निष्कर्ष निकाल सकते हैं कि एफपीजीए पर ऊर्जा कुशल सामान के अन्तरजाल सक्षम रैम डिजाइन के लिए एचएसटीएल\_I\_18 आई/ओ मानक कम कुशल और एचएसटीएल\_III आई/ओ मानक अधिक कुशल है।

### 4. FUTURE SCOPE

Like HSTL I/O standard we can use SSTL, GTLP, GTL, PCIX, PCI33, PCI66 and many more I/O standards for making an energy efficient RAM. We can also use FPGA Virtex-4, Virtex-5, Virtex-7 and Ultrascale Virtex instead of Virtex-6 as well. We can test these I/O standards on different frequencies. So there are many I/O standards and FPGA's by which we can design energy efficient Internet of Things enabled RAM.

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## 28 एनएम एफपीजीए पर संकलना व्याकलनाभयाम द्वारा रूट्स को खोजने के लिए एलवीसीएमओएस आधारित ऊर्जा सक्षम डिजाइन LVCMOS-based Energy Efficient Design for Finding Roots Using Sankalana Vyavakalanabhyam on 28nm FPGA

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### सारांश

इस लेख में, हमने वैदिक गणित के सूत्र जो संकलना व्याकलनाभयाम में है, का उपयोग कर रूट्स को खोजने के लिए एक ऊर्जा सक्षम डिजाइन तैयार किया। संकलना व्याकलनाभयाम एक संस्कृत शब्द है जिसका अर्थ "जोड़ के द्वारा और व्यवकलन के द्वारा" है। यह वैदिक सूत्र समकालिक समीकरण को हल करने के लिए प्रयोग किया जाता है जहाँ चर  $x$  और  $y$  दोनों के गुणांकों दोनों समीकरणों में विनिमय करने योग्य पाए जाते हैं। इस आलेख से हमारा मुख्य उद्देश्य एक ऊर्जा सक्षम कम शक्ति की डिजाइन का निर्माण करना है इसके लिए हमने विभिन्न आवृत्तियों को लिया है और शक्ति की गणना की। हमने शक्ति का विश्लेषण स्थिर तापमान पर किया जो कि 25 डिग्री सेल्सियस है और हवा के प्रवाह को भी स्थिर रखा। हमने विभिन्न एलवीसीएमओएस आईओ मानकों के लिए आवृत्ति को बदला और शक्ति की गणना की। हमारा डिजाइन 28एनएम एफपीजीए पर आधारित है और कोड किंटेक्स-7 पर परीक्षण किया गया है और प्रयुक्त उपकरण एक्ससी 7के160 टी, प्रयुक्त पैकेज एफबीजी 676 है और यह -3 गति ग्रेड पर काम कर रहा है। अंत में हमने यह निष्कर्ष निकाला कि एलवीसीएमओएस33 की तुलना में जब 1400 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 6.08 प्रतिशत बचता है, 1.2 गीगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 4.08 प्रतिशत बचता है, 2100 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 8.44 प्रतिशत बचता है, 1700 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 6.87 प्रतिशत बचता है, 1800 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 7.29 प्रतिशत बचता है, 2.2 गीगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 8.75 प्रतिशत बचता है।

### ABSTRACT

In this paper we have designed an energy efficient design for finding roots using Vedic mathematics, the sutra involved in Sankalana Vyavakalanabhyam. Sankalana Vyavakalanabhyam is a Sanskrit word meaning 'by addition and by subtraction'. This Vedic sutra is used to solve simultaneous equations where the coefficients of both the variables  $x$  and  $y$  are found interchangeable in both the equations. Aim of this paper is to build an energy-efficient, low-power design for this we have taken different frequencies and calculated their power. We have done power analysis on a constant temperature, that is 25 degree Celsius and also kept air flow constant. We have varied frequency and calculated power for different LVCMOS Io Standards. Our design is based on 28nm FPGA and the code has been tested on Kintex-7 and the device used is XC7K160T, package used is FBG676 and it is working on -3 speed grade. At the end we have concluded that there is 6.08 % saving in total power dissipation when using LVCMOS15 at 1400MHz, 4.80 % saving in total power dissipation when using LVCMOS15 at 1.2GHz, 8.44 % saving in total power dissipation when using LVCMOS15 at 2100 MHz, 6.87 % saving in total power dissipation when using LVCMOS15 at 1700 MHz, 7.29% saving in total power dissipation when using LVCMOS15 at 1800MHz, 8.75 % saving in total power dissipation when using LVCMOS15 at 2.2GHz when compared with LVCMOS33..

**Keywords:** Sankalana vyavakalanabhyam, vedic mathematics, FPGA, energy efficient, root finder

### 1. INTRODUCTION

Vedic mathematics is a name given to ancient mathematics from ancient Indian sculptures in early 20<sup>th</sup> century<sup>1</sup>. Vedic mathematics is part of four Vedas

(books of wisdom)<sup>2</sup>. Vedic mathematics deals with various Vedic mathematical formulae and their applications to carry out tedious and cumbersome arithmetic operations<sup>3</sup>. Vedic mathematics formulae or algorithms were designed

in order to minimize the complexity of any question or any trigonometric problem, calculus (integral and differential) and this ancient mathematics is very helpful in various fields like DSP (Digital Signal Processing), Chip Designing, Discrete Fourier Transform (DFT), High Speed Low Power VLSI Arithmetic and Algorithms. Nowadays, research work is being carried out on Vedic mathematics as it takes lesser time and steps to perform a specified task. For low power and high speed application, a multiplier and square architecture has been proposed based on algorithm of ancient Indian Vedic Mathematics<sup>1</sup>. Itawadiya<sup>4</sup>, *et al.* explained DSP operations based on ancient Vedic mathematics using Vedic Urdhva-Triyagbhayam multiplication sutra. A design of 8-bits fixed-point, asynchronous Vedic DSP processor core has also been studied<sup>5</sup>. Implementation of 4x4 multiplier using Urdhva-Tiryakbhayam in 45nm technology<sup>6</sup>, another division architecture using a different Vedic technique known as 'Dhwajam'<sup>7</sup>. In our paper, we have used Sankalana Vyavakalanabhyam Vedic sutra to find the roots. Sankalana Vyavakalanabhyam is a Sanskrit word which means 'by addition and by subtraction'. This Vedic sutra is used to solve simultaneous equations where the coefficients of both the variables *x* and *y* are found interchangeable in both the equations. For example: The coefficients of the variables in 1<sup>st</sup> equation are the same as the coefficients of opposite variable for the 2<sup>nd</sup> equation as shown below:

$$45x - 23y = 113 \tag{1}$$

$$23x - 45y = 9 \tag{2}$$

This equation can be solved used Vedic mathematics sutra Sankalana Vyavakalanabhyam. This technique involves addition and subtraction as shown below:

*Step 1:* Addition of 2 equations:  
 $(45x - 23y) + (23x - 45y) = 113 + 91$   
 $68x - 68y = 204$   
 $x - y = 3 \tag{3}$

*Step 2:* Subtraction of 2 equations:  
 $(45x - 23y) - (23x - 45y) = 113 - 91$   
 $22x + 22y = 22$   
 $x + y = 1 \tag{4}$

*Step 3:* After solving (3) and (4):  
 We get  $x = 2$  and  $y = -1$

These three steps are converted in a Xilinx code and a symbol can be generated from this code using Xilinx ISE Design Suite 14.2 and results are tested on 28nm FPGA platform that is Kintex-7.

Figure 1 shows the symbol of Sankalana Vyavakalanabhyam. From this figure we can observe that there are 7 inputs and 2 outputs. Out of the seven inputs C1, C2, C3, C4, R1, R2 are 4-bit inputs and clock is an input pulse to trigger the device or circuit. C1, C3 are the coefficients of variable *x* and C2, C4

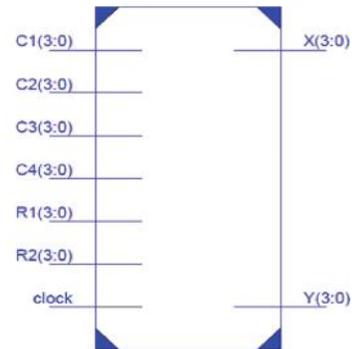
are the coefficients of variable *y*. R1 and R2 are the constants in the equation. From equations (1) and (2), we can design Table 1. Fig. 2 shows the schematic of the root finder using Sankalana Vyavakalanabhyam.

**Table1. Values of coefficients from (1) and (2)a.**

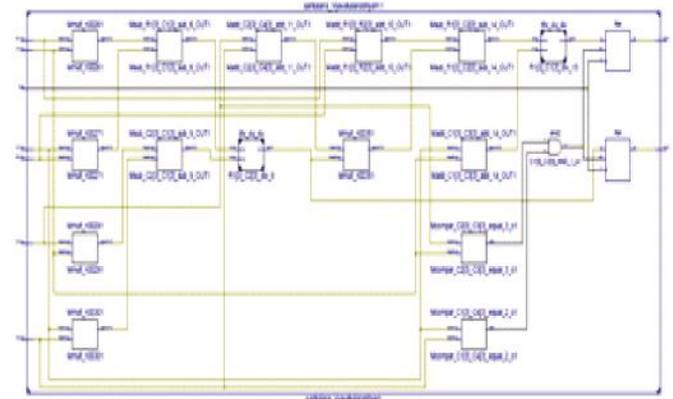
C1	C2	C3	C4	R1	R2
45	23	23	45	113	91

Aim of this paper is to build an energy-efficient low power design. For this we have taken different frequencies and calculated their power. Set of frequencies are mentioned in Table 3. In this research work, we have done power analysis on a constant temperature, that is 25 degree Celsius. We have varied frequency and calculated power for different LVC MOS IO STANDARDS. We have considered LVC MOS18, LVC MOS33, LVC MOS25, and LVC MOS15 in our research work and worked upon it.

**Sankalana\_Vyavakalanabhyam**



**Table 1. Operating Frequency of Different Processor**



**Figure 2. Schematic of Sankalana Vyavakalanabhyam.**

The design is based on 28nm FPGA and the code has been tested on Kintex-7 and the device used is XC7K160T, package used is FBG676 and it is working on -3 speed grade. Table 2 shows different parameters in kintex-7 FPGA.

**Table 2. Different parameters in kintex-7 FPGA**

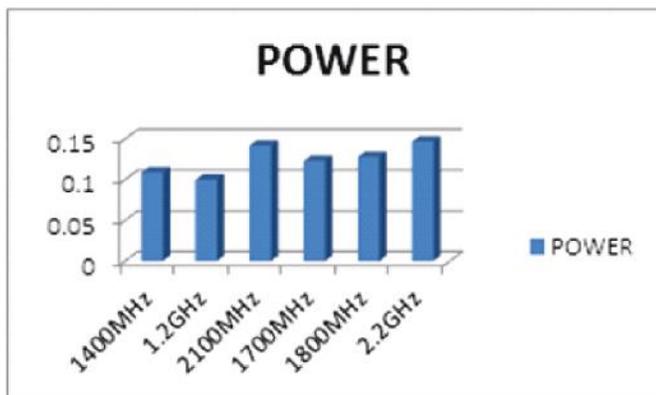
IO pins	676
LUT Elements	101400
Flip Flop	202800
DSPS	600
Available IOBS	400
Gb transceiver	8
Block RAM	325
GTXE2 Transceiver	8
PCI Buses	1.1
MMCMS	8
Min operating temperature	0 degree Celsius
Reference operating temperature	85 degree Celsius
Maximum operating Temperature	85 degree Celsius
Minimum operating voltage	0.97V
Reference operating Voltage	0.97V
Maximum operating Voltage	1.03V
Temperature Grade Letter	C

**Table 3. Set of frequencies considered**

Frequency	Mobile set
1400MHz	Nokia Lumia 710
1.2GHz	Samsung Galaxy Core
2100MHz	I phone6
1700MHz	HTC/T
1800MHz	Micromax X091
2.2GHz	Sony Xperia Z1

**Table 4. Power analysis for LVC MOS18 Io standard**

Frequency	Power
1400MHz	0.109
1.2GHz	0.100
2100MHz	0.142
1700MHz	0.123
1800MHz	0.128
2.2GHz	0.147



**Figure 3. Power analysis for LVC MOS18 Io standard.**

## 2. POWER ANALYSIS

### 2.1 Power Analysis for LVC MOS18 Io Standard

There is 31.97 % saving in total power dissipation with 2.2 GHz when compared with 1.2GHz, as shown in Fig. 3 and Table 4.

### 2.2 Power Analysis for LVC MOS33 Io Standard

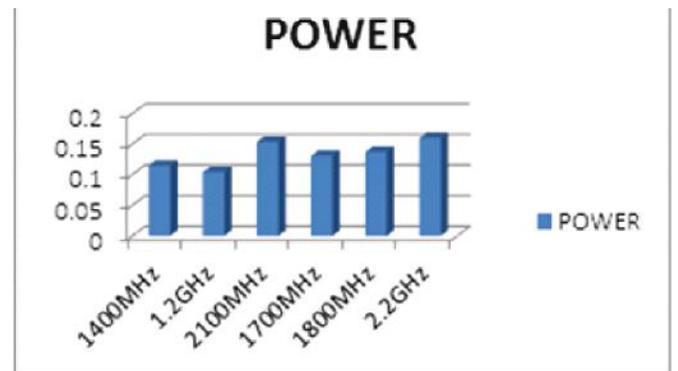
There is 35 % saving in total power dissipation with 2.2 GHz when compared with 1.2GHz, as shown in Fig. 4 and Table 5.

### 2.3 Power Analysis for LVC MOS25 Io Standard

There is 32.89 % saving in total power dissipation with 2.2 GHz when compared with 1.2GHz, as shown in Fig. 5 and Table 6.

**Table 5. Power analysis for LVC MOS33 Io standard**

Frequency	Power
1400MHz	0.115
1.2GHz	0.104
2100MHz	0.154
1700MHz	0.131
1800MHz	0.137
2.2GHz	0.160



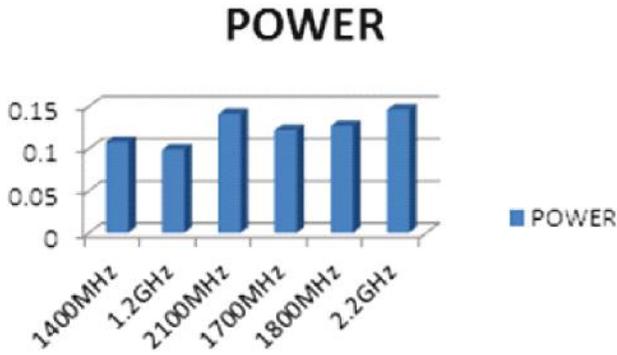
**Figure 4. Power analysis for LVC MOS25 Io standard.**

**Table 6. Power analysis for LVC MOS25 Io standard**

Frequency	Power
1400MHz	0.111
1.2GHz	0.102
2100MHz	0.147
1700MHz	0.126
1800MHz	0.132
2.2GHz	0.152

**Table 7. Power analysis for LVC MOS15 Io standard**

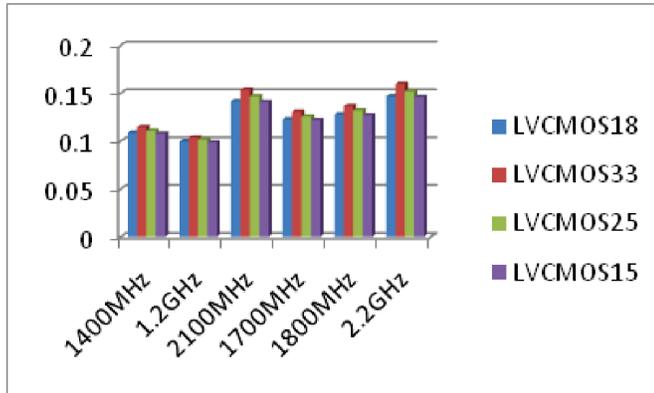
Frequency	Power
1400MHz	0.108
1.2GHz	0.099
2100MHz	0.141
1700MHz	0.122
1800MHz	0.127
2.2GHz	0.146

**Figure 6. Power analysis for LVC MOS15 Io standard.**

#### 2.4 Power Analysis for LVC MOS15 Io Standard

There is 31.19 % saving in total power dissipation with 2.2 GHz, when compared with 1.2GHz as shown in figure 6 and table 7.

#### 2.5 Power Analysis for different Io Standard with Different Frequencies

**Figure 7. Power Analysis for LVC MOS family at different frequencies.****Table 8. Power analysis for LVC MOS family at different frequencies**

	1400MHz	1.2GHz	2100MHz	1700MHz	1800MHz	2.2GHz
LVC MOS18	0.109	0.100	0.142	0.123	0.128	0.147
LVC MOS33	0.115	0.104	0.154	0.131	0.137	0.160
LVC MOS25	0.111	0.102	0.147	0.126	0.132	0.152
LVC MOS15	0.108	0.099	0.141	0.122	0.127	0.146

### 3. CONCLUSIONS

The design is low power energy-efficient and the code has been implemented in Xilinx ISE Design Suite 14.2 and results were tested on 28nm FPGA platform using Kintex-7 FPGA family. The device is designed to find the roots of an equation using the Vedic technique called Sankalana Vyavakalanabhyam. This Vedic root finder consists of 7 inputs and 2 outputs. 1 input is the clock pulse (clock) and other 4 inputs are the coefficients of the variables (C1, C2, C3, C4) and remaining two are the constants (R1, R2) of an equation. Outputs (x, y) are the values of variables present in the equations. The inputs and the outputs all are 4-bit numbers. The design is tested by varying frequency at constant temperature that is 25 degree Celsius and also keeping air flow constant. We can conclude that there is 6.08 % saving in total power dissipation when using LVC MOS15 at 1400MHz, 4.80 % saving in total power dissipation when using LVC MOS15 at 1.2GHz, 8.44 % saving in total power dissipation when using LVC MOS15 at 2100 MHz, 6.87 % saving in total power dissipation when using LVC MOS15 at 1700 MHz, 7.29 % saving in total power dissipation when using LVC MOS15 at 1800MHz, 8.75 % saving in total power dissipation when using LVC MOS15 at 2.2GHz when compared with LVC MOS33.

### निष्कर्ष

डिजाइन कम शक्ति ऊर्जा सक्षम है और कोड जिल्क्स आईएसई डिजाइन सुइट 14.2 में लागू किया गया है और परिणाम किंटेक्स.7 एफपीजीए वर्ग का उपयोग कर 28एनएम एफपीजीए के मंच पर परीक्षण किया गया। यह उपकरण संकलना व्याकलनाभयाम वैदिक तकनीक का उपयोग कर समीकरण के रूट्स को खोजने के लिए बनाया गया है। इस वैदिक रूट खोजक में 7 इनपुट और दो आउटपुट होते हैं। एक इनपुट क्लॉक पल्स (क्लॉक) और अन्य चार इनपुट चर के गुणांक (सी1ए सी2ए सी3ए सी4) और दो पेश समीकरण के अचर (आर1ए आर 2) है। आउटपुट (x, y) समीकरणों में मौजूद चर का मान हैं। इनपुट और आउटपुट सभी 4 बिट संख्या हैं। डिजाइन का परीक्षण विभिन्न आवृत्तियों द्वारा स्थिर तापमान पर किया जो कि 25 डिग्री सेल्सियस है और हवा के प्रवाह को भी स्थिर रखा

गया। हमने यह निष्कर्ष निकाला कि एलवीसीएमओएस33 की तुलना में जब 1400 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 6.08 प्रतिशत बचता है। 1.2 गीगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 4.08 प्रतिशत बचता है। 2100 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 8.44 प्रतिशत बचता है। 1700 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 6.87 प्रतिशत बचता है। 1800 मेगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 7.29 प्रतिशत बचता है। 2.2 गीगा हर्ट्ज पर एलवीसीएमओएस15 का उपयोग करते हैं तो वहाँ कुल शक्ति अपव्यय का 8.75 प्रतिशत बचता है।।

### FUTURE SCOPE

The future scope of “LVCMOS Based Energy-efficient Design for Finding Roots Using Sankalana Vyavakalanabhyam on 28nm FPGA” is that we can also implement this design on 22nm or 18 nm FPGA. We can also use different FPGA families like automotive Artix7, automotive Coolrunner2, automotive Spartan, automotive Spartan-3A DSP, automotive Spartan 3A, automotive Spartan 3E, automotive Spartan6, Spartan3, Spartan3E. Here, we are using frequency scaling in which we are changing the operating frequency of a device and analyzing its power. We can redesign this Vedic root finder with other energy-efficient technique like capacitance scaling, thermal scaling, clock gating, various design goals, impedance matching with different logic family, and mapping. Analysis has been done with different frequencies like 1400 MHz, 1.2 GHz, 2100 MHz, 1700MHz, 1800MHz, 2.2GHz. We can use

any other frequency range and test our design on that also. The temperature has been kept constant that is 25 degree Celsius so if needed it can also be varied. Air flow can also be varied when required.

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## 90 एनएम एफपीजीए पर आईओ स्टैन्डर्ड बेस्ड लो पावर थर्मल अवेयर एडर डिजाइन Low Power Thermal Aware Adder Design on 90 nm FPGA

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### सारांश

हमारा मुख्य विषय एक ऊर्जा दक्ष डिजिटल सर्किट डिजाइन करना है। इस कार्य में, हम 90 एनएम एफपीजीए पर लो पावर थर्मल अवेयर एडर डिजाइन के लिए पीसीआई (पेरिफेरल कम्पोनेन्ट इंटरकनेक्ट), एसएसटीएल (स्टब सीरिज टर्मिनेटेड लॉजिक): एसएसटीएल 18 आई, एसएसटीएल2 आई और एलवीटीटीएल (लो वोल्टेज ट्रांजिस्टर-ट्रांजिस्टर लॉजिक) के मध्य सर्वाधिक उष्मा और ऊर्जा दक्ष आईओ स्टैन्डर्ड खोजने जा रहे हैं। यह पाया गया है कि परिवेश तापमान 343.15 के और 283.15 के हेतु पीसीआई की तुलना में आईओ स्टैन्डर्ड एसएसटीएल2\_आई के लिए आईओ विद्युत क्षय में कमी 15.18% और 26.66% है, परिवेश तापमान 343.15 के और 283.15 के हेतु आईओ स्टैन्डर्ड पीसीआई और एसएसटीएल2\_आई के लिए अधिकतम परिवेश तापमान में कमी 0.59% और 0.60% है और परिवेश तापमान 343.15 के और 283.15 के हेतु आईओ स्टैन्डर्ड पीसीआई, एसएसटीएल2\_आई के लिए जंक्शन तापमान में कमी 82.65%, 84.26% है। इस डिजाइन को भिन्न परिवेश तापमानों पर अन्य आईओ स्टैन्डर्ड पर भी जांचा गया है।

### ABSTRACT

Our aim is to design a power efficient digital circuit. In this work, we are going to search the most thermal and energy efficient IO standard among peripheral component interconnect (PCI), stubs series terminated logic (SSTL):SSTL18\_I, SSTL2\_I and low voltage transistor-transistor logic (LVTTTL) for low power thermal aware adder design on 90nm FPGA. It is observed that there is 15.18 % and 26.66% reduction in IO power dissipation for IO standard SSTL2\_I in comparison with PCI for ambient temperature 343.15 K and 283.15 K, 0.59 %, 0.60 % reduction in maximum ambient temperature for IO standard PCI and SSTL2\_I for ambient temperature 343.15 K and 283.15 K and there is 82.65 %, 84.26% reduction in Junction Temperature for IO standard PCI, SSTL2\_I for ambient temperature 343.15 K and 283.15 K. The design is also tested on other IO standards and at different ambient temperatures.

**Keywords:** IO standard, low power VLSI design, thermal aware, FPGA, ambient temperature

### 1. INTRODUCTION

The Spartan-3E FPGA family provides many dais features and because of its exceptionally low cost, makes it ideal for logically programmable designs and to a broad range of electronics applications. Sparatan-3E is the third family of the Xilinx contrived with very much developed 90 nm process technology and the seventh family in the spearheading low-cost Spartan Series. Spartan-3E FPGAs provide almost 1.6 million system gates, I/Os<sup>1</sup>, and a pliable platform FPGA architecture with the lowest cost per-logic in the manufacturing. This combination of high-tech low-cost built-up and cost-efficient architecture provides unparalleled price points and significance. The Spartan-3E family's capabilities and features are optimized for high-number and economical applications.

In this paper we are going to study the effect of different IO standard in 90 nm Spartan 3E family of FPGA. In this work, we implemented our design using peripheral component interconnect (PCI), SSTL2\_I and

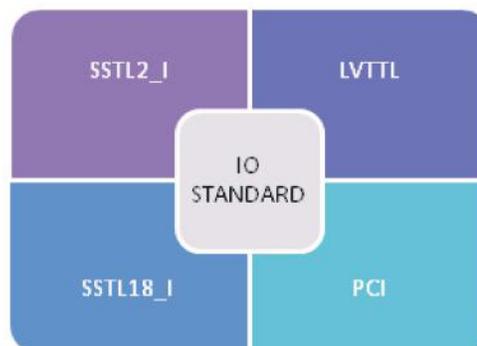


Figure 1. Different IO standards family of Spartan 3E.

SSTL18\_I stub series terminated logic (SSTL), low-voltage transistor-transistor logic (LVTTTL) family of IO standard. We are comparing different IO standard to design a power-efficient digital circuit. Our main objective is to develop an energy-optimised design to save the power and make it more eco-friendly. Full Adder plays a significant role in digital signal processors (DSPs), application-specific ICs (ASICs), Digital processors. Increasing the performance of full adder shows a great impact on increasing the performance of the whole system<sup>2</sup>. Therefore, improvement in its performance is acute for enhancing the overall module efficiency.

$$S = A \oplus B \oplus C_{in}$$

$$C_{out} = (A.B) + (C_{in}.(A \oplus B))$$

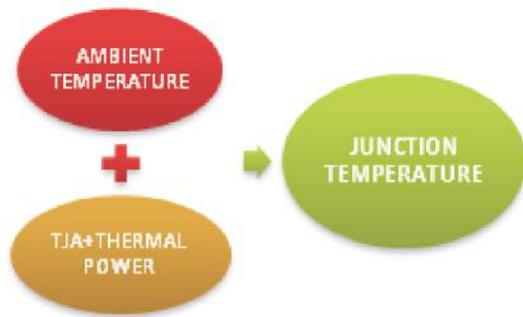


Figure 2. Relation between ambient temperature and junction temperature<sup>4</sup>.

The 1-bit full adder has three 1-bit inputs i.e.  $A$ ,  $B$  and  $C_{in}$  here  $A$  and  $B$  are the two operands and  $C_{in}$  is the carried in bit from the previous less significant level and two 1-bit outputs, i.e., sum and  $C_{out}$ . The relation between the inputs and the outputs is expressed above<sup>3</sup>.

Junction temperature is defined in terms of ambient temperature, thermal power and TJA (TJA is Theta Junction to ambient ( $^{\circ}\text{C}/\text{W}$ ) ) and thermal power is the total power dissipation of design. TJA is measured in terms of TJC (Theta Junction to Case thermal resistance), TCS (Theta Case to hit Sink thermal resistance) and TSA (Theta Sink to ambient thermal resistance)<sup>4</sup>. Junction of working FPGA act sas source and environment act as sink. MAT is an acronym for maximum ambient temperature. The temperature of the atmosphere (Earth's atmosphere) or temperature of the air surrounding a cooler medium or a power supply is called an ambient temperature. During study of existing thermal aware design methodology, we have gone through thermal aware FIR filter design<sup>5</sup>, thermal modelling for temperature aware design<sup>6</sup>, thermal ware ALU<sup>7</sup>, thermal-balanced design in NoC<sup>8</sup>, thermal aware Unicode reader<sup>9</sup>, thermal-aware 3D microprocessor<sup>10</sup>, frame buffer<sup>11</sup> and thermal-aware floor planning at the micro-architectural level<sup>12</sup>.

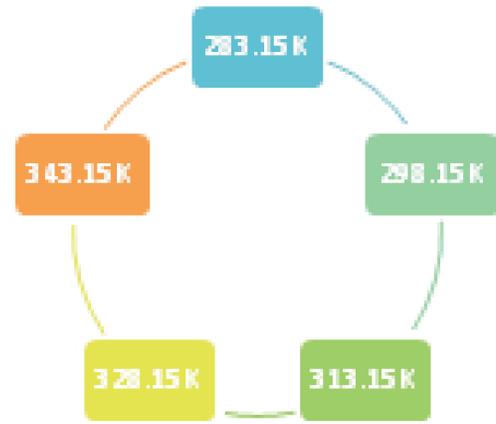


Figure 3. Different ambient temperatures selected for the analysis.

For our analysis, we have chosen four different ambient temperatures 83.15 K, 298.15 K, 313.15 K, 328.15 K, 343.15 K, as shown in Fig. 3. Amount of energy consumed per unit time or equivalently rate of doing work is known as power and power dissipation is loss in rate of energy from the system (here electrical system). Here, power dissipation is in the form of leakage power.

## 2. ANALYSIS OF MAT, JUNCTION TEMPERATURE AND LEAKAGE POWER FOR VARIOUS IO STANDARDS

There is 0.60 % reduction in MAT, 82.6 % reduction in junction temperature, 15.18 % reduction in leakage power when we scale down ambient temperature from 343.15 K to 283.15 K, as shown in Table 1.

There is 0.60 % reduction in MAT, 82.87 % reduction in junction temperature, 16.2 % reduction in leakage power when we scale down ambient temperature from 343.15 K to 283.15 K, as shown in Table 2.

Table 1. MAT, junction temperature and leakage power for SSTL2\_I

	Mat reduction	Junction temp	Leakage power
283.15K	82.3	12.7	0.067
298.15K	82.2	27.8	0.069
313.15K	82.1	42.9	0.071
328.15K	82.0	58.0	0.075
343.15K	81.8	73.2	0.079

Table 2. MAT, junction temperature and leakage power for SSTL18\_I

	Mat reduction	Junction temp	Leakage power
283.15K	82.5	12.5	0.062
298.15K	82.4	27.6	0.064
313.15K	82.3	42.7	0.066
328.15K	82.2	57.8	0.070
343.15K	82.0	73.0	0.074

There is 0.59 % reduction in MAT, 84.26 % reduction in junction temperature, 26.66 % reduction in leakage power when we scale down ambient temperature from 343.15 K to 283.15 K, as shown in Table 3.

There is 0.59 % reduction in MAT, 84.26 % reduction in junction temperature, 26.66 % reduction in leakage power when we scale down ambient temperature from 343.15 K to 283.15 K as shown in Table 4.

**Table 3. MAT, junction temperature and leakage power for PCI**

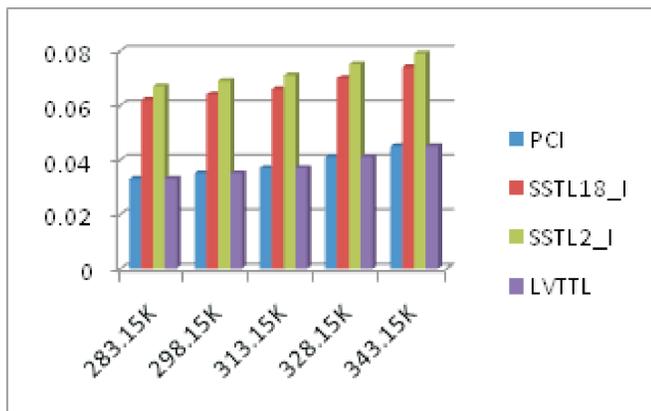
	MAT	Junction temp	Leakage power
283.15K	83.7	11.3	0.033
298.15K	83.6	26.4	0.035
313.15K	83.5	41.5	0.037
328.15K	83.4	56.6	0.041
343.15K	83.2	71.8	0.045

**Table 4. MAT, junction temperature and leakage power for LVTTTL**

	Ambient temp	Junction temp	Leakage power
283.15K	83.7	11.3	0.033
298.15K	83.6	26.4	0.035
313.15K	83.5	41.5	0.037
328.15K	83.4	56.6	0.041
343.15K	83.2	71.8	0.045

**Table 5. Leakage power for PCI, SSTL18\_I, SSTL2\_I, LVTTTL**

	PCI	SSTL18_I	SSTL2_I	LVTTTL
283.15 K	0.033	0.062	0.067	0.033
298.15 K	0.035	0.064	0.069	0.035
313.15 K	0.037	0.066	0.071	0.037
328.15 K	0.041	0.070	0.075	0.041
343.15 K	0.045	0.074	0.079	0.045



**Figure 4. Power dissipation for IO standard PCI, SSTL18\_I, SSTL2\_I, LVTTTL.**

### 3. RESULTS

#### 3.1 Power Analysis

There is 26.66%, 16.21%, 15.18%, 26.66% reduction in leakage power when we scale down ambient temperature from 343.15K to 283.15K for IO standard PCI, SSTL18\_I, SSTL2\_I, LVTTTL, as shown in Table 5.

There is 50.74%, 49.27%, 47.88%, 45.33%, 43.03% reduction in leakage power for ambient temperature 283.15 K, 298.15 K, 313.15 K, 328.15 K, 343.15 K for IO standard SSTL2\_I and PCI as shown in Fig. 4.

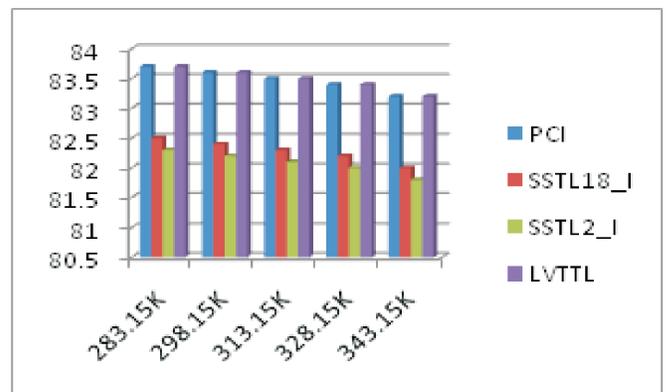
#### 3.2 Thermal Analysis

There is 0.59%, 0.60%, 0.60%, 0.59% reduction in maximum ambient temperature when we scale down ambient temperature from 343.15 K to 283.15 K for IO standard PCI, SSTL18\_I, SSTL2\_I, LVTTTL, as shown in Table 6.

There is 1.67 %, 1.67%, 1.67%, 1.67%, 1.68% reduction in maximum ambient temperature for ambient temperature 283.15K, 298.15K, 313.15K, 328.15 K, 343.15 K for IO standard SSTL2\_I and PCI, as shown in Fig. 5.

**Table 6. MAT for PCI, SSTL18\_I, SSTL2\_I, LVTTTL**

	PCI	SSTL18_I	SSTL2_I	LVTTTL
283.15 K	83.7	82.5	82.3	83.7
298.15 K	83.6	82.4	82.2	83.6
313.15 K	83.5	82.3	82.1	83.5
328.15 K	83.4	82.2	82.07	83.4
343.15 K	83.2	82.08	81.8	83.2



**Figure 5. MAT for IO standard PCI, SSTL18\_I, SSTL2\_I, LVTTTL.**

**Table 7. Junction temperature for PCI, SSTL18\_I, SSTL2\_I, LVTTTL**

	PCI	SSTL18_I	SSTL2_I	LVTTTL
283.15 K	11.3	12.5	12.7	11.3
298.15 K	26.4	27.6	27.8	26.4
313.15 K	41.5	42.7	42.9	41.5
328.15 K	56.6	57.8	58.0	56.6
343.15 K	71.8	73.0	73.2	71.8

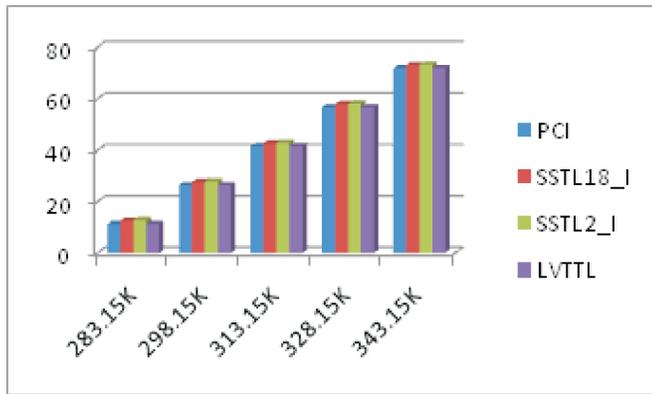


Figure 6. Junction temperature for PCI, SSTL18\_I, SSTL2\_I, LVTTL.

There is 84.26%, 82.87%, 82.65%, 84.26% reduction in junction temperature when we scale down ambient temperature from 343.15K to 283.15K for IO standard PCI, SSTL18\_I, SSTL2\_I, LVTTL, as shown in Table 7.

There is 11.02%, 5.03%, 3.26%, 2.41%, 1.91% reduction in junction temperature for ambient temperature 283.15K, 298.15K, 313.15K, 328.15K, 343.15K, for IO standard SSTL2\_I and PCI, as shown in Fig. 6.

#### 4. CONCLUSION

Among 5 different IO standards used, leakage power is minimum for PCI and LVTTL and maximum for SSTL2\_I. Similarly, as per observation of our thermal analyses maximum ambient temperature is minimum for SSTL2\_I and maximum for PCI AND LVTTL. And junction temperature is minimum for PCI and LVTTL and maximum for SSTL2\_I.

#### 5. FUTURE SCOPE

As future scope of the work, power of the circuit can be further reduced like if we optimise the leakage power, and also, short circuit power dissipation in the circuit can be reduce which can be the future work of this paper. As the proposed design have proven to work efficiently in terms of various performance parameters thus the more effective results are expected to be obtained while incorporating these circuits to implement other complex systems in the field of low power VLSI design. To make a more energy and thermal efficient Adder, there is a wide scope to use LVC MOS, HSTL etc.

#### निष्कर्ष

प्रयोग किए गए 5 भिन्न-भिन्न आईओ स्टैंडर्ड के मध्य पीसीआई और एलवीटीटीएल के लिए विद्युत रिसाव न्यूनतम है और एसएसटीएल2\_आई के लिए अधिकतम है। इसी प्रकार, हमारे उष्मा विश्लेषण से पता चला है कि एसएसटीएल2\_आई के लिए अधिकतम परिवेश तापमान न्यूनतम है और पीसीआई और एलवीटीटीएल के लिए अधिकतम है। और जंक्शन तापमान पीसीआई

और एलवीटीटीएल के लिए न्यूनतम और एसएसटीएल2\_आई के लिए अधिकतम है।

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# कम शक्ति और 28 एनएम एफपीजीए पर थर्मल कुशल चित्र (इमेज) एएलयू कार्यान्वयन के आधार पर धारिता और आवृत्ति अनुमापन

## Capacitance and Frequency Scaling Based Low Power and Thermal-efficient Image ALU Implementation on 28 nm FPGA

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### सारांश

28एनएम काइनेटिक्स –7 एफपीजीए में थर्मल कुशल चित्र एएलयू बनाने के क्रम में धारिता मापन और आवृत्ति मापन किया गया है। चित्र एएलयू को जाइलिंग्स आईएसई 14.6 में बनाया गया है। आईओ शक्ति, रिसाव शक्ति और चित्र एएलयू के जंक्शन तापमान में विभिन्नता आवृत्ति मापन का परिणाम है। धारिता मापन क्लॉक पॉवर, तर्क शक्ति, सिग्नल शक्ति और डीएसपी शक्तियों में कोई भी बदलाव नहीं दर्शाता है। लेकिन यह आईओ शक्ति, रिसाव शक्ति और चित्र एएलयू के जंक्शन तापमान में बदलाव का परिणाम उत्पन्न करता है। 5 पीएफ धारिता के साथ, आईओएस शक्ति में 97.23% परिवर्तन, रिसाव शक्ति में 75.52% परिवर्तन, कुल शक्ति में 96.79% परिवर्तन और 1 गीगाहर्ट्ज से 25 गीगाहर्ट्ज के आवृत्ति परिवर्तन से जंक्शन तापमान में 63.36% का परिवर्तन पाया गया है। 5 गीगाहर्ट्ज धारिता के साथ, आईओएस शक्ति में 80% परिवर्तन, रिसाव शक्ति में 69.35% परिवर्तन, कुल शक्ति में 79.09% परिवर्तन और धारिता के 5 पीएफ से 75 पीएफ में परिवर्तन होने से जंक्शन तापमान में 51.79% का बदलाव पाया गया है।

### ABSTRACT

Capacitance scaling and frequency scaling is done to make thermal-efficient Image ALU in 28nm Kintex-7 FPGA. Image ALU is designed in Xilinx ISE 14.6. Frequency scaling results in variation in IO power, leakage power, and Junction temperature of Image ALU. Capacitance scaling does not show any variation for clock power, logic power, signal power and DSPs powers for a constant frequency. But it results in variation in IO power, leakage power and Junction temperature of Image ALU. Along with 5pF capacitance, it has been found that there is 97.23 per cent change in IOs power, 75.52 per cent change in Leakage power, 96.79 per cent change in total power, and 63.36 per cent change in junction temperature as frequency change from 1GHz to 25 GHz. Along with 5 GHz capacitance, it has been found that there is 80 per cent change in IOs power, 69.35 per cent change in leakage power, 79.09 per cent change in total power, and 51.79 per cent change in junction temperature as capacitance change from 5 pF to 75 pF.

**Keywords:** Capacitance scaling, frequency scaling, image alu, thermal-efficient design, I/OS power, leakage power, FPGA.

## 1. INTRODUCTION

Image arithmetical logical unit (ALU), also called the math co-processor in broader context, used to perform arithmetic and logical functions on different images. Many different types of operations is performed by ALU, i.e., arithmetic operation and logic operations. arithmetic operations includes operations like addition, subtraction, multiplication, division, while logic operations includes operations like OR, AND, NOT, NOR, NAND, XOR and XNOR Operations like shift and rotate are also performed in ALU. Frequency scaling, capacitance scaling, voltage scaling, are various scaling methods

using these changes in power consumption and junction temperature is observed. The basic idea is to perform frequency scaling and capacitance scaling to observe the variations while keeping the other parameters constant. Verilog is used to implement this energy and thermal-efficient Image ALU.

## 2. LITERATURE REVIEW

CPU frequency scaling technique is proposed by Yang<sup>1</sup>, *et al.* to achieve energy efficiency. We are integrating the idea of capacitance scaling<sup>2</sup> along with frequency scaling. Capacitance and technology

scaling using different nm technologies have been described<sup>3</sup>. Arithmetic and logical operations using 8-bit ALU have been performed in this. Capacitance scaling and frequency scaling have been done to make energy-efficient image inverter design<sup>4</sup>. Variation in power consumption and junction temperature have been evaluated. Information about FPGA implementation for various image processing algorithms using the most efficient tool called Xilinx system generator (XSG) for Matlab has been provided<sup>5</sup>. Various morphological and intensity image processing algorithms for negatives, image enhancement, threshold, contrast stretching, Edge detection, boundary extraction for grayscale and colour images have been explored.

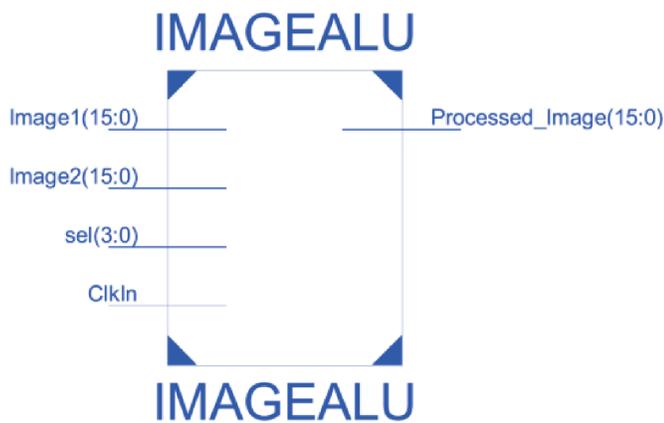


Figure 1. RTL schematic of image ALU.

**3. ARCHITECTURE OF IMAGE ALU**

Image ALU has four input signals and one output signal. Image1, Image2, and Sel are 3 multi bit inputs and ClkIn is one single bit input in Image ALU. There is one multi-bit output i.e. Processed\_Image.

Image 1 and Image 2 are of 16-bits each, Sel is 4-bit and it is a selector line which is used to select the particular arithmetical and logical operation out of total 16 operations performed by ALU, and one clock pulse are input signals. Processed image which is of 16-bit, is the output image produced after the processing of two input images.

**4. RESULTS AND DISCUSSION OF CAPACITANCE SCALING**

Capacitance scaling results in variation in IOs power, leakage power, total power, and junction temperature but there is no variation in clock power, logic power, signal power, DSPs power because these are independent from variation in capacitance.

**4.1 Power Consumption with 5pF Capacitance**

There is 96.2 per cent reduction in Clocks power while frequency is decremented from 25 GHz to 1GHz

with a fixed capacitance of 5pF whereas Logic power faces a reduction of 83.67 per cent, Signals power faces a reduction of 91.58per cent, DSPs power faces a reduction of 97.06 per cent, IOs power faces a reduction of 97.23 per cent, Leakage power faces a reduction of 75.52 per cent, total power faces a reduction of 96.79 per cent and Junction temperature faces a reduction of 63.66 per cent as shown in Table 1. With 5pF, IO power consumption, leakage power consumption and junction temperature for different frequencies is also shown in Fig. 3.

Table 1. Power Consumption with 5pF Capacitance

Frequency (GHz)	1	5	10	15	25
Clock power	0.007	0.037	0.0745	0.111	0.185
Logic power	0.024	0.094	0.11	0.123	0.147
Signals power	0.024	0.102	0.151	0.198	0.285
DSPs power	0.001	0.007	0.013	0.02	0.034
IOs power	0.653	4.535	9.07	13.605	22.676
Leakage power	0.047	0.057	0.074	0.1	0.192
Total power	0.756	4.832	9.493	14.156	23.518
Junction temp	26.6	34.9	44.5	54	73.2

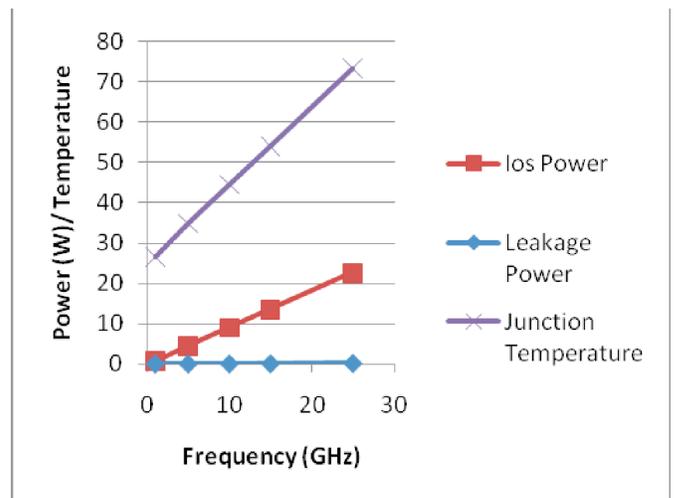


Figure 3. Frequency Vs Power at C = 5pF.

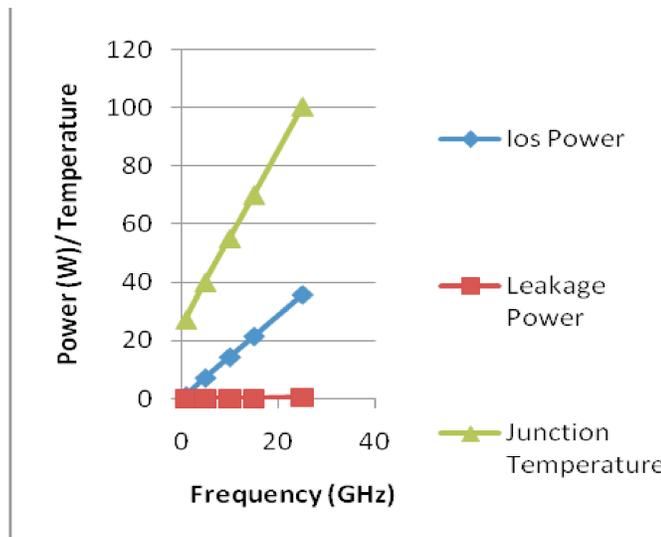
**4.2 Power Consumption with 15pF Capacitance**

There is 96.2 per cent reduction in clocks power while frequency is decremented from 25 GHz to 1GHz with a fixed capacitance of 15pF whereas Logic power faces a reduction of 83.67 per cent, Signals power faces a reduction of 91.58 per cent, DSPs power faces a reduction of 97.06 per cent, IOs power faces a reduction of 97.12 per cent, Leakage power faces a reduction of 90.13 per cent, total power faces a reduction of 96.93 per cent and Junction temperature faces a reduction of 72.29 per cent as shown in Table 2. With 15pF, IO power consumption, leakage power consumption and junction temperature for different

frequencies is also shown in Fig. 4.

**Table 2. Power consumption with 15pF capacitance**

Frequency	1	5	10	15	25
Clock power	0.007	0.037	0.07	0.11	0.185
Logic power	0.024	0.094	0.11	0.12	0.147
Signals power	0.024	0.102	0.15	0.2	0.285
DSPs power	0.001	0.007	0.01	0.02	0.034
IOs power	1.026	7.127	14.3	21.4	35.64
Leakage power	0.047	0.066	0.1	0.17	0.476
Total power	1.13	7.432	14.7	22	36.76
Junction temp	27.3	40.2	55.2	70.1	100.4



**Figure 4. Frequency vs power at C = 15pF.**

**4.3 Power consumption with 25pF capacitance**

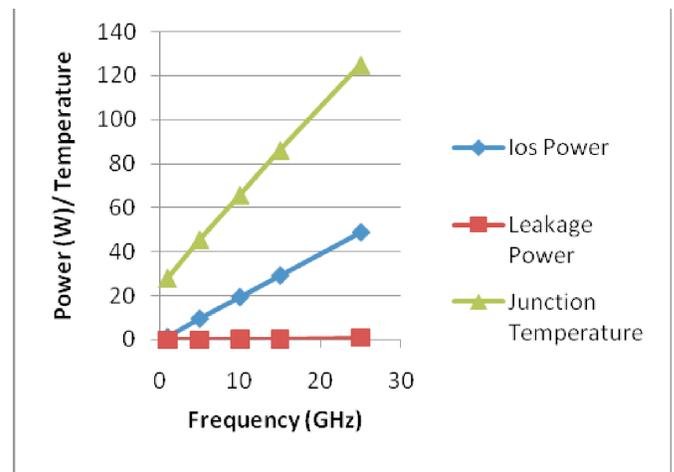
There is 96.2 per cent reduction in Clocks power while Frequency is decremented from 25GHz to 1GHz with a fixed capacitance of 5 pF whereas Logic power faces a reduction of 83.67 per cent, Signals power faces a reduction of 91.58 per cent, DSPs power faces a reduction of 97.06 per cent, IOs power faces a reduction of 97.12 per cent, Leakage power faces a reduction of 95.17 per cent, total power faces a reduction of 97.00 per cent and Junction temperature faces a reduction of 75.52 per cent as shown in Table 3. With 25pF, IO power consumption, Leakage power consumption and junction temperature for different frequencies is also shown in Fig.5.

**4.4 Power Consumption with 35pF Capacitance**

There is 96.2 per cent reduction in Clocks power while Frequency is decremented from 25GHz to 1GHz with a fixed capacitance of 5pF whereas Logic power

**Table 3. Power consumption with 25pF capacitance**

Frequency	1	5	10	15	25
Clock power	0.007	0.037	0.07	0.11	0.185
Logic power	0.024	0.094	0.11	0.12	0.147
Signals power	0.024	0.102	0.15	0.2	0.285
DSPs power	0.001	0.007	0.01	0.02	0.034
IOs power	1.399	9.719	19.4	29.2	48.6
Leakage power	0.048	0.077	0.15	0.3	0.993
Total power	1.503	10.64	19.9	29.9	50.24
Junction temp	28.1	45.6	65.9	86.3	125



**Figure 5. Frequency vs power at C = 25pF.**

faces a reduction of 83.67per cent, Signals power faces a reduction of 91.58per cent, DSPs power faces a reduction of 97.06per cent, IOs power faces a reduction of 97.12per cent, Leakage power faces a reduction of 95.07per cent, total power faces a reduction of 97.01per cent and Junction temperature faces a reduction of 79.96per cent as shown in Table 4. With 35pF, IO power consumption, Leakage power consumption and junction temperature for different frequencies is also shown in Fig. 6.

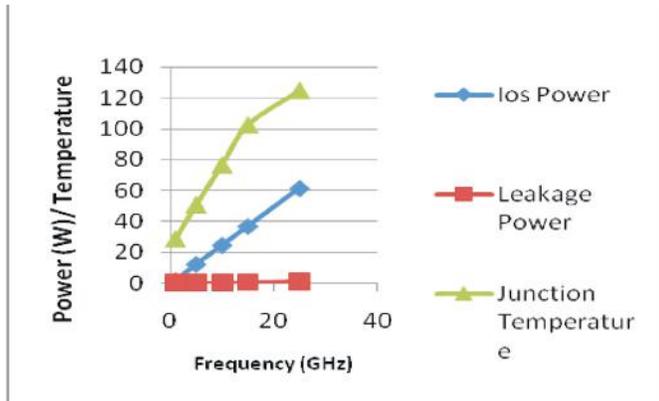
**4.5 Power Consumption with 50pF Capacitance**

There is 96.2 per cent reduction in clocks power while Frequency is decremented from 25GHz to 1GHz with a fixed capacitance of 5pF whereas Logic power faces a reduction of 83.67 per cent, Signals power faces a reduction of 91.58 per cent, DSPs power faces a reduction of 97.06 per cent, IOs power faces a reduction of 97.12 per cent, Leakage power faces a reduction of 94.96 per cent, total power faces a reduction of 97.05per cent and Junction temperature faces a reduction of 76per cent as shown in Table 5.

With 5pF, IO power consumption, Leakage power consumption and junction temperature for different

**Table 4. Power consumption with 35pF capacitance**

Frequency	1	5	10	15	25
Clock power	0.007	0.037	0.07	0.11	0.185
Logic power	0.024	0.094	0.11	0.12	0.147
Signals power	0.024	0.102	0.15	0.2	0.285
DSPs power	0.001	0.007	0.01	0.02	0.034
IOs power	1.771	12.31	24.6	36.9	61.56
Leakage power	0.049	0.09	0.22	0.51	0.993
Total power	1.877	12.64	25.2	37.9	63.2
Junction temp	28.8	50.9	76.7	103	125



**Table 6. Frequency vs power at C = 35pF.**

frequencies is also shown in Fig 7.

### 5. RESULTS AND DISCUSSION OF FREQUENCY SCALING

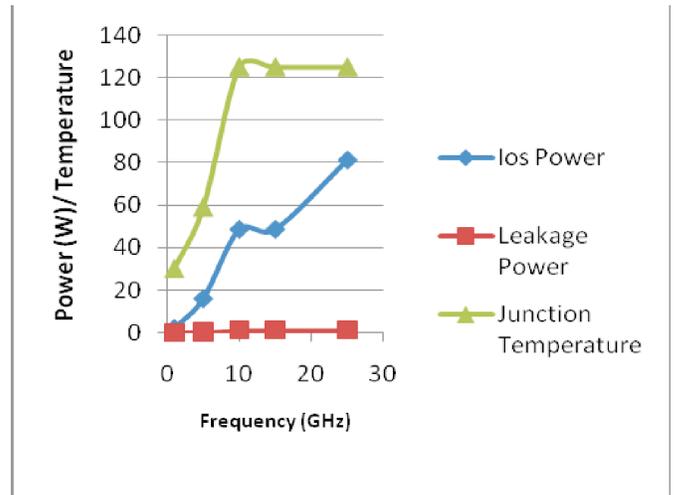
**Table 5. Power consumption with 50pF capacitance**

Frequency	1	5	10	15	25
Clock power	0.007	0.037	0.11	0.11	0.185
Logic power	0.024	0.094	0.12	0.12	0.147
Signals power	0.024	0.102	0.2	0.2	0.285
DSPs power	0.001	0.007	0.02	0.02	0.034
IOs power	2.33	16.2	48.6	48.6	81
Leakage power	0.05	0.118	0.99	0.99	0.993
Total power	2.437	16.56	50	50	82.64
Junction temp	30	59	125	125	125

Frequency scaling results in variation in all powers and junction temperature. These powers include clock power, logic power, signal power, DSPs power, IOs power, leakage power, total power.

#### 5.1 Power Consumption with F=1GHz Frequency

For 1GHz frequency, when we scale down capacitance from 75pF to 5pF then there is 79.98 per cent reduction in IOs power, 11.32 per cent reduction in Leakage power, 77.5 per cent reduction in total power and 16.61



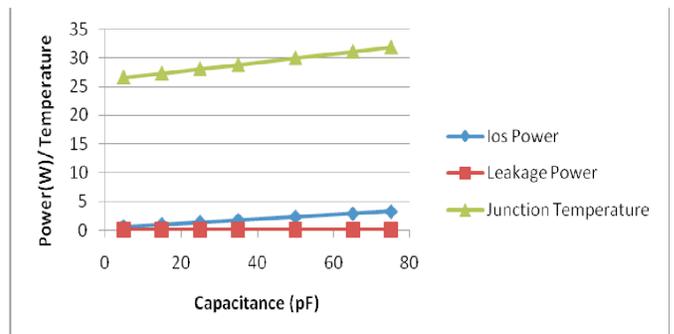
**Table 7. Frequency Vs. Power at C = 50pF.**

per cent reduction in Junction temperature as shown in Table 6. There is no variation in clock power, logic power. With 1GHz, IO power consumption, leakage power consumption and junction temperature for different capacitances is also shown in Fig. 8.

#### 5.2 Power Consumption with F=5GHz Frequency

**Table 6. Power consumption with 1GHz frequency**

Capacitance	5	15	25	50	65	75
Clock power	0.007	0.007	0.007	0.007	0.007	0.007
Logic power	0.024	0.024	0.024	0.024	0.024	0.024
Signals power	0.024	0.024	0.024	0.024	0.024	0.024
DSPs power	0.001	0.001	0.001	0.001	0.001	0.001
IOs power	0.653	1.026	1.399	2.33	2.889	3.262
Leakage power	0.047	0.047	0.048	0.05	0.052	0.053
Total power	0.756	1.13	1.503	2.437	2.997	3.371
Junction temp	26.6	27.3	28.1	30	31.1	31.9



**Figure 8. Capacitance vs power at F = 1 GHz.**

For 5 GHz frequency, when we scale down capacitance from 75pF to 5pF then there is 80per cent reduction in IOs power, 69.35per cent reduction in Leakage power,

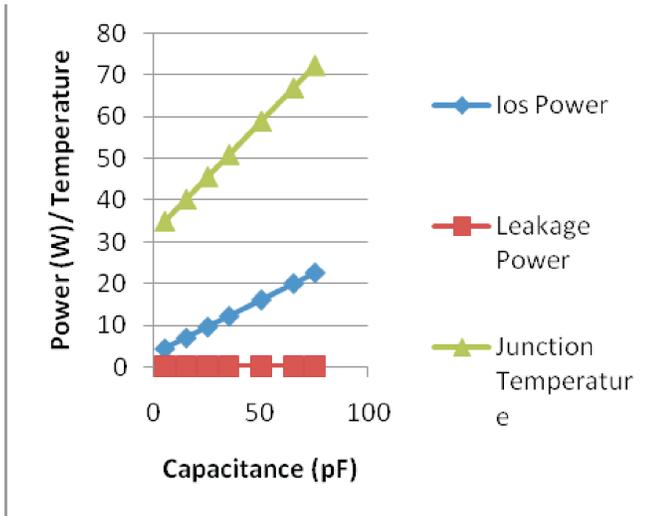
79.09per cent reduction in total power and 51.79per cent reduction in Junction temperature as shown in Table 7. There is no variation in clock power, logic power. With 1GHz, IO power consumption, Leakage power consumption and junction temperature for different capacitances is also shown in Fig. 9.

**5.3 Power Consumption with F=10GHz Frequency**

For 10 GHz frequency, when we scale down

**Table 7. Power consumption with 5 GHz frequency**

Capacitance	5	15	25	50	65	75
Clock power	0.037	0.037	0.037	0.037	0.037	0.037
Logic power	0.094	0.094	0.094	0.094	0.094	0.094
Signals power	0.102	0.102	0.102	0.102	0.102	0.102
DSPs power	0.007	0.007	0.007	0.007	0.007	0.007
IOs power	4.535	7.127	9.719	16.199	20.087	22.679
Leakage power	0.057	0.066	0.077	0.118	0.155	0.186
Total power	4.832	7.432	10.635	16.556	20.481	23.105
Junction temp	34.9	40.2	45.6	59	67	72.4



**Figure 9. Capacitance vs power at F = 5 GHz.**

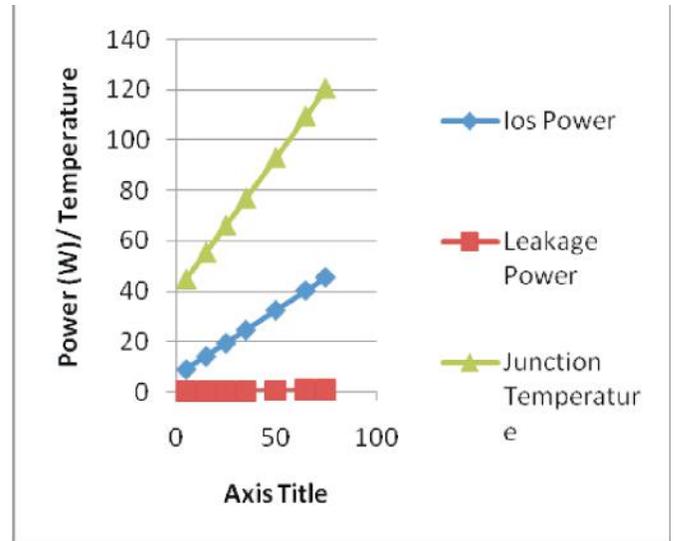
capacitance from 75pF to 5pF then there is 80 per cent reduction in IOs power, 9.15per cent, reduction in Leakage power, 79.62per cent reduction in total power and 63.07per cent reduction in Junction temperature as shown in Table 8. There is no variation in clock power, logic power. With 1GHz, IO power consumption, Leakage power consumption and junction temperature for different capacitances is also shown in Fig. 10.

**5.4 Power Consumption With F=15GHz Frequency**

For 15 GHz frequency, when we scale down capacitance from 75pF to 5pF then there is 80per

**Figure 8. Power consumption with 10 GHz frequency**

Capacitance	5	15	25	50	65	75
Clock power	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745
Logic power	0.11	0.11	0.11	0.11	0.11	0.11
Signals power	0.151	0.151	0.151	0.151	0.151	0.151
DSPs power	0.013	0.013	0.013	0.013	0.013	0.013
IOs power	9.07	14.254	19.438	32.398	40.174	45.358
Leakage power	0.074	0.104	0.149	0.374	0.63	0.874
Total power	9.493	14.706	19.935	33.121	41.152	46.581
Junction temp	44.5	55.2	65.9	92.9	109.4	120.5



**Figure 10. Capacitance vs power at F = 10GHz.**

cent reduction in IOs power, 89.9per cent reduction in Leakage power, 79.63per cent reduction in total power and 56.68per cent reduction in Junction temperature as shown in Table 9. There is no variation in clock power, logic power. With 15 GHz, IO power consumption, Leakage power consumption and junction temperature for different capacitances is also shown in Fig. 11.

**5.5 Power Consumption with F=25GHz Frequency**

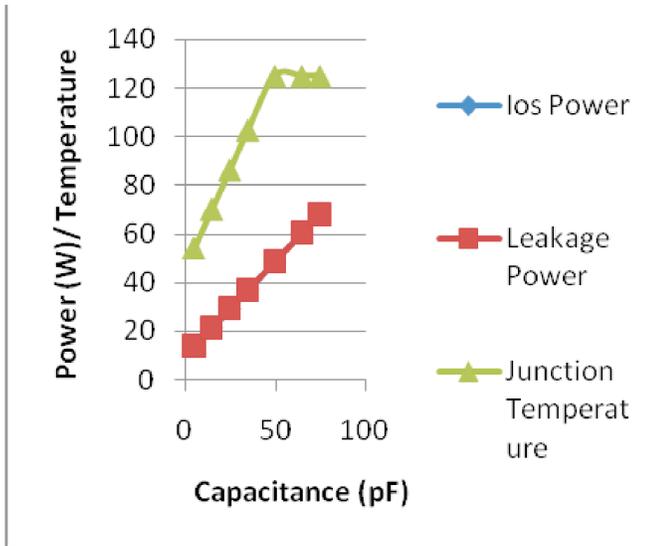
For 25 GHz frequency, when we scale down capacitance from 75pF to 5pF then there is 80per cent reduction in IOs power, 80per cent, reduction in Leakage power, 79.56per cent reduction in total power and 41.44per cent reduction in Junction temperature as shown in Table 10. There is no variation in clock power, logic power. With 25 GHz, IO power consumption, Leakage power consumption and junction temperature for different capacitances is also shown in Fig. 12.

**6. CONCLUSION**

For energy and thermal-efficient design Capacitance scaling and Frequency Scaling are effective techniques. Frequency scaling results in variation in IO power, leakage power and junction temperature of Image ALU.

**Table 9. Power Consumption with 15 GHz Frequency**

Capacitance	5	15	25	50	65	75
Clock power	0.111	0.111	0.111	0.111	0.111	0.111
Logic power	0.123	0.123	0.123	0.123	0.123	0.123
Signals power	0.198	0.198	0.198	0.198	0.198	0.198
DSPs power	0.02	0.02	0.02	0.02	0.02	0.02
IOs power	13.605	21.381	29.157	48.597	60.261	68.037
Leakage power	0.1	0.172	0.3	0.993	0.993	0.993
Total power	14.156	22.005	29.909	50.042	61.706	69.482
Junction temp	54	70.1	86.3	125	125	125



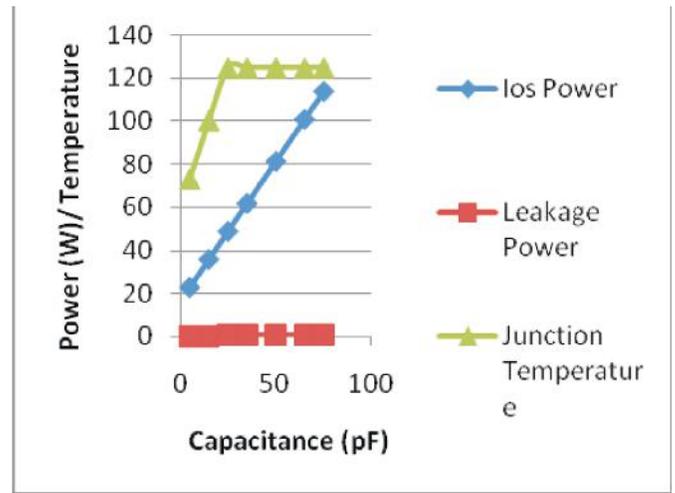
**Figure 11. Capacitance vs power at F = 15 GHz**

**Table 10. Power consumption with 25 GHz frequency**

Capacitance	5	15	25	50	65	75
Clock power	0.185	0.185	0.185	0.185	0.185	0.185
Logic power	0.147	0.147	0.147	0.147	0.147	0.147
Signals power	0.285	0.285	0.285	0.285	0.285	0.285
DSPs power	0.034	0.034	0.034	0.034	0.034	0.034
IOs power	22.676	35.636	48.596	80.996	100.44	113.396
Leakage power	0.192	0.476	0.993	0.993	0.993	0.993
Total power	23.518	36.762	50.24	82.64	102.08	115.04
Junction temp	73.2	100.4	125	125	125	125

Capacitance scaling does not show any variation for Clock power, Logic power, Signal power and DSPs powers for a constant frequency.

Along with 5pF capacitance, it has been found that there is 97.23 per cent change in IOs power, 75.52 per cent change in leakage power, 96.79 per cent change in total power and 63.36 per cent change in junction temperature as frequency change from 1GHz to 25 GHz. Along with 5GHz capacitance, it



**Figure 12. Capacitance vs power at F = 25 GHz.**

has been found that there is 80 per cent change in IOs power, 69.35 per cent change in leakage power, 79.09 per cent change in total power and 51.79 per cent change in junction temperature as capacitance change from 5pF to 75pF.

### 7. FUTURE SCOPE

Image ALU has been designed on 28nm FPGA. There is open scope to redesign this circuit on 16nm Future ultra scale FPGA. Here, frequency and capacitance scaling is applied to get energy efficient design. there is wide scope to redesign this circuit using other energy efficient design technique like clock gating, power gating, mapping, IO standard, LVCMOS IO standard and HSTL IO Standard.

### निष्कर्ष

ऊर्जा और थर्मल कुशल डिजाइन धारिता मापन और आवृत्ति मापन के लिए प्रभावी तकनीक है। आईओ शक्ति, रिसाव शक्ति और चित्र एएलयू के जंक्शन तापमान में विभिन्नता आवृत्ति मापन का परिणाम है। धारिता मापन एक निरंतर आवृत्ति के लिए क्लॉक पॉवर, तर्क शक्ति, सिग्नल शक्ति और डीएसपी शक्तियों के लिए कोई भी बदलाव नहीं दर्शाता है। 5पीएफ धारिता के साथ, आईओएस शक्ति में 97.23% परिवर्तन, रिसाव शक्ति में 75.52% परिवर्तन, कुल शक्ति में 96.79% और 1 गीगाहर्ट्ज से 25 गीगाहर्ट्ज के आवृत्ति परिवर्तन से जंक्शन तापमान में 63.36% परिवर्तन पाया गया है। 5 गीगाहर्ट्ज धारिता के साथ, यह आईओएस शक्ति में 80% परिवर्तन, रिसाव शक्ति में 69.35% परिवर्तन, कुल शक्ति में 79.09% परिवर्तन और 5पीएफ से 75 पीएफ के धारिता परिवर्तन से जंक्शन तापमान में 51.79% परिवर्तन पाया गया है।

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# एसएसटीएल निवेश निर्गम मानक आधारित टेट्रा हर्ट्ज और ऊर्जा दक्ष मलयालम यूनिकोड रीडर का डिजाइन और एफपीजीए पर कार्यान्वयन

## SSTL IO Standard-based Tera Hertz and Energy Efficient Malayalam Unicode Reader Design and Implementation on FPGA

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### सारांश

मलयालम लिपि के लिए शब्दों के यूनिकोड सीमाएँ 0D00–0D7F हैं। इस आलेख में हम मलयालम यूनिकोड रीडर के हार्डवेयर डिजाइन और इसके स्थापन को वरटेक्स-6 एफपीजीए पर करेंगे। यह डिजाइन 1 टेट्राहर्ट्ज, 100 गीगाहर्ट्ज, 10 गीगाहर्ट्ज, 1 गीगाहर्ट्ज, 100 मेगाहर्ट्ज, 10 मेगाहर्ट्ज, 1 मेगाहर्ट्ज एसएसटीएल आवृत्तियों पर परिचालित उपकरणों पर जाँचा गया है। और इसका निवेश-निर्गम मानक का उपयोग इसके डिजाइन को ऊर्जादक्ष बनाता है। एसएसटीएल2\_1 के उपयोग से, 20–90% निवेशनिर्गम ऊर्जा उपलब्ध थी जबकि एसएसटीएल18\_1, ऊर्जा बचत 32–93% तक बढ़ जाती है जब उपकरण 1मेगाहर्ट्ज से 1टेट्राहर्ट्ज की सीमा में कार्य करते हैं। इस यूनिकोड पाठक को काउंटर के साथ प्रयोग करने पर स्वर, व्यंजन, और अंकों की संख्या को गिना जा सकता है।

### ABSTRACT

The Unicode range of characters for Malayalam script is 0D00–0D7F. In this paper the hardware design and implementation of Malayalam Unicode reader for scripts on Virtex-6 FPGA has been covered. This design was tested with the devices operating at the frequency of 1THz, 100GHz, 10GHz, 10MHz, 1GHz, 100MHz, 10MHz, 1MHz SSTL (Stub Speed Transceiver Logic) and this I/O standard is used to make this design more energy efficient. Using SSTL2\_1, 20-90 percent I/O power was THERE and while using SSTL18\_1, the saving increases to 32-93 percent with the device operating in range of 1THz to 1MHz. This Unicode reader can count the number of vowel, consonants, and digit when used with counter.

**Keywords:** Malayalam unicode reader, unicode, SSTL IO standard, energy efficient hardware design, FPGA

## 1. INTRODUCTION

Malayalam language is the official language of the Indian state Kerala. It is spoken by over 35 million people over the world. ‘Malayalees’ are the people who speak this language<sup>[1]</sup>. Apart from Kerala, Malayalam is also spoken by the people of Lakshadweep (a union territory on the western coast of India). The term ‘Malayalam’ is derived from the two words Mala and Alam. ‘Mala’ which means mountain and ‘Alam’ which means land or place<sup>[1]</sup>. Among the 15 major languages of India, Malayalam is the 8th most important language<sup>[2]</sup>. Until the 16th century, Malayalam was written in the vattezhuthu script, a Brahmic script which developed alongside Grantha writing, from which the modern Malayalam script. Malayalam is a descendent of the Grantha script. A new lipi or style of writing was introduced to replace

the old style in 1981. This new style reduced the number of characters radically. As other languages it is also written from left to right. Basically it consists of 53 letters called akṣaras; 37 of them represent full syllables of a consonant and the vowel<sup>[a]</sup>, and 16 represent independent vowel<sup>[3]</sup>. For implementation of Malayalam Unicode reader, Gurumukhi Unicode Reader<sup>[4]</sup>, Devanagari Unicode reader<sup>[5]</sup> and Bengali Unicode reader<sup>[6]</sup> were analyzed. In order to design an energy efficient Malayalam Unicode reader, Stub Series Terminated Logic<sup>[7-9]</sup> was used resulting into an SSTL based energy Unicode reader.

## 2. EXPERIMENTAL SETUP

This design was implemented on Virtex-6 and Spartan-6 FPGA family with Xilinx ISE 12.1 simulator and Verilog HDL (hardware description language).

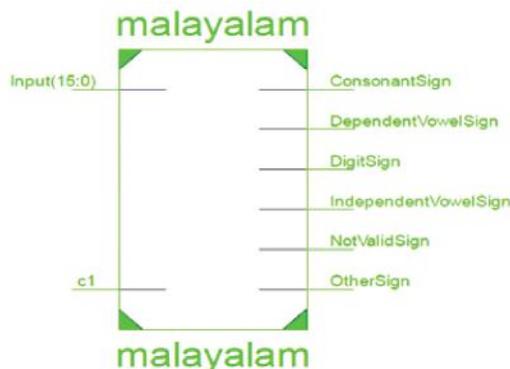
**Table 1. Range allocation of few words of Malayalam unicode scripts<sup>[3]</sup>.**

Hexadecimal code	Malayalam letter
0D0B ള	VOCALIC R
0D0C ഴ	VOCALIC L
0D15 ക	KA
0D19 ണ	NGA
0D35 വ	VA
0D3D ി	SIGN AVAGRAHA
0D3E ി	SIGN AA
0D4A റ്റ	VOWEL SIGN O
0D4D റ്റ	SIGN VIRAMA

XPower Analyzer was used for the analysis of the power. SSTL logic family was used for impedance matching of transmission line, device and port. Initial supply voltage was 1.0V and Output driver supply voltage was 2.5V with 25 °C ambient temperature. In implementation on 6v1x75tff484-3 device of Virtex-6 and Spartan-6 FPGA family, 16 basic elements (BELS), 5 D Flip-flops, 1 clock buffers, 16 input buffers (IBUF) and 6 output buffers (OBUF) were used to implement Malayalam Unicode Reader. Also the numbers of LUT's used are 14. From available resource on Virtex-6 FPGA and Spartan-6, only 5 Slice Registers of the total 93120 available Slice Registers, 14 Slice LUTs out of total 46560 available, and 23 input/output buffers out of 240 input/output buffers were employed.

### 3. SCHEMATIC OF MALAYALAM UNICODE READER

The schematics of Malayalam reader takes 16-bit hexadecimal code of alphabet and clock input as shown in Figure 1. The output that can be given by this reader can be one of five outputs. If alphabet is not Malayalam Unicode then the output will be given at NotValidSign; otherwise depending on the type of Malayalam input, the output will be at the corresponding port.

**Figure 1. Schematic of Malayalam unicode reader.**

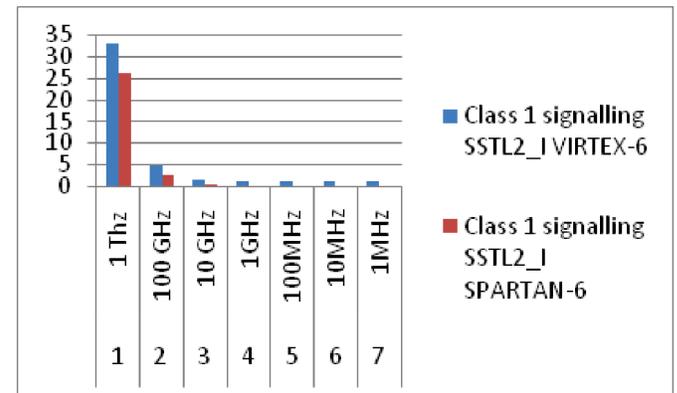
As shown in Figure 1, it is taking Unicode of Gurumukhi reader in form of 16-bit hex-decimal input and specify it as vowel, consonant, digit, and special symbol of Gurumukhi scripts or not.

### 4. RESULTS USING SSTL CLASS I I/O STANDARD

Power reading is taken at the different values of frequency. For SSTL2\_1 class I/O standard at frequencies ranging from 1THz to 1MHz the power efficiency is increased, i.e. from 20-90 percent as we change the technology from VIRTEX-6 to SPARTAN-6 as shown in Table 1 and Figure 2.

**Table 2. Power dissipation with class 1 signaling at SSTL2\_I**

S.No.	Frequency	VIRTEX-6	SPARTAN-6
1.	1 THz	33.223	26.340
2.	100 GHz	4.676	2.745
3.	10 GHz	1.382	0.363
4.	1GHz	1.051	0.121
5.	100MHz	1.018	0.097
6.	10MHz	1.015	0.094
7.	1MHz	1.014	0.094

**Figure 2. Power dissipation at VIRTEX-6 and SPARTAN-6.**

For SSTL18\_I class-I I/O standard at frequencies ranging from 1THz to 1MHz the power efficiency is increased from 31-93 percent as we change the

**Table 3. Power Dissipation With Class 1 Signaling of SSTL18\_I**

S.No.	Frequency	VIRTEX - 6	SPARTAN-6
1.	1 THz	34.022	23.342
2.	100 GHz	4.360	2.426
3.	10 GHz	1.340	0.312
4.	1GHz	1.037	0.097
5.	100MHz	1.007	0.075
6.	10MHz	1.004	0.073
7.	1MHz	1.003	0.072

technology from Virtex-6 to Spartan-6 as shown in Table 2 and Figure 3.

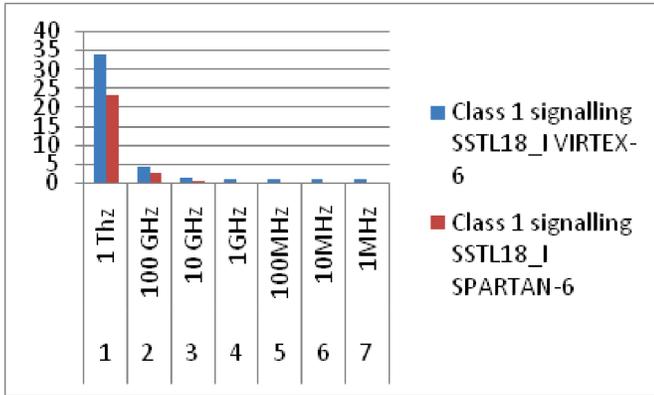


Figure 3. Power dissipation at VIRTEX-6 and SPARTAN-6.

Table 4. Power Dissipation with Class II Signaling at SSSL2\_II

S.No.	Frequency	VIRTEX - 6	SPARTAN-6
1.	1 THz	44.512	33.870
2.	100 GHz	5.460	3.509
3.	10 GHz	1.472	0.453
4.	1GHz	1.072	0.142
5.	100MHz	1.032	0.111
6.	10MHz	1.028	0.108
7.	1MHz	1.028	0.07

For SSSL2\_II class I/O standard at frequencies ranging from 1THz to 1MHz the power efficiency is increased ie from 23-93percent as we change the technology from VIRTEX-6 to SPARTAN-6 as shown in Table-3 and Figure-4. We are using 45nm technology based Spartan-6 and 40nm technology based Virtex-6 FPGA. We are operating our Malayalam Unicode reader with different operating frequency of 1 THz, 100 GHz, 10 GHz, 1GHz, 100MHz, 10MHz and 1MHz.

For SSSL18\_II Class II I/O standard at frequencies ranging from 1THz to 1MHz the power efficiency is increased i.e. from 28-92 percent as we change the

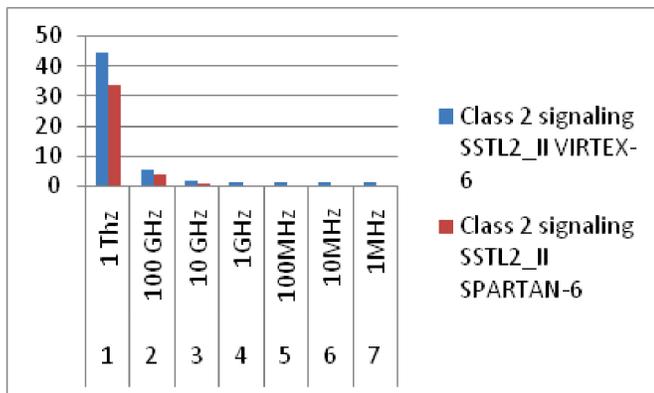


Figure 4. Power dissipation at Virtex-6 and Spartan-6.

technology from Virtex-6 to Spartan-6 as shown in Table 4 and Fig. 5.

Table 5. Power Dissipation with Class II Signaling at SSSL18\_II

S.No.	Frequency	VIRTEX-6	SPARTAN-6
1.	1 THz	37.860	27.190
2.	100 GHz	4.764	2.820
3.	10 GHz	1.390	0.361
4.	1GHz	1.052	0.111
5.	100MHz	1.018	0.086
6.	10MHz	1.015	0.084
7.	1MHz	1.014	0.083

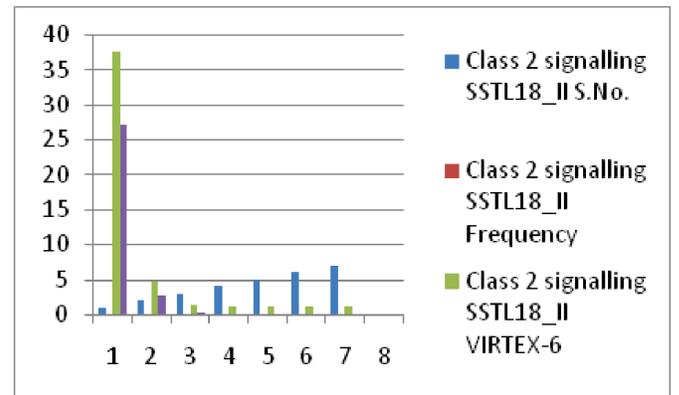


Figure 5. Power dissipation at VIRTEX-6 and SPARTAN-6.

### 5. CONCLUSION

Using SSSL I/O standards, we can conclude that we save more power in case of Spartan-6 than Virtex-6 while operating in range of 1THz to 1MHz. Also by changing the SSSL family, the change in the power dissipation is clear. We can also see that SSSL2\_II studied in Spartan-6 FPGA at 1MHz operating frequency is 93.19 percent efficient (most) than Virtex-6 FPGA at the same frequency.

### 6. FUTURE SCOPE

In this project we design Malayalam Unicode reader and there is wide scope to implement this design for various other languages like Sindhi, Urdu etc. This design is implemented on Virtex-6 and Spartan-6 FPGA. There is wide open to re-implement this Unicode reader design on the latest technology FPGA like 28nm 7-series Kintex-7 FPGA, 22nm ultra scale FPGA, and 14nm future FPGA.

### निष्कर्ष

एसएसटीएल निवेश-निर्गममानकों का प्रयोग से, हम निष्कर्ष निकाल सकते हैं कि वरटैक्स-6 के स्थान पर स्पारटैन-6 को 1 मैगाहर्ज से 1टैराहर्ज की रेंज में कार्य करने से हम काफी ऊर्जा

बचा सकते हैं। एसएसटीएल परिवार में बदलाव से भी ऊर्जा खपत में बदलाव होता है। हम यह भी देखते हैं एसएसटीएल2\_II स्पासटैन-6 एफपीजीए की 1मैगाहर्ज आवृत्ति पर कार्य वैरटैक्स-6 एफपीजीए 1मैगाहर्ज आवृत्ति पर कार्य से 93.19 percent अधिक कुशल हैं।

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## एसक्यूएल बनाम नोएसक्यूएल SQL Vs NoSQL

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### सारांश

अंततः विश्व अनुप्रयोगों (एप्लिकेशन्स) की नई पीढ़ी की ओर बढ़ रहा है, चाहे वे स्वाधारित एप्लिकेशन हो या वेब आधारित एप्लिकेशन या अंतःस्थापित एप्लिकेशन। हर चीज को स्मार्ट, लचीला, मापनीय, अति-तीव्र और साथ ही आसानी से अनुकूलनीय होने की जरूरत है। उपर्युक्त आवश्यकताओं को पूरा करने के लिए दो चीजों पर विचार किया जाना चाहिए—अग्र शीर्ष और पश्च शीर्ष। यदि एक चीज बहुत प्रभावशाली होती है और दूसरी ढीली-ढाली होती है, तो पूरा संयोजन बहुत बड़ी विफलता साबित होगा। हर चीज को दोनों सिरों से स्मार्ट होने की जरूरत है। यहां हम पिछले सिर पर अपना ध्यान केन्द्रित करने जा रहे हैं। परिप्रेक्ष्यों के आधार पर विभिन्न प्रकार के पिछले सिर हो सकते हैं, जैसे फाइल सिस्टम, डेटाबेस, इत्यादि। लेकिन इसमें भी, मुख्यतः दो प्रकार के डेटाबेस हो सकते हैं—1. वे जो एसक्यूएल पर आधारित होते हैं जिन्हें आम तौर पर आरडीबीएमएस के रूप में जाना जाता है, जैसे औरैकल, माईएसक्यूएल, इत्यादि। 2. वे जो पारंपरिक प्रश्नों पर आधारित नहीं होते हैं, जिन्हें नोएसक्यूएल डेटाबेस के रूप में जाना जाता है, जैसे माँगोंडीबी, हडूप, कैसान्द्रा, इत्यादि। किंतु, ऐसे भिन्न-भिन्न परिप्रेक्ष्य हो सकते हैं जिनमें विभिन्न प्रकार के डेटाबेस उपयुक्त होते हैं। सबके अपने संबंधित सशक्त और कमजोर पक्ष हैं।

### ABSTRACT

Eventually the world is heading towards the new generation of applications, be it standalone applications or web based applications or embedded ones. Everything needs to be smart, flexible, scalable, lightening fast and last but not the least, easily adaptable. To fulfill the above requirements, there are two things to be taken under consideration – front end and back end. If one will be ultra impressive and other will be lacking the smartness then the combo will be a big flop. Everything needs to be smart at both the ends. Here we are going to shift our focus on the back end. There can be various types of back ends, depending on the scenarios, like file system, databases, etc. But in that too, there can be mainly two types of databases – (i). The ones which are based on SQL which are commonly known as RDBMS, like Oracle, MySQL, etc. (ii). The ones which are not dependent on the traditional queries, known as NoSQL databases, like MongoDB, Hadoop, Cassandra, etc. But there can be different scenarios where different types of databases fit in. All have their respective pros and cons.

**Keywords:** Database, RDBMS, SQL, NoSQL

### 1. INTRODUCTION

Since 1960s, database technology has been an active topic of research in every field, be it academic or companies based on research and development. Now we are going to discuss about both types of databases, their architecture, usage, scenarios where they fits in, their pros and cons and almost everything about them.

### 2. ARCHITECTURE

Basically, architecture is a high level structure of anything, be it software, database, or a building, etc. It gives the air plane view. There are n numbers of

databases on the planet, be it RDBMS or NoSQL like MySQL, Oracle, PostgreSQL, MongoDb, Cassandra, to name a few. Our main motive is to understand the in-depth working of both types of databases, so let's pick one from both the families and study them. Let it be MySQL (RDBMS) and MongoDB (NoSQL).

#### 2.1 MySQL

MySQL is a schema based database and works on the table based format containing related data to the real life scenarios.

These types of tables can be made in relational databases. These tables are queried using the SQL

Serial no	First name	Last name	Languages known
1	Anuj	Sharma	Java, PHP

(Structured Query Language). SQL queries will be used to work on such type of tables. E.g. insert into table\_name values (“1”, “Anuj”, “Sharma”, “Java, Php”);.The basic architecture of a MySQL database is given in Fig. 1.

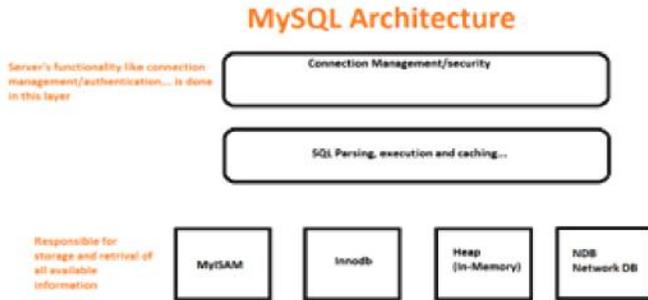


Figure 1. The basic architecture of a MySQL database.

## 2.2 MongoDB

This database is a schema-less and document-oriented database. It basically works on the key-value pair relationship but not on the table based format. What we call tables in MySQL is likely to be called as collections in MongoDB. Collection is actually a collection of key-value pair based documents. They are not based on some specific type of table. e.g. if you have a table in MySQL which is designed to have details of a user, like, name, address, contact details etc. then the database user is bound to enter only that type of details in the database which corresponds to user details only as you cannot enter the name in the address column or vice versa. But there is no such restriction in the case of MongoDB or any other document based or NoSQL based database. Suppose you have a document with the key-value as {'first\_name': 'anuj', 'last\_name': 'sharma'} and then the scenario got changed and you have to write middle name also in the forthcoming entries then there is no dependency on the previously entered data. Fresh entries can be made with the middle name included in them. So basically MongoDB provides much flexibility for the user. Although it is recommended to use same type of data in a particular collection but that is not mandatory. The basic architecture of the MongoDB is given in Fig. 2.

## 3. TERMINOLOGY AND CONCEPTS

### 3.1 Comparison between MySQL and MongoDB

There are a lot of differences and similarities in MongoDB and MySQL related to various types of conditions. Let's go through them one by one a bit in detail.

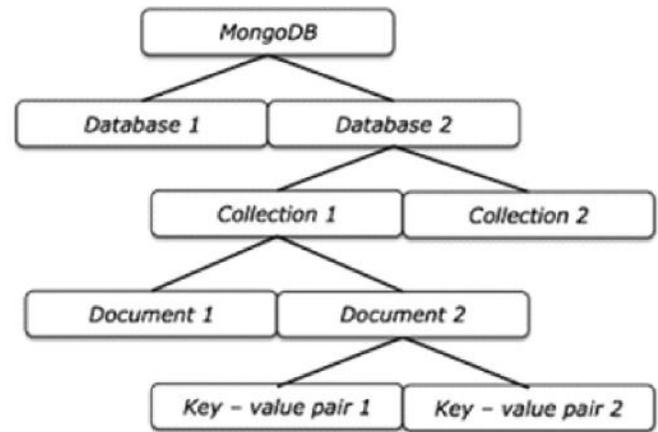


Figure 2. The basic architecture of MongoDB.

Table 1. Comparison of terms and concepts of SQL and MongoDB

SQL Terms/Concepts	MongoDB Terms/ Concepts
database	database
table	collection
row	document or BSON document
column	field
index	index
table joins	embedded documents and linking
primary key	primary key
Specify any unique column or column combination as primary key.	In MongoDB, the primary key is automatically set to the _id field.
aggregation (e.g. group by)	aggregation pipeline

#### 3.1.1 Representation of Data.

MySQL represents data in the form of tables, rows and columns whereas MongoDB represents the data in the form of collections of JSON (Javascript Object Notation) documents.

#### 3.1.2 Querying

SQL stands for Structured Query Language which is basically used to query a MySQL database. In this, string is passed in the query which is parsed by the database system which makes it possible to have an SQL injection attack.

MongoDB is queried by objects. It means that an object will be passed it to tell the system that what we actually want it to perform. It doesn't have any language to be parsed.

#### 3.1.3 Relationships in the Ddata

MySQL comes with the JOIN operation which allows the user to query over multiple tables whereas MongoDB doesn't support any functionality as JOINS. But it supports multi-dimensional data types such as

arrays. If some data needs to be embedded or connected then that particular document can be inserted in the other documents. E.g. if you have to design a blog using MySQL then you will have two tables, one for posts and one for comments but that will not be the case of MongoDB as you can have only one collection of posts and can have multiple arrays of comments embedded in those posts.

#### 3.1.4 Schema Design

MySQL doesn't provide much flexibility about how the data will be structured in the database. It will force you to have pre-defined tables and columns to start to store anything and every row must have the same related data as per the columns. But that is not the case with MongoDB, just the documents need to be dropped there and that's it. And multiple documents are not mandatory to have same name or number of fields.

#### 3.1.5 Performance

MySQL gets blamed for its performance being poor very often. But if you have indexed your data properly and using a database wrapper then its performance can be considerably good. Contrary to it, by dropping the things like joins and by having fantastic tools for analysis of performance, MongoDB can perform far better than any other relation database. But to get the most out of it, you will still have to index your data. But in most of the cases, you won't have the enough data to actually witness the difference.

#### 3.1.6 When to choose MySQL

If you are sure that your data can easily be the part of the standard tables and columns culture then MySQL can be your best bet. If performance is your biggest concern and SQL is the hardcore choice of yours then just index your data properly and sophisticatedly and you can get the considerably good performance.

#### 3.1.7 When to choose MongoDB

If you think that the data is complex enough not to suit a standard system of tables and columns. If

you are not in a condition to pre-decide that how would your schema will look like or you want to store the data in a single collection but with multiple types of fields and not with one standard type of fields then there is no doubt that you must go with the MonogoDb.

## 4. CONCLUSION

In this paper we have discussed almost everything about the relational and non-relational databases or you can say NoSQL databases. We have gone through their architectures, their pros and cons, which size they fit in, where to use them and where not to use them. So, any person who reads this paper paper can make a decision to select which database will be of better choice for the project and where else it can be implemented.

## निष्कर्ष

इस पत्र में हमने संबंध आधारित या गैर-संबंध आधारित डेटाबेस अथवा आप कह सकते हैं नोएसक्यूएल डेटाबेस के बारे में लगभग सारी बातों पर चर्चा की है। हमने उनके वास्तुशिल्प, उनके पक्ष और विपक्ष, किस आकार में वे उपयुक्त बैठते हैं, कहां उनका उपयोग किया जाए और कहां नहीं किया जाए, इन सब पर विचार किया है। अतः, इस पत्र का कोई भी पाठक अपना निर्णय ले सकता है कि उसकी परियोजना के लिए चयन किए जाने हेतु कौन सा डेटाबेस बेहतर विकल्प होगा और इसे कहां और भी कार्यान्वित किया जा सकता है।

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## औपचारिक सॉफ्टवेयर विशिष्टता और सत्यापन Formal Software Specification and Verification

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### सारांश

मेरी षोध पद्धति एडवांस सॉफ्टवेयर इंजीनियरिंग के ज्ञानानुशासन पर आधारित है। मेरा प्रपत्र विनिर्देश और प्रोग्राम शुद्धता के सत्यापन को अलगाने का प्रयास है। इस प्रपत्र में प्रश्न का उत्तर है "हम कैसे धारणात्मक सॉफ्टवेयर इंजीनियरिंग का अनुशासन प्रभावी ढंग से औपचारिक एल्गोरिदम की क्षमता का उपयोग कर सकते हैं।" यह प्रपत्र अद्वितीय चुनौतियों और अवसरों के साथ औपचारिक विनिर्देश और सत्यापन अवधारणा के वर्णन से शुरू होता है। इसके बाद यह एडवांस सॉफ्टवेयर इंजीनियरिंग के ढांचे के बारे में बताता है और अंत में यह ह्योरे की तरह अनुसंधान के अवसरों का वर्णन करता है।

### ABSTRACT

The research methodology is based upon advance software engineering discipline. The paper is an attempt to differentiate specification and verification of program correctness. This paper is an answer to the question: What is unique about formal Methods and conceptually how software engineering discipline can effectively utilise potential of formal algorithms? The paper begins by describing formal specification and verifications concept along with challenges and opportunities. Next, it summarises the life cycle advance software reengineering framework. Finally, it describes the research opportunities in topic like Hoare logic.

**Keywords:** Advance software engineering, formal methods, formal algorithms, Hoare logic

## 1. INTRODUCTION

Formal methods consist of writing specification of a program using formal techniques. A formal technique is a mathematical method to specify hardware and software architecture. It also verify whether a specification is realizable, verify that an execution and implementation satisfies its specification, logically prove properties of a system without necessarily reengineering the system, etc. The mathematical basis of a formal method is provided by the specification language.

System analyst must learn both syntax and semantic of program construct, while writing system descriptions. Both SYN and SEM must be synchronized so that during later phase, correctness can be achieved.

A formal specification language consists of two parameters SYN(X) and SEM(Y). The parameter 'X' is called the syntactic domain, the parameter 'Y' is called the semantic domain, and the relation 'f' should synchronize satisfactory properties.

X----- 'f'----->Y

Formal methods is the application aspect of mathematic logic in the development of 'correct' software systems.

Formal specification is an example of formal methods applied to verification and validation procedure.

Now let us define Algorithm Correctness (how to prove programs are correct) using two keywords Pre (P) and Post (Q)

The algorithm is correct if it can be proved that if the pre-condition is true, the post-condition must be true. Pre-condition (P)  $\Rightarrow$  Post-condition (Q)

Pre-condition of the algorithm: a predicate that describes the initial state (before execution)

Post-condition of the algorithm: a predicate that describes the final state (after execution).

### 1.1 Statement of the Problem

The major problems with informal specifications:

- Informal specifications have generally been seen ambiguous, which is likely to cause wrong interpretations.
- In many cases use of Informal specifications create difficulties during inspection and testing of programs because of the large gap between the functional descriptions in the specifications and

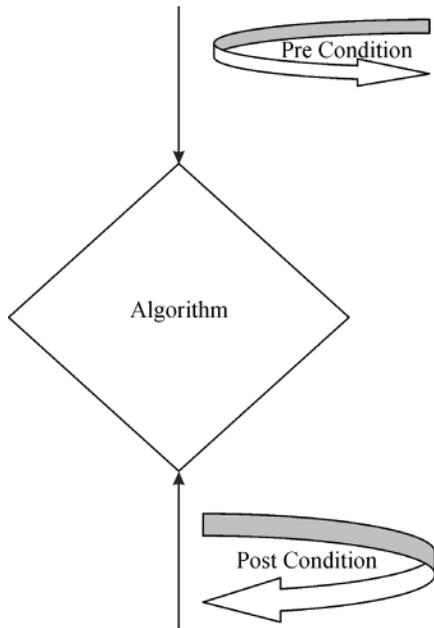


Figure 1. Pre and post condition

the program design.

- Informal specifications are difficult to be fully analysed during program debugging and hence problems like consistency and validity.
- Information specifications are not compatible and difficult to support by application and software tools in their life cycle like analysis, transformation, and management (search, engineer, change, and reuse).

1.2 Possible Solution

- Adopt formal methods
- Exercise these methods using set theory and algebra
- apply logics (Hoare and Dizkstra Logic)
- Introduce mathematical induction
- Use CAV and CASE tools.
- Formal notation (formal language) for writing specifications.
- Logical calculus for formal verification (proof calculus)

2. RESEARCH METHODOLOGY

2.1 Specification in the Software Process

Formal methods primarily depend on traditional SAD with one exception. Formal specifications are expressed in a mathematical logic with defined vocabulary, syntax and semantics of assertions. Architectural design is essential to structure a specification. Major requirement of formal specification can be conceptualised using formal languages.

2.4 Why Use Formal Methods?

Formal methods refer to a variety of mathematical

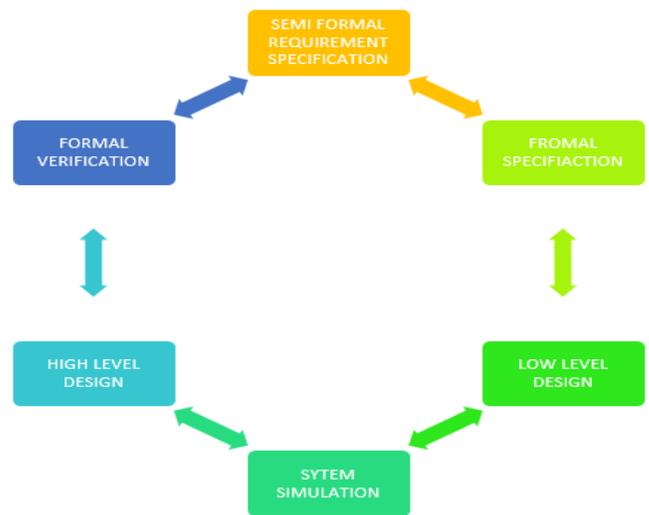
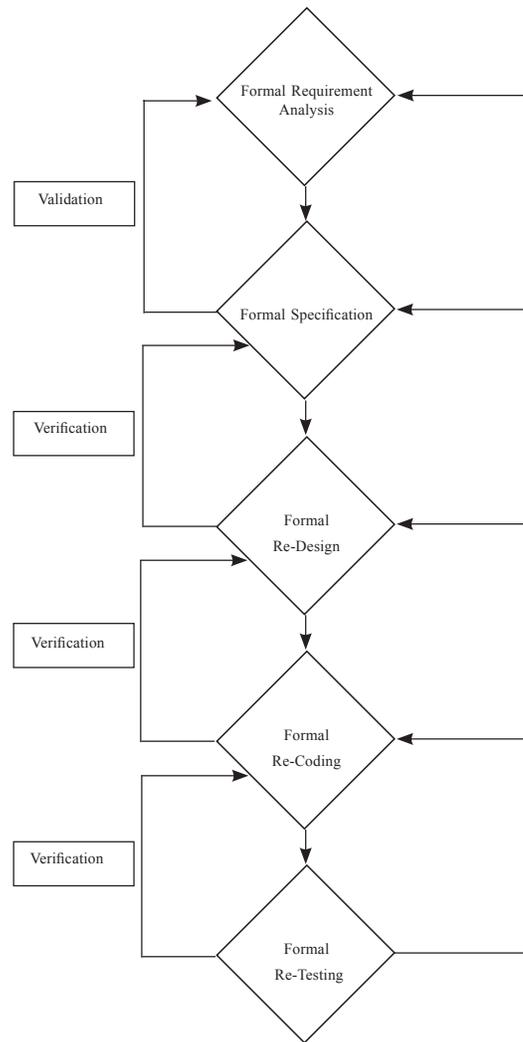


Figure 2. Life cycle software specification of program (stages)

modeling techniques, which are used both to (a) Model the behavior of a computer system and to verify that the system satisfy design, safety and functional properties. (b) Formal methods are typically employed for the following reasons:

## 2.2 Formal Life cycle SAD framework (Modified Version)



Figure 3. Development costs with formal specification.

## 2.3 Formal Specification Languages

FSL	Sequential	Concurrent
Algebra-Based FSL	Larch & OBJ	Lotos
Framework-Based FSL	Z, VDM, B	CSP, Petri Nets

- Formal methods usually have a well-founded mathematical basis
- The mathematical basis of the formal methods facilitates automating the analysis of specifications
- Formal methods have well-defined semantics.
  - o To find correctness of algorithm using mathematical derivation (Hoare logic)
  - o They are expected to save development costs
  - o The product can be made sufficiently reliable and mathematical sound and complete
  - o Typically used in theoretical computer science fundamentals, in particular logic calculi, formal languages, automata theory, and program semantic
  - o To correct liveness and safety properties

## 2.5 Where are Formal Methods Used?

- Microprocessor architectural design
- Cache coherency protocols and model
- Electronics and telecommunications protocols
- Transport rail and track signaling theory
- Financial and security protocols
- Industrial and automotive companies

## 3. FORMAL VERIFICATION

Formal verification is an example of formal methods applied to verification. Formal verification is a process of constructing a proof that a software system will react in accordance with its said specification.

Edsger W. Dijkstra has defined more generic verification procedure, ‘The ‘standard’ verification

technique is testing, but Program testing can be a very effective way to show the presence of bugs, but it is hopelessly inadequate for showing their absence’.

## 3.1 Challenges of Formal Verification

- Complexity of verification
  - Automatic for finite state systems (HW, protocols)
  - Semi-automatic in the general case of infinite state systems (software)
- State explosion problem
  - Symbolic model checking
  - Compositional reasoning
  - Localisation Reduction (Formal Check)
  - Partial Order Reduction (Spin)

## 3.2 Hoare Logic

Charles Antony Richard Hoare is British computer scientist modified Dijkstra logic of formal verification using formal system with a set of logical rules for reasoning rigorously about the correctness of computer programs.

## 3.3 Background

Hoare - An axiomatic basis for computer programming (1969), describes a deductive system for proving program correctness using set of a set of axioms and inference rules about asserted programs

Dijkstra in his research article state that program testing can be used to show the presence of bugs, but never to show their absence!”

Hoare had tried to prove total correctness using axiom.

Hoare triple:  $\{P\} S \{Q\}$ -using some predicate  
 $\{P\}$ .....Precondition  
 $[Q]$ .....Postcondition  
 $(S)$ .....Program Statement

Partial correctness: If S is executed in a store initially satisfying P and it terminates, then the final store satisfies Q

Total correctness: As partial, but also requires termination

Axiomatic logic: Axioms and rules defining valid Hoare triples.

## 4. CONCLUSIONS AND FUTURE LEARNING

Scientists and mathematicians across the globe have already experienced real power of formal specification and verification. Formal methods are promising field in computer science and engineering. Recent advancement in mathematical theorem proving, model checking, temporal logic, I/O automata has resulted more robust software verification. But still Future work needs to

be done in several areas

- Composition
- Combinations of mathematical theories
- Data structure and algorithms
- Decomposition
- Abstraction
- Reusable models and theories.

### निष्कर्ष

दुनिया भर के वैज्ञानिकों और गणितज्ञों ने पहले ही औपचारिक विनिर्देश और सत्यापन की वास्तविक शक्ति का अनुभव किया है। औपचारिक तरीके कंप्यूटर विज्ञान और इंजीनियरिंग क्षेत्र में विश्वसनीय कार्य कर रहे हैं। गणित प्रमेय साबित करना, मॉडल जाँच, लौकिक तर्क और इनपुट/आउटपुट की हाल में हुई शोध से सॉफ्टवेयर सत्यापन ने और अधिक प्रभावी परिणाम दिए हैं। लेकिन अभी भी भविष्य में कई क्षेत्रों में काम किया जाना शेष है।

- रचना

- गणितीय सिद्धांतों के युग्म
- डेटा संरचना और एल्गोरिदम
- अपघटन
- अमूर्त
- पुनः प्रयोज्य मॉडल और सिद्धांत

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## उच्च निष्पादन करने वाली कार्यक्रम प्रबन्धन प्रणाली का डिजाइन High Performance Event Management System Design

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### सारांश

किसी कार्यक्रम के सफल होने के लिए कार्यक्रम के प्रबन्धन की आवश्यकता होती है। इस परियोजना का लक्ष्य कॉलेज स्तर के कार्यक्रम का प्रबन्धन करना है उदाहरण जैसे कॉलेज उत्सव। कार्य प्रबंधक के लिए कार्य प्रबन्धन, उनके स्थानों, समय, बजट, प्रतिभागियों आदि का प्रबन्धन एक मुश्किल कार्य है। कार्यक्रम प्रबंधक को प्रतिभागियों, आगंतुकों जो कि कार्यक्रम में भाग ले रहे हैं उनके प्रबन्धन का कार्य भी करना है। प्रबन्धन को कार्यक्रम प्रबन्धन परियोजना की आवश्यकता होती है जो कार्य प्रबन्ध करने में कार्यक्रम प्रबंधक की मदद करता है। यह परियोजना प्रशासकों को अकाउंट प्रदान करती है जो कि पासवर्ड से सुरक्षित हैं, ये उन्हें कार्यक्रम के प्रबन्धन में, डाटाबेस को देखने और बदलाव करने में आजादी प्रदान करते हैं। यह प्रतिभागियों को सुरक्षित अकाउंट प्रदान करता है जिससे वे विभिन्न प्रकार के कार्यक्रम को देख सकते हैं और उसमें पंजीकरण करा सकते हैं। आगंतुक कार्यक्रमों को देख सकते हैं और उसमें पंजीकरण करा सकते हैं। नेटबीन्स और माईस्क्यूल डाटाबेस नामक प्लेटफार्म का इस्तेमाल किया गया है जो डाटाबेस रिकार्ड को बनाए रखते हैं।

### ABSTRACT

For an event to be successful event management is required. This project aims for management of a program at college level example college fest. It is a difficult affair to manage events their venues, timing, budget, participants etc for the event manager. Event manager also has task of managing participants, visitors taking part in the event. Management of such a program requires an event management project which can provide ease to event manger to manage the program. This project provides account for administrators, secured with passwords, which gives them liberty to manage the event, view the database and make changes. It also provides secure account to participants where they can view different type of events and register. Visitors can view events and register in them. Platform used is NetBeans and MySQL database is used to maintain the records.

**Keywords:** High performance, event management system, java, user friendly interface, college fest management

### 1. INTRODUCTION

An event is something that happens, not just exits, somebody has to make it happen. Management characterizes the process of and personnel leading and directing all or part of an organization. Event management which is an application of project management is a way through which events are organized by an organization. Objectives of event are taken into consideration and accordingly roles and responsibilities are assigned, event handling procedures are followed [6]. Event manager is who plans and executes the events. The project is based on college fest management .In a college fest there are administrators or event manager who look after management of project, participants who participate in the events organized in the fest and visitors for other colleges who take part in fest.

Administrators have privileges to change, modify or delete the events, view details of participants and visitors. Participants have their separate accounts. In their account there are details of events, registration in an event. Visitors view list of events and can register in an event. Project provides different accounts to administrators, participant and visitors. Accounts of administrator and participants and secured with password. Software implementation is first stage and hardware implementation is second stage. Our design is delivering high performance [3] because there is no significant delay in receiving input and there is no major delay in delivering output and we are also using efficient coding practices [5] in our high performance event management system. In later stages, we can make hardware chip for our design using Verilog

and taken consideration of Low Voltage Electronics [4] and before fabrication of chip we can use Field Programmable Gate Array (FPGA) to test it.

## 2. METHODOLOGY USED

Java version 7.2.1 has been used to design and develop this project. Java was developed at Sun Microsystems by a team headed by James Gosling. In 1995 first version JDK 1.0 was released. Major release in JDK includes version 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 and latest version JDK 8 which was released on March 18, 2014. Various features of java are simple, object oriented, portable, multithreaded, robust, etc<sup>[8]</sup>. Java is a high-level language. Other high-level languages are C, C++ etc. While in other languages code is compiled into executable code in java code is compiled and interpreted both. Java compiler converts code into byte code. Byte code is easy and fast to interpret and is portable. It can be compiled on one machine and interpret it on other. Java provides features like platform independence, portability, security, etc., which makes it unusual than the other high-level languages.

## 3. PURPOSE OF PROJECT

Events in college such as fest are organized every year. Fest promotes the hidden talent and aim to exhibit it. Series of events are conducted to test logical ability, creativity, spontaneity and knowledge of participating students [7]. Aim of this project is to design and develop event management system which will help to manage such a program.

## 4. IMPLEMENTATION

Java application is created in NetBeans platform. In the new project JFrame form are designed in the design view using palette. As shown in Fig. 1 palette provides an easy and efficient way to design the form as it saves developer time. Coding is done in the source view.

The NetBeans editor provides code templates, tips and refactoring tools. NetBeans also provides features as line indentation, matches word and brackets also highlights source code syntactically and semantically [8]. Main page provides different options for administrator, participant and visitor. Administrator as event manager has maximum privileges. As shown in Fig. 2 administrator account is secured with password and provides authority to make suitable changes in the event. Administrator can add a new event, delete existing event, or make changes in an existing event. Participant account has less privilege than administrator. Account is secured with password and gives option to view event details, participate in an event. Visitor account has least privileges, registering in an event



Figure 1. Palette containing options to create form.

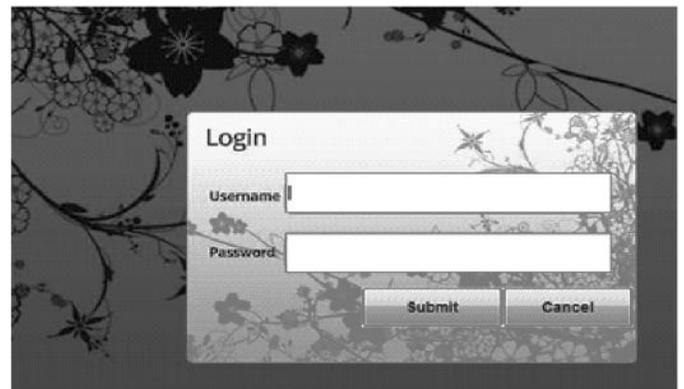


Figure 2. Login page.

and view events. MySQL is used to create database. Tables in MySQL are created through option provided in object browser. As shown in Fig. 3 object browser leads to another window where user can create table by filling the Create Table pane. Data type, precision, scale, Not Null constraints can be chosen accordingly. By following series of steps primary key, foreign key and constraints are chosen. By clicking create option table is created.

As shown in Fig. 4 Project table is created and has various editing options which are used to edit table. Data options shows the entries present in table. Connection is set up between MySQL databases from NetBeans IDE. Once connected information is added, updated and deleted from the forms example as used in various forms to add new event, change existing

Figure 3. Create table window.

Column Name	Data Type	Nullable	Default	Primary Key
NAME_OF_EVENT	VARCHAR2(4000)	Yes	-	-
DESCRIPTION	VARCHAR2(4000)	Yes	-	-
TYPE_OF_EVENT	VARCHAR2(4000)	Yes	-	-
VENUE	VARCHAR2(4000)	Yes	-	-
TIME	VARCHAR2(4000)	Yes	-	-
PRIZE	VARCHAR2(4000)	Yes	-	-
FEE	VARCHAR2(4000)	Yes	-	-
CATEGORY	VARCHAR2(4000)	Yes	-	-
PARTICIPANTS	VARCHAR2(4000)	Yes	-	-
QPS	VARCHAR2(4000)	Yes	-	-

Figure 4. New table created.

event, delete an existing event etc. Information can also be retrieved from tables as used in the change existing event form, where the user enters the event name and type of event and the rest of the information is retrieved from the MySQL database. The project is compiled and executed with valid and invalid data and executes successfully. Validation checks introduced have greatly reduced the error, hence entries in the database are nearly accurate. The constraints are met and overcome successfully. The system is designed as described in the purpose of the project.

## 5. CONCLUSIONS

The project provides a facility for the management of a fest in a university. It provides a facility for an event manager to easily manage, update, and add new events and participants. It provides a facility for registering students and visitors in a fest. Additional modules can be added when necessary. The software is tested with valid data and invalid data and everything works successfully. Thus, this project has fulfilled all the objectives mentioned. In the future, this project can be used on a large scale instead of a small scale like a college level. Accuracy and non-redundant data are the main advantages. Data entry errors can be minimized through validity checks.

## निष्कर्ष

यह परियोजना विश्वविद्यालय में होने वाले उत्सव के प्रबंधन की सुविधा प्रदान करता है। यह परियोजना प्रबंधकों को कार्यक्रम के आसान प्रबंधन, अद्यतन और नए कार्यक्रम एवं प्रतिभागियों को जोड़ने की सुविधा प्रदान करता है। यह परियोजना उत्सव में छात्रों और आगंतुकों के पंजीकरण के लिए सुविधा प्रदान करता है। अतिरिक्त मॉड्यूल आवश्यकता होने पर जोड़ा जा सकता है। सॉफ्टवेयर को मान्य डेटा और अमान्य डेटा के साथ परीक्षण किया जाता है और सब कार्य सफलतापूर्वक हो जाता है। इस प्रकार यह परियोजना सभी उल्लेखित उद्देश्यों को पूरा करती है। भविष्य में इस परियोजना को कॉलेज स्तर के एक छोटे स्तर की बजाए बड़े स्तर पर आयोजित किया जा सकता है सटीकता और गैर अनावश्यक डेटा मुख्य लाभ है। डेटा प्रविष्टि त्रुटियों को वैधता जाँच के माध्यम से कम किया जा सकता है।

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## सॉफ्टवेयर परीक्षण का जीवन चक्र Software Testing Life Cycle

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### सारांश

सॉफ्टवेयर परीक्षण जीवनचक्र कुछ नहीं है ये केवल साफ्टवेयर परियोजना के जीवन चक्र के दौरान परीक्षण इंजीनियर द्वारा की जानी वाली विभिन्न गतिविधियाँ हैं। सॉफ्टवेयर परीक्षण जीवन चक्र परीक्षण के दौरान होने वाली चरणबद्ध गतिविधियाँ हैं। सॉफ्टवेयर टेस्टिंग उत्पाद की गुणवत्ता में सुधार करता है। यह सॉफ्टवेयर की उत्पादकता बढ़ाता है और सॉफ्टवेयर की लागत को कम करता है। परीक्षण केवल टेस्ट केशों का निष्पादन करना ही नहीं है परन्तु यह साफ्टवेयर के सम्बन्धित संपूर्ण दस्तावेजों को पढ़कर उसमें दोषों की पहचान करना है। साफ्टवेयर परीक्षण सॉफ्टवेयर विकास जीवन चक्र का एक महत्वपूर्ण चरण है। परीक्षण दोषों को दूढ़ने के लिए किया जाता है और इन दोषों को ठीक करने से उत्पाद की गुणवत्ता बढ़ाई जाती है।

### ABSTRACT

Software Testing life cycle is nothing but the activities done by test engineers during project life cycle. Software Testing Life Cycle defines the steps by steps activities in testing. Software Testing improves the quality of the product. It also increase productivity of software and reduces the cost of the software. Testing is not to execute the test cases but also by reading the document of the product the test engineer can identify the defects. Testing is an important phase of Software development life cycle.

**Keywords:** Defect, priority, severity, defect tracking tool, stress testing, performance testing

### 1. INTRODUCTION

Following steps are involved in the software testing life cycle (Fig. 1)

Step 1: Test engineer to prepare the quality test plan and test plan is a planning document which contains following information-

- Release milestones/dates.
- Resource allocation.
- Risk
- Test deliverables
- Stop criteria

Step 2: Study the FRS document of the project.

Step 3: Prepare the test strategy document. Send this document to all technically sound people for reviews.

Document contains the following information: -

- Overview of feature.
- Test environment set up.
- Not in scope of testing.
- Test case techniques.
- Which test methodology we are using?

Step 4: Prepare test specification document on the basis of FRS document. This document is in tabular format for testing purpose. After completing

the document send this document to all technically sound people for their reviews.

Step 5: Once the product build is given to test team, test engineer executes the test cases.

Step 6: During the execution, if enter the any defect then is found defect in to defect tracking tool.

Step 7: Test engineer to in retest and regression testing.

Step 8: Test engineer to prepare the test report.

#### 1.1 When to Start Testing?

Software testing is involved in early part of the project development. Once the FRS document is ready, the functional test team is involved in following activities:-

- Reviewing the document and giving the defects.
- Prepare test strategy document.
- Prepare test cases.

#### 1.2 When to Stop Testing?

Testing of features stopped if the following criteria is met.

A. More than 95% test cases are in "Passed" state.

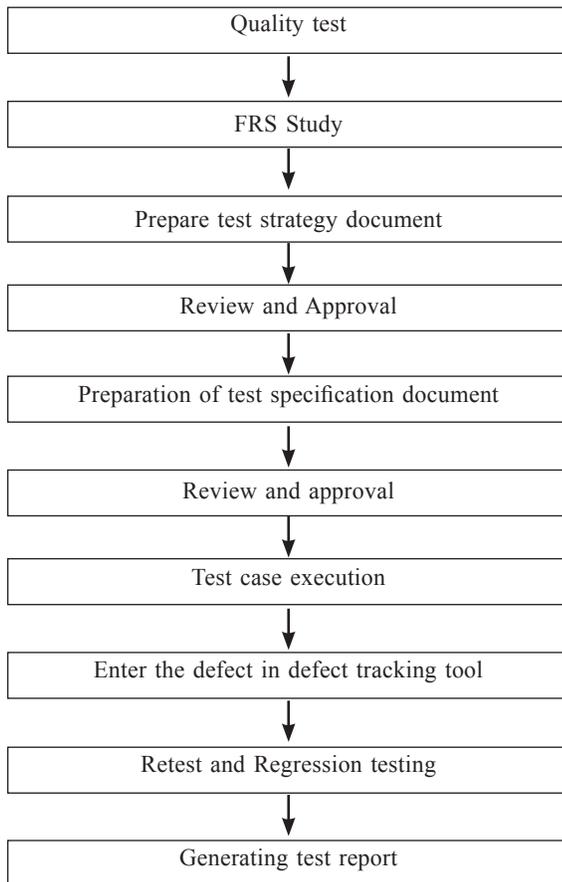


Figure 1. Different activities in testing process.

- B. There should not be any high severe defects available in defect tracking tool in “open” state.

**2. TESTING TYPES**

Testing of software product can be done both using automation and manual testing methods.

1. *Manual Testing*- Testing of the Software product manually means that we are not using any automated tool or any script. In this type tester take over the role of an end user and tests the software to identify any unexpected behaviour or bug<sup>2</sup>.
2. *Automation Testing*- In this method, we use the automation tools to run test script that repeats the predefined steps. Automation Testing is used to re-run the test scenarios/scripts that were performed manually and repeatedly<sup>2</sup>.

**3. LEVELS OF TESTING**

Following are the main levels of Software Testing:

- Functional Testing.
  - Non-functional Testing.
- 1 *Functional Testing*- Testing is done by an analysis of the specification of the functionality of a software or product. All the module of all feature are integrated and given as a product to functionality

team to test the functionality of product as per FRS. It involves the following:

- A. *Unit testing*- Testing is done by developer by testing his own developed code. A unit is the smallest test able part of software. It usually has one or a few inputs and usually a single output. In procedural programming a unit may be an individual program, function, procedure, etc <sup>[3]</sup>.
- B. *Integration Testing*- Integrating the modules of one feature this testing is done<sup>3</sup>. Two approaches are there
  - Top to Down- Top Down is an approach to Integration Testing where top level units are tested first and lower level units are tested step by step after that. This approach is taken when top down development approach is followed.
  - Bottom to UP- Bottom Up is an approach to Integration Testing where bottom level units are tested first and upper level units step by step after that.
- C. *Re Testing*- If a defect which is previously raised and solved properly is called re-testing.
- D. *Regression Testing*- The main aim of regression testing is to find the side effect (in the passed test case) introduced because of code change. Code change in the scene is due to following
  - Either due to bug fixing.
  - Due to addition of any new feature.
- E. *Acceptance Testing*- If the testing done by client/customer before accepting the product. This testing can be done by own testing team of client which is called alpha testing.

If acceptance is done by 3rd party organization then it is called beta testing.

2. *Non Functional Testing*- Non-functionality testing is done to check the stability and robustness of the product. Here we look for hang or crash kind of issues and try different test methods likes:-Stress testing, Load testing, Performance testing

**4. TESTING METHODOLOGIES AND TYPES**

Two testing methodologies and types considered are:

1. Black box testing
2. White box testing

**4.1 Black Box Testing**

In this technique, user is not aware of internal knowledge of application. The tester is oblivious to the system architecture and does not have access to source the code.

Black box testing technique<sup>5</sup>-

1. *Equivalence partitioning*- A The equivalence partitioning technique in which test cases are

designed to executed representative from equivalence partitioning . We need to test only one condition from each partition.

2. *Boundary value analysis*-This technique is used for range given in a requirement
3. *Decision table testing*- A technique in which test cases are used to execute the combination of input and stimuli (causes) has shown in decision table.
4. *State transition testing*- Here our aim is to find more defects by involving different states. In which test cases are designed to execute valid and invalid state transition.
5. *Use case testing*- A techniques in which test cases are designed to execute user scenario.

#### 4.2 White Box Testing

In this technique user is not aware of internal knowledge of application.White box testing is the detailed investigation of internal logic and structure of the code.

White Box Techniques<sup>5</sup>

1. Statement Coverage – Execute all statements at least once  
Example: -Read A  
              Read B  
              If A>B then C=0  
              ENDIF
2. Decision Coverage-100 % decision coverage implies 100 % statement coverage.

#### 5. CONCLUSION

Testing can ensure that defects are present, but cannot ensure that there is no defect or bug. Testing reduces the probability of unidentified defects remaining in the product but, if there is no defect that does not mean our software is correct. Testing is identified the defect and eliminating that defect in software product.

#### निष्कर्ष

परीक्षण सुनिश्चित कर सकते हैं कि दोष मौजूद हैं लेकिन यह सुनिश्चित नहीं कर सकते कि कोई दोष या बग मौजूद नहीं हैं। परीक्षण उत्पाद में बचे हुए अज्ञात दोषों की संभावना को कम कर देता है परन्तु यदि कोई दोष नहीं मिलता तो इसका मतलब यह नहीं है कि हमारा सॉफ्टवेयर सही है। परीक्षण साप्टवेयर में दोषों की पहचान करता है और साप्टवेयर उत्पाद में इन दोषों को हटाता है।

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# डेटा संकुचन और सरल एन्कोडिंग तकनीक से पारगमन गतिविधि और वीएलएसआई सर्किट में ऊर्जा के अपव्यय को कम करना

## Data Compression and Simple Encoding Techniques to Reduce Transition Activity & Power Dissipation in VLSI Circuits

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### सारांश

कम बिजली की गहरी सबमाइक्रोन प्रौद्योगिकी के क्षेत्र में पारगमन गतिविधि ऊर्जा अपव्यय के लिए प्रमुख कारक है। ऊर्जा अपव्यय को डेटा बसों पर होने वाली पारगमन गतिविधि को कम करके और डेटा कोडिंग तकनीक के उचित कार्यान्वयन द्वारा प्राप्त किया जा सकता है। डेटा प्रेषण की गति मुख्य रूप से डाटा बसों पर प्रेषित बिट्स की संख्या पर निर्भर करता है। जब डाटा प्रेषण की ज्यादा मात्रा का संचालन करना होता है तब विशाल भंडारण स्थान (स्टोरेज स्पेस) की आवश्यकता सूचना के प्रसंस्करण, भण्डारण और प्रेषण के लिए होती है। यह एनकोडर कम्प्यूटेशनल जटिलता, देरी और क्षेत्र में वृद्धि करता है जो स्वचालित रूप से सर्किट में ऊर्जा के अपव्यय में वृद्धि करते हैं। एनकोडर जटिलता को कम करने के लिए डेटा को एक कॉम्पैक्ट रूप में प्रदर्शित किया जा सकता है। इसलिए इस आलेख में एन्कोडिंग करने से पहले, डेटा को सरल बाइट संपीड़न तकनीक (सीम्पल बाइट कम्प्रेसन तकनीक) से संकुचित किया गया है और फिर इसे बाइनरी कोडन तकनीक द्वारा कोडित किया गया है। दोनों तकनीकों से पारगमन गतिविधि को 59.3%, संकुचन (कंप्रेशन) अनुपात को 1.987 तक बेहतर किया गया है। अंत में ऊर्जा की खपत को 66.6% मात्रा को बचाया गया है।

### ABSTRACT

In low power deep submicron technology the transition activity is the major factor for energy dissipation. Energy dissipation can be reduced by minimizing the transition activity on data buses and can be achieved by proper implementation of data coding techniques. Speed of data transmission mainly depends on the number of bits transmitted through buses. When handling large data transmission, huge storage space is required especially for processing, storing or transferring information. This will increase the encoder computational complexity, delay and area, which will automatically increase power dissipation of the circuit. To reduce encoder complexity the data's can be represented in a compact form. So in this paper before encoding, the data has been compressed by simple byte compression technique and then it is coded by binary coding technique. Both techniques will improve transition activity up to 59.3%, compression ratio up to 1.987. Finally the overall energy is saved up to 66.6%.

**Keywords:** Transition activity, data compression, octo coding, energy dissipation, self transition and coupling transition

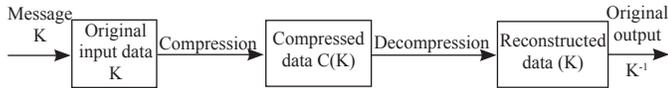
### 1. INTRODUCTION

Deep submicron technology allows billions of transistors on a single chip. According to semiconductor industry association (SIA) the number of transistor per chip and the local frequencies for high performance devices will continue to grow exponentially in near future. With ever growing length of interconnect and on chip clock frequency will increase the delay, area and transition activity on data bus, which will degrade the performance of the device. Nowadays power is the primary concern for any kind of application or

system. Power dissipation has been considered as one of the very critical issue in the performance of the high speed VLSI circuits. Power dissipation can be reduced by minimizing the transition activity on interconnects<sup>[16]</sup>. While transmission, due to large number of data, increases storage space and transition activity on data buses. Signal encoding techniques have been proposed to reduce the transition activity. Simple byte compression algorithm is our proposed compression technique. Compression generally increase bit toggling<sup>[11]</sup>. So Octo coding method is used to

reduce the bit toggling effect during data compression. Since both compression and data coding effectively reduce the delay, area and power dissipation.

Compression techniques consist of two basic components such as an encoding (Compression) and decoding (Decompression) process. The encoding algorithm that takes input data (K) and generates compressed data C(K) which is less number of bits compare to input data 'K' and a decoding algorithm that reconstructs the original data 'K1' from the compressed data C(K) are shown in Figure 1. Both compression and decompression together called compression technique or algorithm.



Based on the requirement of data compression it is broadly classified in to lossy compression scheme and lossless compression scheme. Lossy compression algorithm can only reconstruct an approximation of the original message that is not an exact replica of input data. It is applied to images and sound where a least bit of loss in resolution is usually undetectable or acceptable level. Lossless algorithm, which can reconstruct the original message accurately, that is exact replica of original input data. It is typically used in text data, scientific data such as medical, industrial application and also in military application.

## 2. BUS ENERGY MODEL

The DSM model of data bus coding uses simple electrical model [13] in which lines are replaced by parasitic resistors and capacitors are shown in Figure 1. Here, CS and Cc are the self and coupling capacitances, R represents the on-off resistance, Vni and Vnf denote the initial and final voltages in the nth interconnect [15]. Let  $V_{1i}, V_{2i}, \dots, V_{ni}$  are initial voltages of n bit data bus wire and  $V_{1f}, V_{2f}, \dots, V_{nf}$  are final voltages of n bit data bus wire. Here  $V_{1i} \dots V_{ni}$  and  $V_{1f} \dots V_{nf}$  can be either VDD or gnd potential. The approximate energy expression for the self and coupling transitions considering n-bit data bus can be expressed as [13].

$$E_1 = [(1 + \lambda)(V_1^f - V_1^i) - \lambda(V_2^f - V_2^i)]V_1^f$$

$$E_2 = [-\lambda(V_1^f - V_1^i) + (1 + 2\lambda)(V_2^f - V_2^i) - \lambda(V_3^f - V_3^i)]V_2^f$$

$$E_3 = [-\lambda(V_2^f - V_2^i) + (1 + 2\lambda)(V_3^f - V_3^i) - \lambda(V_4^f - V_4^i)]V_3^f$$

$$E_4 = [-\lambda(V_3^f - V_3^i)(1 + \lambda)(V_4^f - V_4^i)]V_4^f$$

$$E_n = [-\lambda(V_{n-1}^f - V_{n-1}^i)(1 + \lambda)(V_n^f - V_n^i)]V_n^f$$

Finally the percentage of energy saved due to reduction of transitions is calculated by

$$\% \text{ of Energy saved} = \left( \frac{E_{unc} - E_{cod}}{E_{unc}} \right) \times 100$$

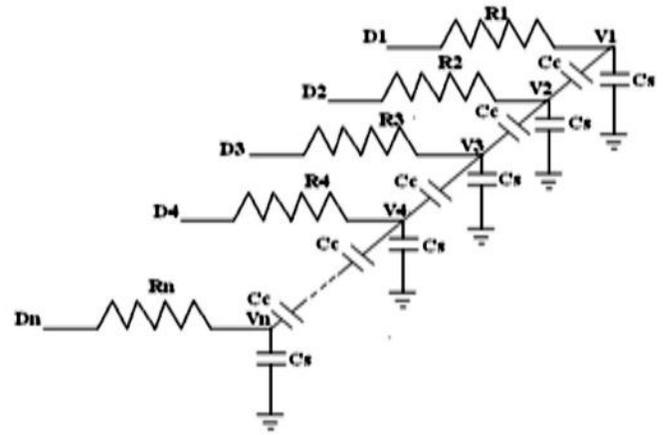


Figure 2. Deep submicron model of N bit data bus.

The dynamic power dissipation has two components in a complex design. The internal node power and the capacitive load power. The internal node power consists of the power dissipated by the internal capacitive nodes. Sometimes the internal short circuit power is added to the internal node dynamic power. So the dynamic power cannot be estimated by the simple expression  $CLV_{DD}^2f$ , because it might not always switch when the clock is switching. The Transition activity determines how often this transition occurs on a capacitive node. For N periods of  $0 - V_{DD}$  and  $V_{DD} - 0$  transitions the transition activity E determines how many  $0 - V_{DD}^2$  transition occur at the output. In other words the activity E represents the probability<sup>2</sup> that a transition  $0 - V_{DD}$  will occur during the period  $T = 1/f$ . The average dynamic power of a complex design due to the output load capacitance is given by

$$P_D = E C_L V_{DD}^2 f$$

The internal power dissipation, due to internal nodes, the internal dynamic power of a cell is given by;

$$P_{int-dvn} = \sum_{i=1}^n E_i C_i V_i V_{DD} f$$

It is defined as due to charging and discharging the data changed from 1 to 0 or from 0 to 1 vice versa between adjacent bus wires or on the same bus wire. Based on it is classified in to self Transition and coupling Transition.

## 3. PREVIOUS WORK

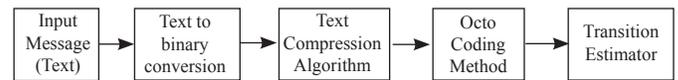
Nowadays data compression is a very essential tool in the multimedia applications. Most of the research work deals with coding for text data compression, some of them are discussed here. Arithmetic coding for data compression is an accessible implementation of text data and detailing of its performance characteristics are analyzed<sup>[9]</sup>. A.Wolfe and A.Chanin have been executing compressed programs on an embedded RISC architecture. In their approach, a system with code compression incorporates an instruction cache which

holds uncompressed code and a main memory which holds compressed code. Huffman codes have been used to encode an instruction cache<sup>[10]</sup>. A comparative study of text compression algorithm survey of different basic lossless data compression algorithm using statistical compression techniques and dictionary based compression techniques were performed on text data<sup>[5]</sup>. In reduction of bus transition for compressed code systems arithmetic coding technique is used for compression, decompression and bit toggling reduction is done by shift invert coding technique<sup>[11]</sup>. Division free adaptive arithmetic coding method to achieve better compression results for various types of source data<sup>[8]</sup> An encoding scheme known as Bus invert (BI) coding is used for encoding purpose and include a redundant bit along with bit line. This scheme is simple and effectively reduces the switching activity<sup>[1]</sup>. Similar to this encoding scheme, Partial bus invert (PBI)<sup>[12]</sup> is also analyzed. In low power bus coding techniques considering inter wire capacitances an additional bus line is added to creates transition matrix for selecting codeword patterns such that neighboring bus line changes value in the same direction. Thus coupling transition and inter wire energy is reduced<sup>[13]</sup>. An encoding scheme odd/even bus invert code the authors considered the numbered bus line and also coupling capacitances will charge and discharge by the activity of the neighbors. One line will be odd and the other neighbor line will be even. The coupling activity can be minimized by controlling the odd and even transitions separately<sup>[14]</sup>. Naveen K. Samala et al have implemented a novel deep submicron bus coding for low Energy. Odd and even positions of data are inverted using Bus invert coding method to reduce the coupling transition<sup>[4]</sup>. An adaptive address bus coding for low power deep sub micron designs the authors proposes Adaptive cross connection encoding scheme is used to reduce the coupling transition activity on address buses<sup>[2]</sup>.

**4. PROPOSED METHOD**

The reason data compression is needed is that most of the information that are generated and used in digital form is in the form of numbers and represented by bytes of data. If the application is multimedia, the number of byte required to represent the data can be very large. This huge number of data is coded and transmitted as it is, we face encoder and decoder complexity. This will increase Transition activity, area, and delay and power dissipation. To overcome these effects a simple byte compression algorithm with Octo coding Technique has been implemented. Simple byte compression algorithm is originally implemented for text message and bulk data transmission. This algorithm compresses the 8 byte of information in to 5 byte information. Figure 3 shows block diagram of

Encoder for proposed method. It consists of binary converter, byte compression algorithm, Octo coding technique and Transition estimator.



**Figure 3. Block diagram of encoder for proposed method.**

**4.1 Text Compression Technique**

Here input text file is converted in to binary form, then binary information is compressed using simple text compression algorithm. The following steps will explain how the compression is achieved effectively.

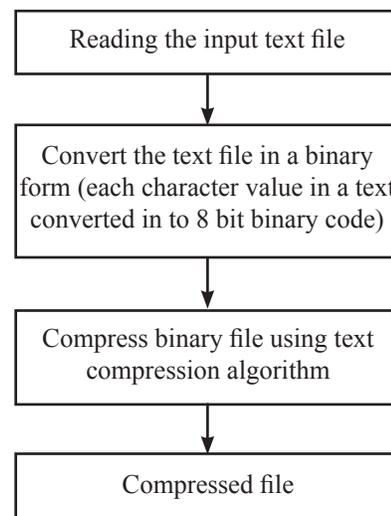
Step 1: Read the input Text

Step 2: Assign frequency(decimal) value to the corresponding text characters.

Step 3: Convert decimal in to 8 bit binary form then assign 8 bit binary value to corresponding character. So this needs 8 bytes for storing 8 characters.

Then remove some of the bits in each byte of data from the position of 3rd bit starting from left side onwards and isolate 5 least significant bits in each byte of information.

Step 4: Then rearrange the isolated 5 bits properly in an array of bytes, finally the 8 bytes of information reduced in to 5 bytes.



**Figure 4. Flow diagram for text compression algorithm.**

**4.2 Simple Encoding Method**

Here input data has been chosen randomly and coded in eight different ways such as Invert, Swap, Invert even position, Invert odd position, Rotate left with invert, Rotate Right with invert, Circular Left Shift and Circular Right Shift. Here the coding techniques are grouped as four, each having two coding methods. Hamming distance d is calculated

for all the coding techniques. With respect to the minimum hamming distance, one coding technique is selected and another discarded in a group. Similarly the same technique is applied to the remaining three groups. Here from the eight coding techniques is reduced to four coding techniques. Again based on the minimum hamming distance, we chose one from the four coding techniques and the finally selected data will be transmitted to the decoder with three control bits for easy recovery.

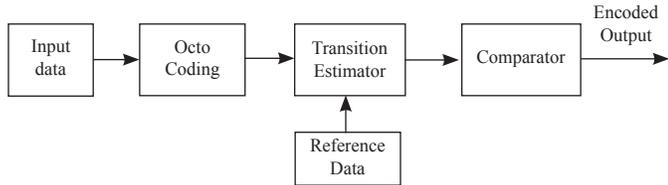


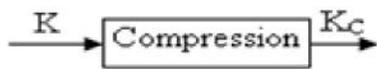
Figure 5. Simple encoding technique.

**5. RESULTS AND DISCUSSIONS**

In this section the performance of different compression techniques like Run length encoding (RLE), Huffman coding, Arithmetic coding and simple byte compression (SBC) algorithms are analyzed. To reduce the bit toggling effect the compressed data's then coded by Octo coding method. The results are analyzed using Xilinx and modelsim. The evaluated results are tabulated is listed below.

1. *Compression Ratio (CR)*

It is defined as the ratio of the number of bytes in the uncompressed representation to the number of bytes in the compressed representation  $CR = \text{Size of uncompressed data} / \text{Size of compressed data}$   $CR > 1$  indicate Compression and  $CR < 1$  indicate Expansion



K – Input data (Uncompressed data)  
 Kc – Compressed data  
 Compression ratio (CR) = Bits in K/Bits in Kc

2. *Bits per symbol (BPC)*

It is defined as the difference between number of bits used in the compressed text and number of characters used in the original (input) text

$$BPC = \frac{\text{Number of bits used in the compressed text}}{\text{Number of characters used in original text}}$$

**6. SAVING PERCENTAGE (SP)**

It is also a reasonable measure of compression performance. The value gives how much percentage of space occupied by the output data of its original size.

$$Sp = \frac{\text{Size before compression} - \text{Size after compression}}{\text{Size before compression}} \%$$

Table 1. Analysis of BPC for different compression methods

File Name	Original Size	RLE	Huffman	Arithmetic	SBC
		BPC	BPC	BPC	BPC
Text 1	256	7.01	5.60	6.01	5.00
Text 2	240	6.40	5.31	5.65	5.06
Text 3	640	6.62	5.24	5.19	5.00
Text 4	816	15.56	6.23	5.83	5.01
Text 5	592	14.27	5.82	5.11	5.03
Average BPC		9.972	5.64	5.558	5.011

Table 2. Saving percentage of different compression techniques

File Name	Original Size	Saving %			
		RLE	Huffman	Arithmetic	SBC
Text 1	256	25	32.89	29.578	37.5
Text 2	240	20	34.21	36.789	36.66
Text 3	640	24.13	23.665	37.54	37.93
Text 4	816	-100	30.44	22.601	37.25
Text 5	592	-78.37	38.31	24.25	49.673

Table 3. Transitions in encoding method

Data	Invert	Swap	Number of Transitions					
			IEL	IOL	RLI	RRI	CLS	CRS
Input 1	2	3	5	8	5	8	4	5
Input 2	8	9	7	6	3	4	6	7
Input 3	7	8	8	5	4	3	5	8
Input 4	3	4	6	7	6	7	3	4
Input 5	7	8	6	7	4	3	5	8

Table 4. Energy saved in different coding technique

SL.No	Coding methods	% of Energy saved
1	BI	27.4
2	Shift inv	31.4
3	Rotate	48.89
4	MDSMBC	21
5	NBCMEI	26
6	Proposed method	66.6

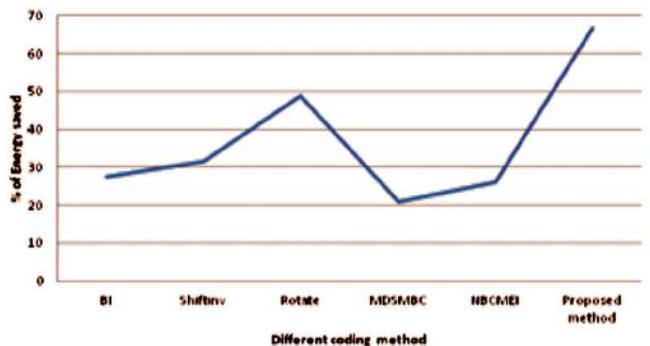


Figure 6. Energy saved in different coding method.

## 7. CONCLUSIONS

Many research works have been done in the area of transition activity reduction using data coding technique. Most of the work uses only different encoding to reduce the transition activity and power dissipation. In the proposed method we introduced simple byte compression method to compress the data before encoding. Due to compact representation of input data the encoder computational complexity and area is reduced. Then compressed data will be encoded by Octo coding method to reduce Transition activity. So here simple byte compression algorithm coupled with Octo coding technique has been proposed to reduce the Transition Activity and power dissipation for random text samples. By the proposed method we could achieve a compression factor of 62.5 % and compression ratio up to 1.978. With Octo coding technique the compressed data are effectively coded in eight different ways and has improved transition activity up to 59.3 % in comparison to other existing methods.

## निष्कर्ष

कई शोध कार्य पारगमन गतिविधि को डेटा कोडिंग तकनीक के उपयोग से कम करके करके किए गए हैं। ज्यादातर कार्य एनकोडिंग तकनीक से पारगमन गतिविधि और ऊर्जा का अपव्यय को कम करने के लिए किए गए हैं। प्रस्तावित विधि में हम एन्कोडिंग से पहले डेटा संकुचन करने के लिए सरल बाइट संपीड़न विधि का उपयोग करते हैं। इनपुट डेटा के कॉम्पैक्ट प्रतिनिधित्व के कारण एनकोडर कम्प्यूटेशनल जटिलता और क्षेत्र (स्पेस) की आवश्यकता कम किया जा सकता है। फिर संकुचित डाटा को ओक्टो कोडिंग के द्वारा कोडिंग करके पारगमन गतिविधि को कम किया गया है। इसलिए ओक्टो कोडिंग और सरल बाइट संपीड़न अभिकल्पन (अलगोरिदम) को जोड़कर कर यादृच्छिक (रैंडम) पाठ के नमूने के लिए पारगमन गतिविधि और ऊर्जा का अपव्यय को कम करने का प्रस्ताव किया गया है। प्रस्तावित विधि से हमने संपीड़न फैक्टर को 62.5 % और संपीड़न अनुपात को 1.978 तक प्राप्त किया है। ओक्टो कोडिंग तकनीक और संकुचित डेटा को प्रभावी ढंग से आठ अलग अलग तरीकों से कोडित कर सकते हैं और पारगमन गतिविधि को अन्य मौजूदा तरीकों की तुलना में 59.3 % तक सुधारा गया है।

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# एक्स और केयू बैंड एप्लिकेशन्स के लिए सिमेट्रिक टॉगल स्विच का उपयोग करके बड़े ट्यूनिंग रेंज वाले डीएमटीएल फेज शिफ्टर का डिजाइन

## Design of DMTL Phase Shifter with Large Tuning Range using Symmetric Toggle Switch for X- and Ku-Band Applications

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### सारांश

आरएफ एमईएमएस कैपेसिटिव सिंगल-पोर्ट-सिंगल-थ्रो (एसपीएसटी) स्विच की संरचना और विशेषताओं को इस पत्र में प्रस्तुत किया गया है। यह स्विच विद्युतरथैतिक प्रेरण तंत्र का उपयोग करता है जो कोप्लेनर वेवगाइड (सीपीडब्ल्यू) पर क्रियान्वित किया जाता है और सर्फेस माइक्रोमशीनिंग तकनीक का उपयोग करके बनाया जाता है। मापी गई पुल-इन वोल्टेज और अनुनाद आवृत्ति क्रमशः 30V और 6.09 KHz है। मापी गई प्रविष्टि हानि 0.09dB है और पृथक्ता X बैंड के लिए -25 dB से बेहतर है। इस अध्ययन का उद्देश्य बड़ी ट्यूनिंग रेंज वाले डीएमटीएल फेज शिफ्टर को डिजाइन करना और उसका विश्लेषण करना है। अतः, उच्च धारिता अनुपात (5.88) प्राप्त होता है। 10 गीगाहर्ट्ज पर प्रविष्टि हानि -0.49dB और प्रतिगमन हानि-19.91dB के साथ 6 एमईएमएस ब्रिजों वाला सिमुलेटेड फेज शिफ्ट 95.560 है। 17 गीगाहर्ट्ज पर प्रविष्टि हानि और प्रतिगमन हानि क्रमशः -1.10dB और -16.32dB है और फेज शिफ्ट 177.15° है।

### ABSTRACT

The fabrication and characterization of RF MEMS capacitive single-port-single-throw (SPST) switch is presented in this paper. The switch employs electrostatic actuation mechanism, implemented on coplanar waveguide (CPW) and fabricated using surface micromachining technique. The measured pull-in voltage and resonance frequency are 30V and 6.09 KHz, respectively. The measured insertion loss is -0.09dB and isolation is better than -25dB for X band. The aim of this study is to design and analysis of DMTL phase shifter with large tuning range. Thus, high capacitance ratio (5.88) is achieved. The simulated phase shift with 6 MEMS bridges is 95.56° with insertion loss -0.49dB and return loss -19.91dB at 10GHz. At 17GHz, insertion and return losses are -1.10dB and -16.32dB, respectively, with 177.15° phase shift.

**Keywords:** Micro-electro-mechanical-system, coplanar waveguide, single-port-single-throw switch, distributed MEMS transmission line phase shifter, radar

## 1. INTRODUCTION

Recent advancement in radio frequency micro-electro-mechanical systems (RF MEMS) has significantly improved the performance of switches and phase shifters, which are important for commercial and military applications such as military radars, millimeter and microwave communication systems. MEMS capacitive switch, promises to combine useful properties of both mechanical and semiconductor switches e.g. low loss, low DC power consumption, reduced size, weight and cost<sup>1</sup>. RF MEMS single-port-single-throw (SPST) switches or varactors are fundamental block of various RF MEMS circuits or sub-systems such

as single-port-double-throw(SPDT), redundancy switch matrix, DMTL phase shifter in phased array antenna. The advantage of utilizing MEMS over FET's or p-i-n diodes is their low-loss performance<sup>2</sup>. Employing, RF MEMS capacitive switches in phase shifters can drastically reduce losses, size, thus can significantly scale down the area of phased array antenna where thousands of phase shifters are mounted<sup>3-6</sup>.

Depending on application, phase shifter can be designed as: analog DMTL phase shifter where continuously variable phase shift is obtained for example 0 to 360° and built using MEMS varactors. Other is digital approach which provides a discrete

set of phase delays and built using MEMS switches. For example, a 2-bit phase shifter is based on the 90°/180° set of delay networks and can provide phase shifts of 0°, 90°, 180°, 270°, depending on the combination of bit used<sup>7-8</sup>.

## 2. FABRICATION PROCESS

The fabrication process of symmetric toggle switch<sup>9</sup>, begins with 250-300µm thick high resistivity (>5kΩ-cm), p-type<100>single side polished Silicon substrate. The relative permittivity of substrate is 11.9 and complete process flow is shown in Fig. 1. Silicon wafer is preferred for its process compatibility with semiconductor fabrication techniques. High resistivity silicon substrate is followed by 1 µm thick thermal oxide (to reduce cpw/electrical losses and provides better Q at higher frequencies). Next, the patterning of actuation electrodes is followed by Poly-Si layer deposition with n-type dopants. The preceding step is followed by deposition of PECVD oxide which acts as a passivation layer. After this, underpass area is patterned which acts as capacitive area of RF MEMS switch. Further dielectric is deposited; 0.1µm of PECVD oxide (SiO<sub>2</sub>). Sacrificial layer (3µm) is patterned for metallic structures such as fixed-fixed beam, cantilevers and other structures. Afterward, sacrificial layer is covered with seed layer (Cr/Au≈10/30nm). The subsequent lithography defines the mould of (+) ve PR for electroplating. CPW and bridge, both are incorporated in same mask to reduce mask levels. Finally mould was removed in acetone, Au/Cr seed layer is etched out in selective Au and Cr etchants. Later sacrificial layer of hard photoresist is removed in mild piranha, further released in CPD tool.

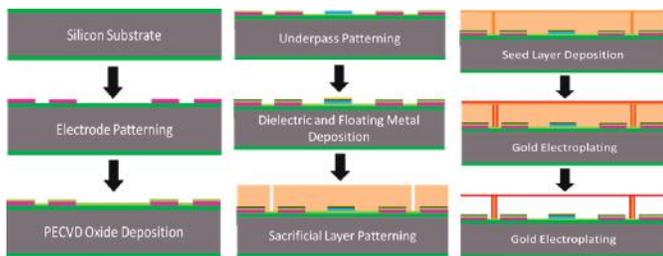


Figure 1. Process flow of RF MEMS capacitive switch.

## 3. SWITCH (SPST) CHARACTERIZATION

The capacitive RF MEMS switch is a fundamental block of DMTL phase shifter. The single-port-single-throw (SPST) is developed on CPW transmission line with characteristic impedance 53Ω, where  $(W + 2G)$  is 240 µm, on high resistivity silicon (>5kΩ-cm) wafer. The overlap capacitive area is 190x110 µm<sup>2</sup>. The SEM micrograph of silicon dioxide based RF MEMS capacitive switch is shown in Fig. 2. The measured insertion loss is -0.09dB in on state (no bias is applied) and isolation in off state ( $V_p$  at pull-in

electrode) is better than -25dB in X band as shown in Fig. 3. The measured pull-in voltage is 30V and resonance frequency is 6.09 KHz.

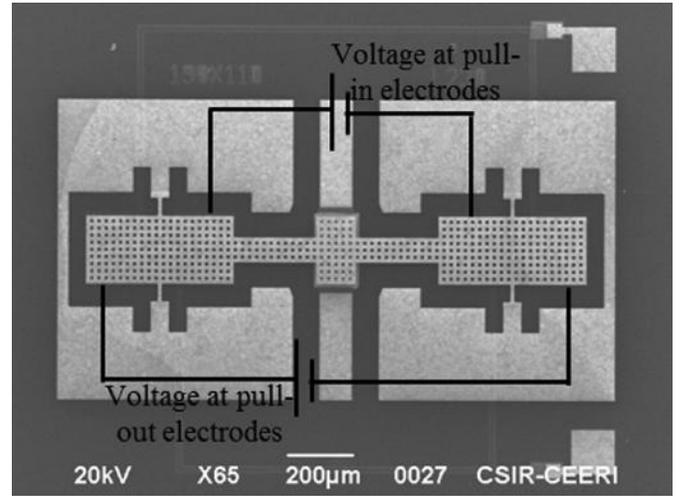


Figure 2. SEM micrograph of fabricated RF MEMS capacitive switch.

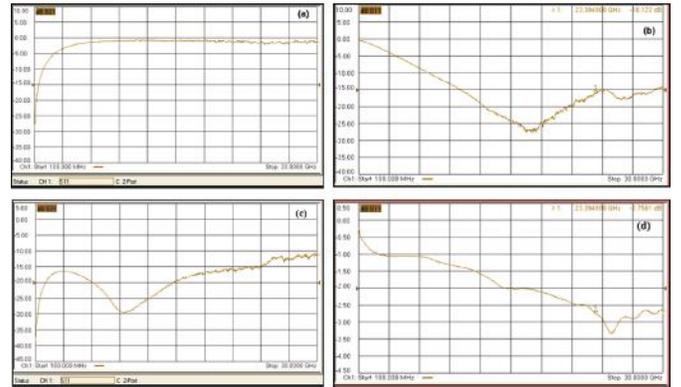


Figure 3. Measured S-parameters of SPST: (a) & (b) insertion and return loss in on state, respectively; (c) & (d) isolation and return loss in off state, respectively.

## 4. DESIGN OF PHASE SHIFTER

The DMTL phase shifter consists of a high impedance (>50Ω) CPW transmission line and loaded periodically with MEMS bridges (work as variable capacitor). The differential phase shift,  $\nabla\phi$ ,  $\nabla\phi$  in degree per meter is given by:

$$\nabla\phi = \frac{360fZ_0\sqrt{\epsilon_{eff}}}{c} \left( \frac{1}{Z_{l2}} - \frac{1}{Z_{l1}} \right) \text{deg/meter}, \quad (1)$$

where  $f$ , is the operating frequency.  $\epsilon_{eff}$  is the effective dielectric constant of unloaded line.  $Z_0$  is the unloaded line characteristic impedance  $Z_{l1}$  and  $Z_{l2}$  are the loaded line impedances at two variable gaps and given by:

$$Z_l = \sqrt{\frac{L_u}{[C_u + (C_{MEMS}/s)]}} \quad (2)$$

where  $L_u$  and  $C_u$  are the inductance and capacitance per unit length of the unloaded CPW, respectively<sup>10-</sup>

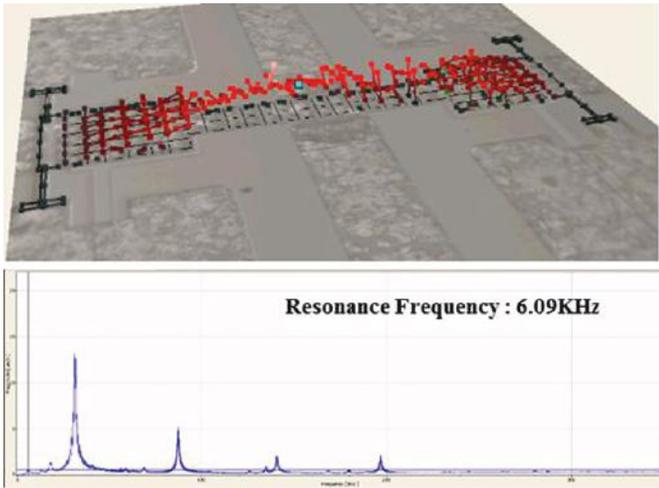


Figure 4. Measured resonance frequency is 6.09 KHz using laser doppler vibrometer (LDV).

<sup>11</sup>  $C_{MEMS}$  is capacitance at two variable states and  $s$  is the periodic spacing between the MEMS bridges. The variation in distributed capacitance ( $C_{MEMS}$ ) of the MEMS bridge results in change in phase velocity,  $v_l$ , of the electromagnetic wave on the loaded CPW, as given by relation:

$$v_l = \frac{1}{\sqrt{L_u [C_u + (C_{MEMS} / s)]}} \quad (3)$$

The periodic structure has an upper frequency limit due to the Bragg reflection

$$f_{Bragg} = \frac{1}{\pi s \sqrt{L_u [C_u + (C_{MEMS} / s)]}} \quad (4)$$

$$\epsilon_{eff} = \frac{c \sqrt{(s L_u (s C_u + C_{MEMS}))}}{s} \quad (5)$$

where,  $f_{Bragg}$ , is the Bragg frequency at which the characteristic impedance of loaded line goes to zero, indicating no power transfer.  $\epsilon_{eff}$ , is the effective dielectric constant of the loaded line.

The DMTL phase shifter is optimized with unloaded line impedance of  $70\Omega$  on silicon substrate (effective dielectric constant of 5.98) using Ansoft-HFSS 15 as shown in Fig. 5. On applying a voltage at pull-out electrodes and pull-in electrodes as shown in Fig. 2, large tuning range can be achieved in two variable gaps by symmetric toggle switch and thus resulting a maximum capacitance ratio (Cr) of 5.88 (with-in the pull-in limits).

Fig. 6 shows the simulated data for insertion loss (S21) and return loss (S11) in up state (bias voltage at pull-out electrode) and in down state ( $V < V_p(30V)$  at pull-in electrode). It is seen from the return loss that the S11 in down state has more closely spaced nulls which indicates that the line is electrically longer than up state. Since the physical length of the DMTL is

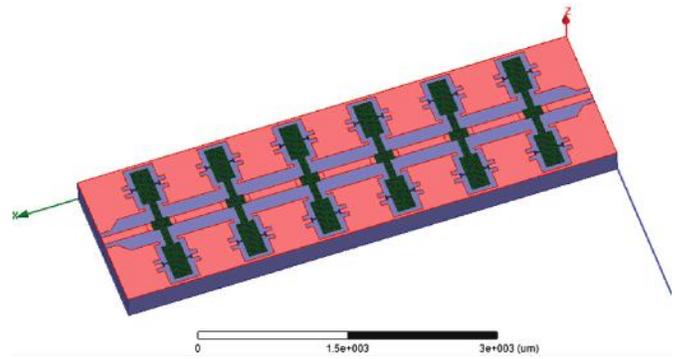


Figure 5. Analog DMTL phase shifter using six symmetric toggle switches.

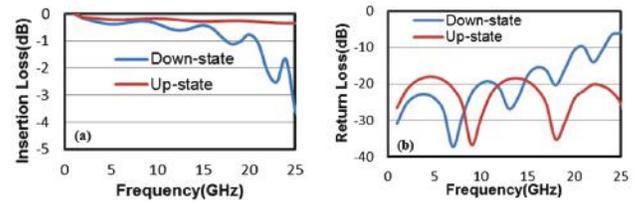


Figure 6. (a) Simulated insertion loss; (b) return loss of analog phase shifter with 6 unit cells.

not changed from (3), increasing, the phase velocity decreases; keeping all parameters constant, as expected. According to Eqn (2), the upstate characteristic impedance is  $60.70 \Omega$  and in down state  $40.85 \Omega$ . However, the loaded line impedances ( $Z_{lu} = 53.72 \Omega$  and  $Z_{ld} = 46.53 \Omega$ ) are determined from the first peak in  $S_{11}$  at 4 GHz from Eqns (6) and (7). At this frequency, the loaded line is acting as a quarter-wave transformer. The smaller variation in loaded line impedance is due to an effect of the feed line at either end of the DMTL which add a small inductance at either end of the loaded line.

$$Z_{lu} = Z_0 \sqrt{\frac{1+S_1}{1-S_1}} \quad (6)$$

$$Z_{ld} = Z_0 \sqrt{\frac{1-S_1}{1+S_1}} \quad (7)$$

where  $Z_0$ ,  $Z_{lu}$  and  $Z_{ld}$  are unloaded and loaded(in two states) line impedances, respectively.

As seen from the Fig. 7, phase shift ( $\nabla \phi$ ) increases linearly with frequency as expected for a TTD type phase shifter having  $C_r = 5.8$ . There is deviation from the linearity at approximately 22GHz which is a result of approaching the Bragg frequency (calculated Bragg frequency is 28 GHz). The maximum simulated phase shift for 6 MEMS bridges is  $95.56^\circ$  with insertion loss  $-0.49$  dB and return loss  $-19.91$  dB at 10 GHz. At 17 GHz, insertion and return losses are  $-1.10$  dB and  $-16.32$  dB, respectively, with  $177.15^\circ$  phase shift.

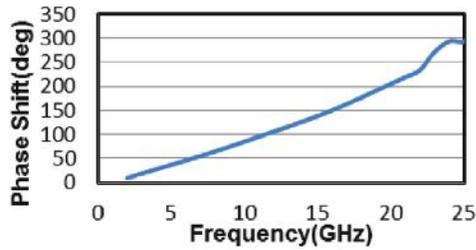


Figure 7. Simulated phase shift of analog phase shifter with 6 unit cells.

## 5. CONCLUSION

RF MEMS capacitive switch is fabricated and characterized. The measured pull-in and resonance frequency is 30V and 6.09 KHz, respectively. Insertion loss is -0.09 dB in on state and isolation is better than -25 dB in X band. The DMTL phase shifter is designed for X and Ku band with large tuning range. The maximum simulated phase shift for 6 MEMS bridges is  $95.56^\circ$  with insertion loss -0.49 dB and return loss -19.91 dB at 10GHz. At 17 GHz, insertion and return losses are -1.10dB and -16.32 dB, respectively, with  $177.15^\circ$  phase shift.

## ACKNOWLEDGMENT

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## निष्कर्ष

आरएफ एमईएमएस कैपेसिटिव स्विच का निर्माण किया जाता है और उनमें विशेषताएं डाली जाती हैं। मापी गई पुल-इन और अनुनाद आवृत्ति क्रमशः 30 V और 6.09 KHz होती है। मूल स्थिति में प्रविष्टि हानि 0.09 dB होती है और पृथक्ता X बैंड में -25 dB से बेहतर होती है। बड़ी ट्यूनिंग रेंज के साथ एक्स और केयू बैंड के लिए डीएमटीएल फेज शिफ्टर को डिजाइन किया जाता है। अतः उच्च धारिता अनुपात (5.88) प्राप्त होता है। 10 गीगाहर्ट्ज पर प्रविष्टि हानि -0.49कठ और प्रतिगमन हानि-19.91 dB के साथ 6 एमईएमएस ब्रिजों के संबंध में अधिकतम सिमुलेटेड फेज शिफ्ट  $95.56^\circ$  होता है। 17 गीगाहर्ट्ज पर प्रविष्टि हानि और प्रतिगमन हानि क्रमशः -1.10dB और -16.32dB होती हैं और फेज शिफ्ट  $177.15^\circ$  होता है।

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## वीडीआर के साथ प्रोपोर्शनल इंटीग्रल डेरिवेटिव कंट्रोलर का कार्यनिष्पादन विश्लेषण On the Performance Analysis of PID Controller with VDR

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### सारांश

यह पत्र वीडिआर (वैरिएबल डैम्पिंग रेशियो) के साथ प्रोपोर्शनल इंटीग्रल डेरिवेटिव (पीआईडी) कंट्रोलर का कार्यनिष्पादन विश्लेषण प्रस्तुत करता है। ये नवीन पद्धतियां अपनी सरलता, सुदृढ़ता और सफल व्यावहारिक अनुप्रयोगों के कारण बहुत उपयोगी हैं। पीआईडी कंट्रोलर उद्योगों में सर्वाधिक लोकप्रिय और व्यापक रूप से उपयोग किया जाने वाला कंट्रोलर है। कई प्रोपोर्शनल इंटीग्रल डेरिवेटिव डिजाइन पद्धतियां प्रस्तावित की गई हैं, प्रत्येक के अपने गुण और अवगुण हैं। किंतु, प्रोपोर्शनल इंटीग्रल डेरिवेटिव कंट्रोलरों के लिए उपयुक्त मानदंडों का पता लगाना अब भी आसान कार्य नहीं है। इस पत्र में, वीडिआर (वैरिएबल डैम्पिंग रेशियो) वाले प्रोपोर्शनल इंटीग्रल डेरिवेटिव को कंट्रोलर के निष्पादन में सुधार करने के लिए विकसित किया गया है। इस पद्धति का उपयोग करने से, जाइगलर निकोलस द्वारा प्रस्तावित पद्धति की तुलना में सेटलिंग समय में 60% की बचत होती है और सलेम द्वारा प्रस्तावित तकनीक की तुलना में सेटलिंग समय में 84.6% की बचत होती है। हमारी पद्धति अधिकतम ओवरशूट से स्वतंत्र है जो एक विशिष्ट लाभप्रद स्थिति है जो प्रणाली के कार्यनिष्पादन को बढ़ाती है। यह कंट्रोलर उस प्रणाली के आधार पर डिजाइन किया गया है जो मैटलैब वर्जन 2013 का उपयोग करके प्राक्कलित किया जाता है। मॉडल प्राक्कलन के लिए आंकड़े प्रायोगिक कार्यों से लिए जाते हैं, वीडिआर वाले पीआईडी कंट्रोलर का निष्पादन पारंपरिक प्रोपोर्शनल इंटीग्रल डेरिवेटिव कंट्रोलर की तुलना में अत्यधिक उन्नत हुआ है।

### ABSTRACT

This paper presents more on the performance analysis of Proportional Integral Derivative (PID) controller with VDR (Variable Damping Ratio). This novel methods very useful because of their simplicity, robustness and successful practical applications. PID controllers are the most popular and widely used controllers in industries. Many Proportional Integrative Derivative designs method have been proposed, each has its own merits and demerits. How ever finding appropriate parameters for the Proportional Integrative Derivative controllers is still not easy. In this paper, Proportional Integrative Derivative having VDR (Variable Damping Ratio) is developed to improve the performance of the Controller. By using this method there is a 60% saving in settling time as compared to the method proposed by Ziegler Nicholas and 84.6% saving settling time as compared to technique proposed by Salem. Our method is independent of maximum over shoot which is distinguishable advantage which increases the performance of system. The controller is designed based on the system which is estimated by using MATLAB version 2013. Data for model estimation is taken from an experimental works, the performance of the PID controller having VDR has improved significantly compare to conventional PID controller.

**Keywords:** VDR, PID, MATLAB, damping ratio, controller, settling time

### 1. INTRODUCTION

The Proportional Integral Derivative (PID) controller is the most popular and widely used controller in the industry<sup>1</sup>. Because of their simplicity, robustness and successful practical application that can provide excellent control performance despite the varied dynamic characteristics of plant<sup>2</sup>.

The term control system design refers to the process of selecting feedback gains that meet design

specifications in a closed loop controls system<sup>3</sup>. Most design method are iterative, combine parameter selection with analysis, simulation and insight into the dynamics of plant proposed by A. Mahfouz<sup>2</sup>, *et. al.* recently in 2013. An important compromise for control system design is to result in acceptable stability, and medium fastness of response, one definition of acceptable stability is when the undershoot that follows the over shoot of the response is small, or barely observable<sup>4</sup>. Beside world

wide known and applied PID design method including Ziegler-Nichols many PID design methods have been proposed in different papers and text including Astrom K, J *et. al.* in 1994, (Ashish Tewari in 2002, Susmita das et al in 2012) each method has its advantages and limitations.<sup>5,6</sup> R. Matousek in 2012 presented multi-criterion optimization of PID controller by means of soft computing optimization method HC 12. In 2001 K. J. Astron *et. al.* introduced an improved PID tuning approach using traditional Ziegler-Nicholas tuning method with the help of simulation aspects and new built in function.<sup>7,8</sup> L Ntogramatzidis *et. al.* in 2010 proposed a unified approach has been presented that enable the parameters of PID, PI and PD controllers with the corresponding approximations of the derivative action when needed to be computed in finite terms given appropriate specifications expressed in terms of steady-state performance, phase/ gain margins and gain cross over frequency. M. Saranya *et.al.* in 2012 proposed an internal Model Control (IMC) tuned PID controller method for the DC motor for robust operation.

This paper presents a performance analysis of PID having variable damping ratio controller for achieving acceptable stability, less rise time, less settling time and zero overshoot, the methodology is based on variable damping ratio.

**2. PID CONTROLLER**

In most of the industrial process control industry the PID controllers are widely used because of their simple structure, easy designing method, clear functionality, easy understanding and robust performance over a wide range of operating conditions<sup>9-10</sup>. It has been known that PID controller is used in more than 90 per cent of process control industry. If exact mathematical model of system to be controlled is not known, PID controllers are very effective.

PID controller is a control loop feedback structure (Fig.1). Difference between measured process value and desired value (set-point) is said to be an 'error'. It calculates 'error' and tries to minimize this error by doing appropriate adjustment in the process input. The PID controller has three different parameters; the proportional, the integral and derivative.

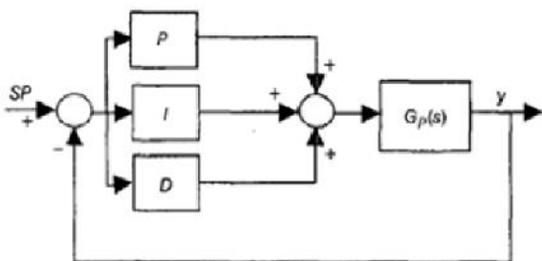


Figure 1. Block diagram representation of a PID controller.

**2.1 Computational Approach**

This type of method can be well suited if the mathematical model of the plant is known. Ziegler –Nicholas (ZN) is known as one of the most popular techniques for performance analysis of the PID Controller. In this method tuning provides a basis for computational approach. The second order system with velocity feedback is shown in Fig. 1.  $\tau$  is the velocity feedback. Obviously the system's closed-loop transfer function is described as

$$\Phi(S) = Y(S)/R(S) = (\omega_n^2) / (s^2 + (2\xi_0 \omega_n + \tau \omega_n^2)s + \omega_n^2) \quad (1)$$

where  $\omega_n$  is called the system's undamped natural oscillation angle frequency,  $\xi_0$  is the typical second order system damping ratio and  $\tau$  is the velocity feedback.

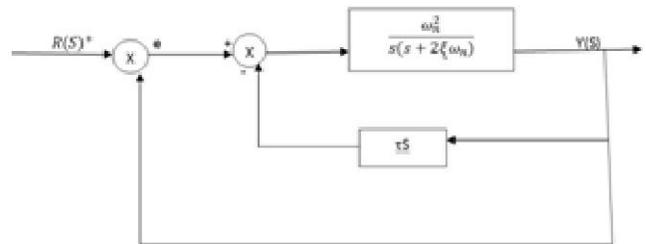


Figure 2. System with velocity feedback.

Comparing typical second-order system's standard closed-loop transfer function,

we define,

$$\xi = \xi_0 + \tau \omega_n / (2)^2 \quad (2)$$

as equivalent damping ratio. The parameter  $\omega_n$  is called the system's undamped natural oscillation angle frequency,  $\xi_0$  is the typical second order system damping ratio. Table 1 shows the different values of parameter using the transfer function (1).

The result obtained for different values of damping ratio's are shown in Figs. 3-5.

*2.1.1 Inferences from Table 1 as follows:*

- 1) Inferences from table that the rise time increases when  $\xi_0$  increases and it is maximum for  $\xi_0 = 1.5$

**Table 1. Different values of parameters**

Variable Damping Ratio	Rise Time (sec)	Settling Time (sec)	Phase Margin (rad/sec)	Controller Parameters Tuned KP
0.20	1.36	2.47	11.9	9.3
0.40	2.29	4.11	17.1	21.2
0.60	2.6	4.76	19.2	27.5
0.80	2.83	5.07	20.3	27.5
0.75	2.79	4.99	20	30.9
0.85	2.88	5.15	20.5	30.1
0.90	2.92	5.23	20.8	31.8
1.50	3.46	6.19	24.1	32.7

- 2) It is observed that settling time minimum for variable damping ratio = 0.2
- 3) It is also observed that phase margin increases as variable damping ratio increases so that system stability increases.
- 4) From Table 1, we can easily see our method is independent of maximum overshoot which is a distinguishable advantage.

**3. SIMULATION AND RESULT ANALYSIS**

In order to test and verify the second order system adjust PID variable damping ratio control scheme's feasibility and the control system's performance, the second order system. The velocity feedback coefficient is  $\tau=1$ .

The damping ratio change region is  $[-0.5,+1.5]$ .

The criteria for the optimal closed loop performance output will be: (a) Rise time (b) Maximum Overshoot (c) Stability (d) Settling time, and (e) Disturbance rejection capacity.

**Table 2. Comparative table for different parameter**

Tuning Method	Rise Time (Sec)	Maximum Overshoot	Setting Time (Sec)
Ziegler Nicholas	<1	60%	5
Salem[9]	12	No	13
Using Damping Variable Ratio	1	0	2

The Result of this work is compared with two previous works, Ziegler Nicholas and model based approach of Salem. It can be well observed that system response with PID controller tuned with Ziegler Nicholas method has large overshoot, whereas when tuning with the method Salem, it has large rise time. PID controller tuned with damping ratio variable has acceptable rise time (1sec), has no overshoot and smooth response with very less setting time. Comparisons for all the three are given in the table. There is a 60 per cent saving settling time as compared to Ziegler Nicholas and 84.6 per cent saving settling time as compared to Salem. This method is independent of maximum overshoot which is distinguishable advantage that is why the performance of system increases (Figs. 6&7)

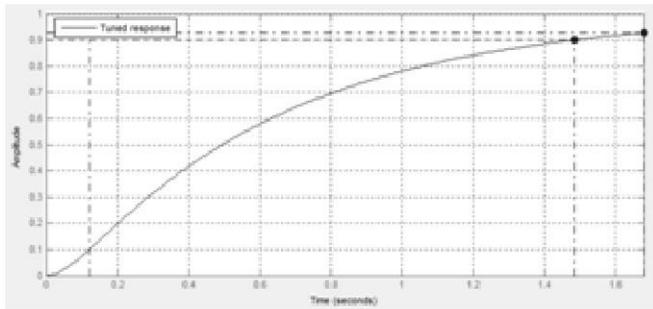


Figure 3. Output for variable damping ratio=0.2.

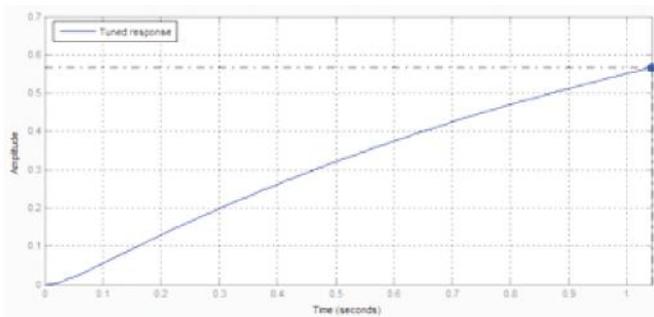


Figure 4. Output for variable damping ratio=0.8.

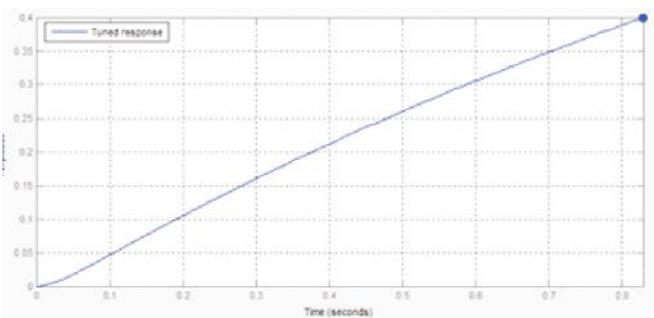


Figure 5. output for variable damping ratio= 1.5.

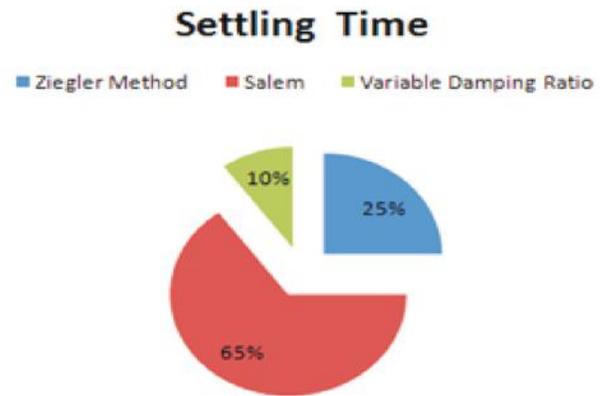


Figure 6. Comparison in settling time of PID.

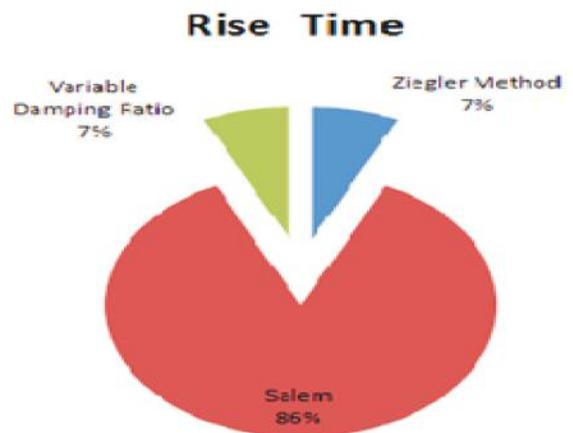


Figure 7. Comparison in Rise time of PID.

#### 4. RESULT AND CONCLUSION

By using this method there is a 60 per cent saving settling time as compared to Ziegler Nicholas and 84.6 per cent saving settling time as compared to Salem. Our method is independent of maximum overshoot which is a distinguishable advantage that is why the performance of system increases.

#### 5. FUTURE SCOPE

In future, for performance analysis of PID controller, some FIS could be adopted. We know that gain and phase margin is the two parameter that deals with the system robustness. It can be good research work, for performance analysis of PID controller when gain and phase margin has been specified.

#### निष्कर्ष

इस पद्धति का उपयोग करने से, जाइगलर निकोलस द्वारा प्रस्तावित पद्धति की तुलना में सेटलिंग समय में 60 प्रतिशत की बचत होती है और सलेम द्वारा प्रस्तावित तकनीक की तुलना में सेटलिंग समय में 84.6 प्रतिशत की बचत होती है। हमारी पद्धति अधिकतम ओवरशूट से स्वतंत्र है जो एक विशिष्ट लाभप्रद स्थिति है जो प्रणाली के कार्यनिष्पादन को बढ़ाती है।

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## FBG के विभिन्न मापदंडों का EDFA के निष्पादन पर प्रभाव Effect of Different Parameters on the Performance of FBG for EDFA

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### सारांश

यह अध्ययन आंशिक परावर्तन और पारेषण के सिद्धांत पर कार्य करने वाले ऑप्टिकल फाइबर के छोटे से हिस्से के लिए विशेष रूप से डिजाइन किए गए फाइबर ब्रैग ग्रेटिंग (एफबीजी) के निष्पादन विश्लेषण को रेखांकित करता है। समग्र आउटपुट पैटर्न में सुधार लाने के लिए दोहरे पास एम्प्लिफिकेशन वाली एल-बैंड एरिबियम डोपेड फाइबर एम्प्लिफायर (ईडीएफए) पद्धति का उपयोग किया जाता है। इस पत्र का मुख्य उद्देश्य एफबीजी के विभिन्न कॉन्फिगरेशन के लिए एकसमान एपोडाइजेशन, गॉस्सियन एपॉयजेशन और हाइपरबॉलिक टैन्जेन्ट एपोडाइजेशन से प्राप्त परिणामों की तुलना करना है। यह पाया जाता है कि उच्च अपवर्तनांक वाले पॉलिमर एक रैखिक गेन पैटर्न रखते हैं और इनपुट भिन्नताओं के साथ अधिक स्थायी प्रतीत होते हैं। परिणाम को वैध करने के लिए सिमुलेशन वेवफॉर्म को शामिल किया जाता है। एफबीजी की इस पद्धति और कॉन्फिगरेशन का उपयोग करने से एल बैंड में आउटपुट पावर अत्यधिक सपाट होता है और इसमें बहुत कम स्पाइक होते हैं जो इसके स्थायित्व को दर्शाते हैं।

### ABSTRACT

This research highlights the performance analysis of especially-designed Fibre Bragg Grating (FBG) for a short segment of the optical fibre operates on the principle of partial reflection and transmission. To improve overall output pattern a FBG in L-Band Erbium Doped Fibre Amplifier (EDFA) with double pass amplification method is used. The main objective of this paper is to compare the results obtained from uniform apodization, gaussian apodization and hyperbolic tangent apodization for different configurations of the FBG. It is observed that high refractive index polymer have a linear gain pattern and seems more stable with input variations. Simulation waveforms are included to validate the result. The output power in the L band is considerably flat consisting very few spikes which indicates its stability, by using this method and configuration of the FBG.

**Key words:** apodization, gaussian, fibre bragg grating, L-Band

### 1. INTRODUCTION

Erbium-doped fibre amplifier's (EDFA) have been used for the amplification of the optical signals. The initial use of the EDFA was to amplify the signals of the conventional Band (C-Band)<sup>[1]</sup>. Range of C band is generally between 1525 nm to 1565 nm. Now the EDFA's are being popularly used for the amplification of the Long wavelength Band<sup>2</sup>. The range of the L band generally between 1565 nm to 1620 nm. Combination of C-Band and L band can be used for the optical fibre amplification.

The Fibre Bragg Grating as a main component, which reflects the C band signal to the Erbium-doped fibre Amplifier. In the proposed techniques gain of the amplifier and gain pattern is improved. Gain is flat in the L band region. Gain enhancement in the L

band EDFA through the C band amplified spontaneous emission is demonstrated here.

In this configuration a tunable laser source was used as a L band signal source. TLS output has to pass from the fibre Bragg grating and then The Pump coupler signal and Transmitted Laser Signal is combined in the pump coupler. Before combining of the signal in the pump coupler, the Signal from the Transmitter laser source have to pass from a optical circulator, which routes the signal in the forward direction. The circulator used here is bi-directional, so when a signal comes from the opposite direction, it simply circulate it to the WDM analyzer. The diagram of typical fibre bragg grating is shown in Fig. 1.

Fibre Bragg grating reflects the C-band backward spontaneous emission which was generated at the

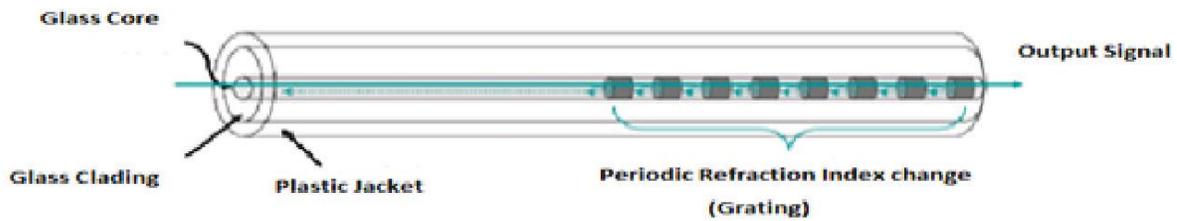


Figure 1. Typical fiber Bragg grating.

input of the Erbium-doped fibre amplifier. This C band backward ASE (amplified spontaneous emission) reduces the performance of the EDFA amplifier.

By incorporating the fibre Bragg grating, this C band backward ASE can be sent back to the input where it can be used for pumping. Now C band signal is not present in the output, only L band signal is there, it improves the output pattern of the EDFA. And because of the double stage amplification, significant gain can be achieved.

### 1.1 Types of Grating

The grating mainly found are of many types but the most commonly used gratings include the following:

### 1.2 Chirped Fibre Bragg Grating

The Refractive index profile of the grating may be modified to add other feature, such as a linear variation in the grating Period, called chirp. The Reflected wavelength changes with the Grating period, broadening the reflected spectrum. A grating Possessing chirp has the property to adding dispersion as shown in Fig. 2.



Figure 2. Chirped fiber Bragg grating.

### 1.3 Tilted Fibre Bragg Grating

In standard FBG's, the grating or variation of the refractive index is along the length of the fibre, and is typically uniform across the width of the fibre. In a tilted FBG, the variation of the refractive index is at angle to the optical axis, as shown in the Fig. 3.

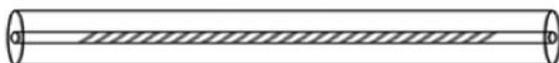


Figure 3. Tilted fiber Bragg grating.

## 2. FBG IN ERBIUM-DOPED FIBRE AMPLIFIER

The basic structure of the Erbium-doped Fibre amplifier with out incorporating is shown in the Figure 4.

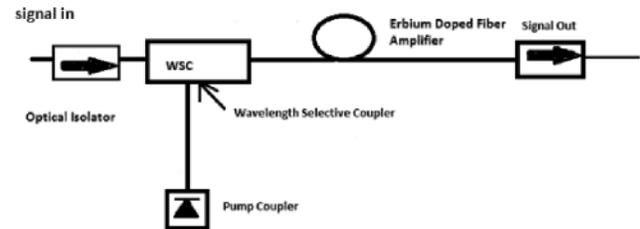


Figure 4. General EDFA amplifier.

The general parameters for the Erbium Fibre using as an amplifier are shown in the Table 1.

Table 1. Specification of different parameters of EDFA.

Parameters	Value
Signal emission Cross Section (m <sup>2</sup> )	3.80×10 <sup>-25</sup>
Length of EDF (m)	10 to 90
Pumping Power (mW)	10 to 100
Signal input power (dbm)	-30 to 10
Signal wavelength (nm)	1570
Pump wavelength (nm)	980
Er <sup>3+</sup> ion Density (m <sup>-3</sup> )	1.0 × 10 <sup>25</sup>
Fibre Radius (μm)	2

## 3. DOUBLE STAGE AMPLIFICATION TECHNIQUE

To improve the gain of the L band erbium doped fibre, several methods are reported. Some of them were using c band assistant pumping, utilizing unwanted backward amplified spontaneous emission (ASE), incorporating a fibre Bragg grating to reflect a part of ASE into erbium-doped fibre amplifier and using double pass configuration. In this paper a very efficient technique for the Gain enhancement and flat spectrum has been proposed. Here-double pass configuration with incorporating the Fibre Bragg grating is used. Here a part of C band backward amplified spontaneous emission (ASE) is reflected back to the Erbium doped fibre and the forward L band signal is reflected back by the mirror reflector. The L band signal have to travel two times through the Erbium doped Fibre and hence there is double amplification

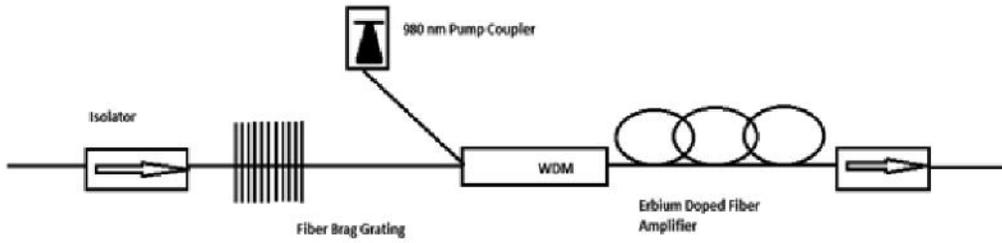


Figure 5. FBG in EDFA amplifier.

through the Erbium-doped fibre amplifier. The double stage amplification method using fibre Bragg grating is shown in Fig. 5.

**4. Results and Simulations**

In the results, it is important to have the knowledge of the structure of the fibre Bragg grating. Different configurations of the FBG are used here with different apodization. It is observed that each time output varies. It is important to know that because the introduction of the FBG the spikes in the L band can be completely removed, however other techniques can also be used for amplification. It is clear that fibre Bragg grating plays an important role in order to reflect the backward amplified spontaneous emission to the erbium doped fibre amplifier. The simulations are included to validate the result.

**4.1 Grating Specification**

For high refractive index polymer, having refractive index of the 1.50, following results were observed for the different lengths and different apodizations.

**4.2 Uniform Apodization**

The power VS wavelength results were observed for 2 mm, 3 mm, 4 mm for the same apodization, i.e., uniform apodization and is shown in Fig. 6.

It is clear from the simulation result that For all lengths of the fibre Bragg grating, The output spectrum is flat from 1570 nm – 1620 nm. There is no peak point out there. It is also clear that in C-band There is not flat spectrum. Results show that a much flat spectrum can be obtain if grating is incorporated in the Erbium-doped fibre amplifier circuit.

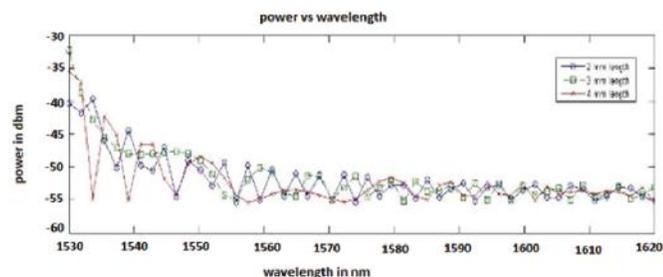


Figure 6. Uniform apodization.

Table 2. Grating specification

Parameter	Value
Operating frequency of the grating (nanometer)	1528
Effective Index of the Grating	1.50
Material	High Refractive Index Polymer
Length of the Grating (mm)	2 , 3 , 4
Apodization Profile	Gaussian, Uniform, Hyperbolic Tangent
Gaussian Parameter	0.5
Tanh Parameter	0.5
Chirp Function	Cubic Root, Linear, square Root, Quadratic
Linear Parameter (micrometer)	0.0001
Quadratic Parameter (micrometer <sup>0</sup> )	0.0001
Square root Parameter (μm)	0.0001
Cubic Root Parameter(μm)	0.0001
No. of Segments	101
Max. Number of spectral	1000
Bit Rate (bits/ sec)	10000000000
Signals	Number of Iteration – 10
Initial Dealy	Enabled

**4.3 Gaussian Apodization**

The power VS frequency results were observed for the Gaussian apodization for 2 mm, 3 mm, and 4 mm length is shown in Fig. 7.

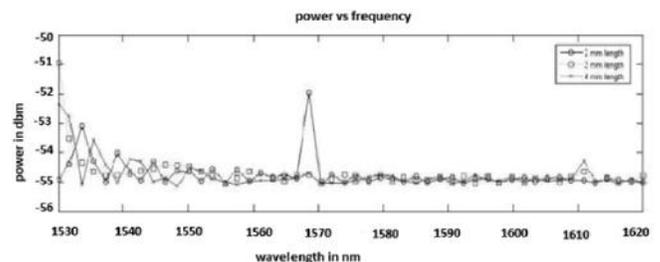


Figure 7. Gaussian apodization.

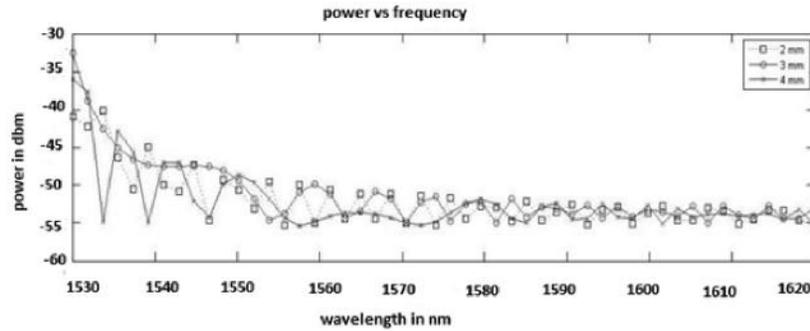


Figure 8. Hyperbolic tangent apodization.

### 4.3 Hyperbolic Tangent Apodization Profile

It is clear from the simulation result that output is flat spectrum in the L-band for the Hyperbolic tangent apodization. The output is optimal for the Grating length of 3 mm.

## 5. CONCLUSION

It is presented that EDFA is widely used as an amplifier to amplify the light signals. EDFA's have the non-uniform gain over the 1500 nm to 1600 nm band, with peak values having at different wavelengths. The different equalization techniques employed to remove this peak. It is shown that the peak values are eliminated using the fibre Bragg grating and the flat gain is achieved in the L-band. The reflection property of the fibre Bragg grating is used here to reflect the C-band backward amplified spontaneous emission. This C-band ASE is used to pump the signal again and hence by incorporating the fibre Bragg grating the flat gain pattern is achieved. It is clear from the results that no peak is there in the L-band and it is almost constant in the L-band region.

## निष्कर्ष

यह प्रस्तुत किया जाता है कि ईडीएफए लाइट सिग्नलों को परिवर्धित करने के लिए एक एम्प्लिफायर के रूप में व्यापक रूप से उपयोग किया जाता है। ईडीएफए अलग-अलग तरंगदैर्घ्यों वाले उच्चतम मानों के साथ 1500 एनएम से 1600 एनएम बैंड पर असमान गेन रखता है। इस उच्चतम मान को हटाने के लिए विभिन्न समानता तकनीकों का प्रयोग किया जाता है। यह दर्शाया जाता है कि फाइबर ब्रैग ग्रेटिंग का उपयोग करके उच्चतम मानों को हटाया जाता है और सपाट गेन को एल बैंड में प्राप्त किया जाता है। सी बैंड पश्चगामी परिवर्धित सहज उत्सर्जन को परावर्तित करने के लिए फाइबर ब्रैग ग्रेटिंग के परावर्तन गुण का यहां उपयोग किया जाता है। सी बैंड एएसई का उपयोग सिग्नल को दुबारा भेजने के लिए किया जाता है और इस प्रकार फाइबर ब्रैग ग्रेटिंग को शामिल करके सपाट गेन पैटर्न प्राप्त किया जाता है। परिणामों से स्पष्ट है कि एल बैंड में कोई भी उच्चतम मान नहीं है और यह एल बैंड क्षेत्र में लगभग स्थिर है।

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# एक आदर्श क्रियाशील चलायमान विद्युत वाहक आधारित लो पावर सैंपल और वैकल्पिक/प्रत्यक्ष (ऑल्टर्नेट/डायरेक्ट) संपरिवर्तन के लिए होल्ड प्रवर्धक (एम्पलीफायर) का विश्लेषण और डिजाइन Design and Analysis of a Novel Operational Floating Current Conveyor based Low Power Sample and Hold Amplifier for A/D Conversion

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## सारांश

प्रस्तुत लेख में एक आदर्श क्रियाशील चलायमान विद्युत वाहक आधारित सैंपल और होल्ड एम्पलीफायर का विवरण दिया गया है। डिजिटल संपरिवर्तन में अनुरूप (अनालोग) करने के लिए ऊर्जा और उच्च गति सैंपल तथा होल्ड एम्पलीफायर (प्रवर्धक) मुख्य ब्लॉक होते हैं। उच्च निहद दर और क्रियाशील चलायमान विद्युत वाहक की विशाल गति रेंज बेहतर अनुकरणीय परिणाम प्रदान करते हैं। सभी परिणामों को 0.18um and 1.8V TSMC CMOS Model पर 421  $\mu$ W की शक्ति वाले PSPICE का उपयोग करके प्राप्त किया जा रहा है।

## ABSTRACT

A novel operational floating current conveyor (OFCC) based sample and hold amplifier (SHA) is described in this paper. The power and high speed Sample and hold amplifier (SHA) is main block for Analog to Digital Conversion. High slew rate and large dynamic range of OFCC provides better simulation results. All the results are obtained using 0.18 um and 1.8 V TSMC CMOS Model on PSPICE has a power dissipation of 421  $\mu$ W.

**Keywords:** OFCC, SHA, speed, dynamic range, A/D convertor

## 1. INTRODUCTION

The evolution and application of current-mode processing<sup>1</sup> has given a drastic boost in the analog integrated circuit design. The outcomes of the current mode processing stems from the fact that the circuits based on it possess larger bandwidth, greater linearity and greater dynamic range. The operational floating current conveyor (OFCC)<sup>2,3</sup> is versatile analog building block which posses the features of current conveyor and the current feedback op-amp. It has both low impedance port for current input and high impedance ports which can be used as voltage inputs. Additionally, it also has a low impedance voltage output port and high impedance current output ports. The OFCC is used as an analog building block for implementing variety of circuits such as voltage mode filter<sup>4,6</sup>, current mode filter<sup>7</sup>, variable gain amplifier<sup>8</sup>, instrumentation amplifier<sup>10</sup> and wheat-stone bridge<sup>9</sup> and read out circuit<sup>11</sup>, rectifier<sup>15</sup>.

For an analog to digital converter (ADC), the sample and hold amplifier (SHA) plays a vital role in determining linearity, dynamic range and frequency

range. It is hard to design SHA for a high speed operation, as OFCC is current mode device therefore speed of operation is very high as compared to the other available voltage mode circuit. Another advantage of current mode devices is its bandwidth; therefore it can operate for high frequency range.

## 2. CIRCUIT DESCRIPTION

The circuit symbol of operational floating current Conveyor (OFCC) is shown in Fig.1. It has a low impedance current input port X and a high impedance voltage input port Y. It also has a low impedance voltage output port W and high impedance current output port Z. The output voltage at port W is multiplication

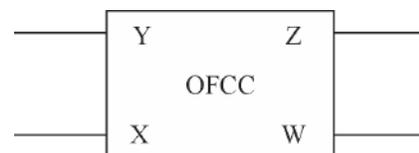


Figure 1. Circuit symbol of operational floating current Conveyor.

of input current at port X and the open loop trans impedance gain  $Z_t$ . The port relationships of the OFCC is characterized by the following matrix

$$\begin{bmatrix} I_y \\ V_x \\ V_w \\ I_z \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & Z_t & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} V_y \\ I_x \\ I_w \\ V_z \end{bmatrix}$$

It may be noted that the voltage at port X is the same as input voltage at port Y so voltage tracking action is available at input port. The output current flowing through port W is copied to port Z, thereby offering current tracking at the output ports. Fig. 2 shows the CCII based OFCC implementation.

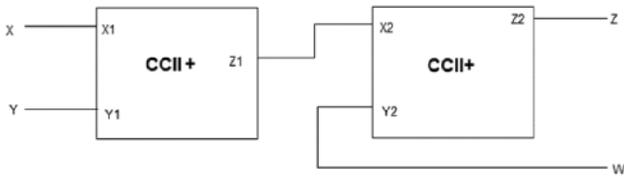


Figure 2. CCII based OFCC implementation.

Port relation metrics of second generation current conveyor (CCII+) is given below. The voltage of input terminal Y is followed by X and the current through ‘X’ terminal is followed by ‘Z’ terminal in a current conveyor. CCII+ implies that ‘Z’ terminal current is in same phase as ‘X’ terminal

$$\begin{bmatrix} I_y \\ V_x \\ I_z \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} I_y \\ V_x \\ I_z \end{bmatrix}$$

CMOS realization of CCII+ is shown in the Fig. 3.

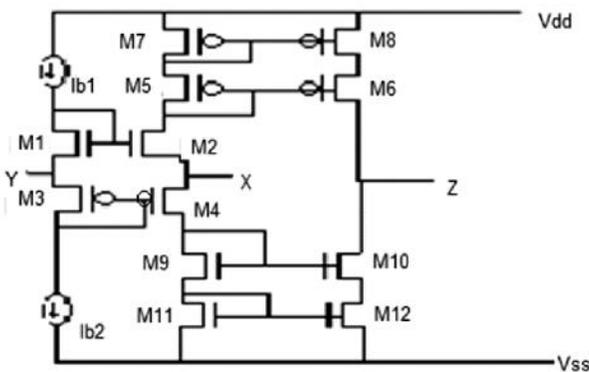


Figure 3. CMOS realization of CCII+.

### 3. PROPOSED CIRCUIT

The proposed SHA based on a single OFCC, NMOS(N1) and a capacitor (C) as shown in Fig.

4. The sampling pulse is applied to the gate of M1 transistor, and input voltage is connected to the drain of M1, source of M1 is connected with the capacitor. When gate voltage of M1 is high, M1 starts conducting and voltage is transferred from drain to source. This input voltage then stored by capacitor, as C is also connected to the Y terminal of OFCC the voltage of terminal Y is followed by X. Therefore voltage at X is equal to the input voltage when gate pulse is high. When gate voltage is low ; MOSFET shifts into cutoff region. Therefore capacitor has no charging path or discharging path so it retains its voltage.

Thus for

$$V_{Sam} > 0, V_{out} = V_{in} \tag{1}$$

and

$$V_{sam} < 0, V_{out} = V_c(\text{Capacitor Voltage}) \tag{2}$$

The charging equation for capacitor is

$$V(t) = V_{final}(1 - \exp(-t/RC)) \tag{3}$$

and discharging equation is

$$V(t) = V_{initial} \exp(-t/RC) \tag{4}$$

Where R is the resistance on charging discharging path, in this circuit R is the on resistance of M1 which we made so smaller to meet the timing criteria.

### 4. SIMULATION RESULTS

The functionality of proposed SHA of Fig. 4 is validated through current conveyor based realization of OFCC block as shown in Fig. 2. The TSMC 0.18µm CMOS model parameter and supply voltages  $V_{DD}=1.8$  V and  $V_{SS}=-1.8$ V are used for simulations. The aspect ratios of various transistors are given in Table 1. The transient response of the proposed circuit is shown Figs. 5. An input signal, of 500mV amplitude and 10 kHz frequency, as shown in Fig. 5(a) is applied and the voltage at gate of M1 is depicted in Fig. 5(b). It may be noted that for positive half cycle, M1 ON which implies voltage at ‘X’ is equal to the input voltage. For negative half cycle, voltage at gate of ‘M1’ is negative which implies voltage at ‘X’ is equal to the capacitor stored voltage which works as hold

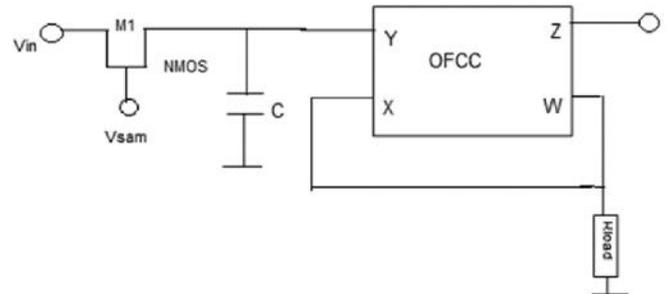
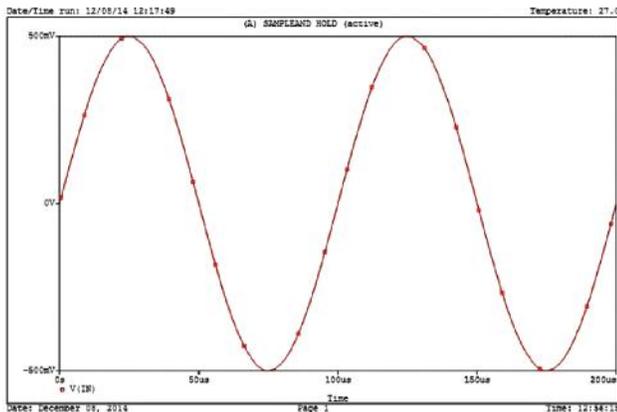
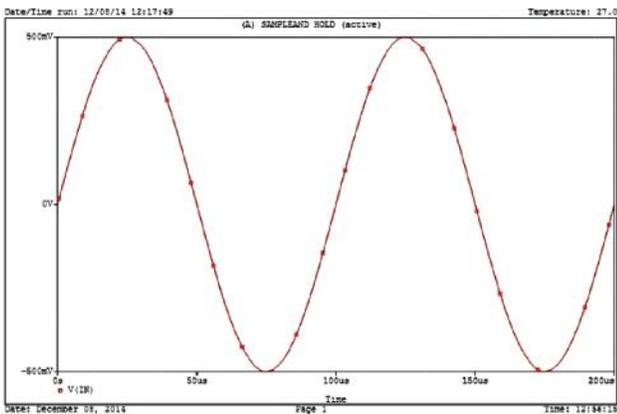


Figure 4. Proposed SHA based on single OFCC NMOS (N1) and capacitor.

voltage. The total power consumption of the circuit is simulated to be 421  $\mu$ Watt.



(a) Input signal of 500mV amplitude and 10 kHz frequency



(b) Voltage at gate of N1

## 5. CONCLUSION

A Novel OFCC based low power SHA is presented in this paper. The proposed circuit used OFCC which is a current mode device therefore it has high linearity, greater bandwidth and larger dynamic range. We use 180nm and 1.8V CMOS process parameter therefore it consumes low power and very useful in quantization process for A/D converter. The circuit described is very suitable for integrated circuit implementation. The performance of the proposed circuit is confirmed from Cadence Orcade PSPICE Simulation results.

## निष्कर्ष

प्रस्तुत लेख में एक आदर्श क्रियाशील चलायमान विद्युत वाहक आधारित कम ऊर्जा सैंपल और होल्ड प्रवर्धक (एम्पलीफायर) को प्रस्तुत किया गया है। आदर्श क्रियाशील चलायमान विद्युत वाहक में प्रस्तावित सर्किट का प्रयोग किया जाता है जो एक प्रकार का विद्युत प्रवाह मोड उपकरण है इसलिए इसमें उच्च रेखिकता,

अधिक से अधिक बैंडविड्थ और विशाल गतिशील रेंज विद्यमान है। हम 180 nm और 1.8V CMOS वाले प्रक्रिया मानदण्ड का प्रयोग करते हैं इसलिए कम ऊर्जा की खपत होती है और वैकल्पिक/प्रत्यक्ष संपरिवर्तन के लिए परिमाणीकरण प्रक्रिया में बहुत उपयोगी होते हैं। वर्णित सर्किट एकीकृत परिपथ कार्यान्वयन के लिए बहुत उपयुक्त हैं। Cadence Orcade PSPICE अनुकरणीय परिणामों से प्रस्तावित सर्किट के प्रदर्शन की पुष्टि की गयी है।

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## सेंसर्स और सौर कोशिकाओं अनुप्रयोगों के लिए प्रवाहकीय पॉलिमर क्षेत्र में अग्रिम Advances in Conductive Polymers for Sensors and Solar Cells Applications

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### सारांश

सेंसर्स और विद्युत रासायनिक उपकरणों को दिलचस्प सामग्री के रूप में उनके उत्कृष्ट ऑप्टिकल और यांत्रिक गुणों के कारण प्रवाहकीय पॉलिमर की तरफ विशेष ध्यान दिया गया है। जहां अकार्बनिक सामग्री शक्तिशाली सामग्री साबित होने में विफल रही वहां इन्हें इस्तेमाल किया जा सकता है। प्रवाहकीय पॉलिमर पर आधारित सेंसरों और विद्युत उपकरणों को उनके सरल निर्माण की वजह से उन्हें इस हद तक विकसित किया गया है कि विशिष्ट क्षेत्रों में प्रौद्योगिकी को विकसित करके उन्हें आसानी से डिजाइन किया जा सके। इतना ही नहीं, इलैक्ट्रो सक्रिय प्रवाहकीय पॉलिमर ने ठोस जैव प्रौद्योगिकी से अनुप्रयोगों की एक विस्तृत रेंज स्पेक्ट्रम को भी कवर किया है। मौजूदा पेपर्स आगे बढ़ने वाली विभिन्न प्रक्रियों से संबद्ध हैं जिन्हें सेंसर और सोलर सेल्स उपकरणों को शक्तिशाली सामग्री बनाने के लिए प्रवाहकीय पॉलिमर के क्षेत्र में लिया गया है।

### ABSTRACT

Conducting polymers have received special attention as an interesting material for sensors and electrochemical devices due to their excellent optical and mechanical properties. They can be used in a situation where inorganic materials failed to prove a potent material. Due to their ease of fabrication they have been developed to such an extent that sensors and electrochemical devices based on conductive polymers can be designed easily, making evolution of a technology in the particular field. Not only this, electro-active conductive polymers covered a broad range spectrum of applications from solid state technology to biotechnology. The present paper deals with the various advancements that have taken in the field of conductive polymers to make them a potent material for sensors and solar cell devices.

**Keywords:** Cyber-security, cyber-terrorism, cyber space

### 1. INTRODUCTION

Polymers as a material have dominated the modern world as they offer wide application from being used in containers to clothing. Due to their good insulating property they are used to coat metal wires in order to prevent electric shocks<sup>1</sup>. In recent years chemists have work hard to make polymers that conduct electricity as well as metals. The major classes of semiconducting materials that have been developed till date include charge transfer polymers, ionically conducting polymers, conductively filled polymers and conjugated conducting polymers<sup>2</sup>. In 1970's with invention of conductive polyacetylene a special class of polymers which named conducting polymers (CPs) is receiving special attention from the science as well as engineering communities. With the invention of electrically conductive polymers by Alan J. Heeger, Alan G. MacDiarmid, and Hideki Shirakawa in 2000 they have seen great advancement

during the last two decades<sup>3</sup>. In an ideal condition for the conduction of electricity in metals the outer electrons are free to move in order to carry the charge whereas in insulators the condition is reversed they have tightly bounded electrons and offers high resistance for the flow of charge. However for making polymer electrically conductive, a polymer has to behave like a metal, that is, its electrons should be free to move and are not bounded by atoms<sup>4</sup>. There are two conditions which can make polymer conductive firstly it should have conjugated double bonds means alternating single and double bonds. These alternating single and double bonds in polymers introduces the band width of 1.5 eV making polymers high energy gap semiconductor. Second condition is doping either by partial oxidation (p-doping) of the polymer chain with electron acceptors or by partial reduction (n-doping) with electron donors. Through such a doping process

charge defects are introduced, which could then be available as the intrinsic charge carriers<sup>5</sup>. The  $\pi$  electron backbone introduced by conjugation and doping at various levels is responsible for properties that make these conductive materials so useful. These properties include electrical conductivity, low energy optical transition, low ionization potential and high electron affinity<sup>6-8</sup>. Abundant literature exists on the various uses of CPs. Applications of CPs can be divided into two major groups: Firstly CPs in electronics, optoelectronics, and electrochemical devices and on the other hand in sensors. The first group relies on the chemical stability of CPs while sensors applications use the physical changes possible in CPs by using different chemicals<sup>9-10</sup>.

## 2. CONDUCTIVE POLYMERS IN SENSORS

Sensors are the devices that measure a physical or chemical quantity (e.g. temperature or pressure) and produce a signal which can be read by an observer or by an instrument<sup>11</sup>. Sensors have been a driving force for developing conductive polymers from the very start as commercially available sensors made up of metal oxides suffer from drawbacks like low sensitivities, long response time, difficulties in fabrication, etc. Whereas sensors made up of conductive polymers provide certain advantages like high sensitivities and short response time at room temperature even conductive polymers provide mechanical strength to sensors which make them more facile<sup>12-14</sup>. Formation of composite conductive polymers by incorporation of secondary components such as ions, nanoparticles, or nanowires of metals, metal oxides, carbon or molecular species etc. provides an additional advantage over conductive polymers such as improved chemical properties for chemical sensing. Addition of ions develops electrostatic interactions which influence the electronic and physical properties of the materials<sup>15-17</sup>. Conductive polymers are being used in various groups of sensors like gas sensors, electronic chemical sensors, chemiresistors, transistors and diode sensors, biosensors, etc<sup>18-19</sup>.

With increasing number of combustion engines, power plants, etc., the emission of poisonous gases has been increased extensively. These poisonous gases when exposed in the atmosphere cause acid rain and photochemical smog. Therefore, efficient gas sensing materials have been studied widely for the detection of even very low concentration of these poisonous gases. Conductive polymers which work efficiently even in normal temperature have emerged as an important class of sensing materials for detecting such poisonous gases in the atmosphere. Various types of conducting polymers such as poly (para-phenylene vinylene), polyaniline (PANi), polypyrrole, polycarbazole, polythiophene, and their derivatives are

frequently used as gas sensing materials<sup>20-21</sup>. Polyaniline is frequently used as a conductive material because of its polymer backbone which provides it a unique electrical property and stability but it suffers from poor processing ability which makes it less suitable as a gas sensing material<sup>22</sup>. Therefore the heterojunction between organic and inorganic materials has been studied to solve the problem. In this direction the introduction of nanomaterials in PANi is also beneficial as it provides large gas absorptive capacity and higher sensitivity. Construction of a polyaniline nanofibre proved to be an efficient sensor for acidic gases. Similarly the formation of polyaniline/TiO<sub>2</sub>/carbon nanotube composite conductive polymer improved the sensitivity and response time for NO gas<sup>23</sup>. PANi single film deposited on a silicon substrate by spin coating technique was employed as a sensing element to detect NH<sub>3</sub> molecules. The film showed excellent response to ammonia gas. It can prove to be an important and low cost material for making ammonia gas sensor<sup>24</sup>. Talwar et al, also studied the sensing response of Polyaniline nanofibre powder with varying amount of ZnO nanoparticles deposited over alumina substrate towards ammonia gas. The fabricated sensor exhibited excellent selectivity towards ammonia gas and sensing response was proportional to the ammonia gas concentration<sup>25</sup>.

Poly (para-phenylene vinylene) is another important class of conductive polymer made up of rigid-rod polymers. Improvement in the properties of Poly (para-phenylene vinylene) can be brought about by altering its side functional groups<sup>26</sup>. To increase the sensitive and selective responses of poly (para-phenylene vinylene) towards gases like carbon monoxide, ketone vapors etc. selective microporous adsorbents are introduced into the polymer matrix of poly (para-phenylene vinylene). Na<sup>+</sup>-exchanged zeolite, Cu<sup>+</sup>-exchanged zeolite, and the poly (para-phenylene vinylene)/zeolite composite have been studied with the view to possible carbon monoxide sensing applications. The strongest absorption was observed for the copper ion-exchange ZSM5 followed by sodium ion exchange-ZSM5. The response of poly (para-phenylene vinylene) doped with H<sub>2</sub>SO<sub>4</sub> mixed into zeolite Y matrices was studied towards ketone vapors. From the studies it can be concluded that the sensing response of the prepared film is directly proportional to the surface area and inversely proportional to the cationic radius of the cation in zeolite<sup>27-28</sup>.

Chemiresistors are the most common type of gas and chemical sensors array, manufactured with low cost conductive polymers. Chemiresistor sensor fabricated with the blend of poly (3, 4-ethylene dioxythiophene) and polystyrene sulfonated acid (PEDOT-PSS) polymers doped with methylene red dye in the acid showed excellent sensing response for the ethanol vapour.

From the studies it can be concluded that we can improve the sensing response of chemiresistor sensor by incorporating dye molecules which can open up the era of new type of chemiresistor<sup>29</sup>. Large arrays of chemiresistors based on conductive polymers are being developed for detecting volatile organic compounds (VOCs). These chemiresistors are found to be useful as VOCs can be monitored inexpensively in real time<sup>30</sup>.

Conducting polymers are also coming up as suitable materials in the manufacturing of biosensors. As CPs are easy to prepare and its structure can easily be modified by surface functionalization techniques. CPs has been widely used as bioactuators devices that are used to create mechanical force. Basically polypyrrole, polyaniline and composites of these polymers with carbon nanotubes (CNTs) have been used widely as they show ability to function as actuators. Out of all these materials composite of polypyrrole with polyaniline produced the highest work per cycle<sup>31</sup>. CPs even exhibited excellent free radical scavenging ability or antioxidant activity which makes them beneficial for tissues suffering from oxidative stress<sup>32</sup>. CPs also posses immense potential in drug delivery systems as by changing the redox state of CPs controlled release of drug can be facilitated. Poly (3, 4-ethylenedioxythiophene) nanotubes (PEDOT NT) polymerized on top of electrospun poly (lactic-co-glycolic acid) (PLGA) nanofibres have been used for the release of the drug dexamethasone<sup>33</sup>. CPs are also widely used in tissue engineering the properties which make CPs an efficient materials for tissue engineering includes conductivity, reversible oxidation, redox stability, biocompatibility, hydrophobicity, three-dimensional geometry and surface topography. Poly (3, 4-ethylenedioxythiophene) (PEDOT) is also receiving attention in tissue engineering. Polypyrrole and PEDOT film with nanotubes was used as an *in vitro* dorsal root ganglion model<sup>34</sup>.

### 3. CONDUCTIVE POLYMERS IN SOLAR CELLS

The increasing energy demands have encouraged scientists to develop cheap and easily accessible sources of energy. Among all sources of energy, renewable energy sources are gaining importance as it has a fair amount of consistency. Solar energy has emerged with the vast potential to meet the present energy demands. As a result, the conversion of solar energy into different forms has been the core of research for the recent past years. The conventional solid-state silicon based solar cells, though highly efficient, are yet to become popular for mass applications as they are highly expensive. The necessity for developing low cost devices for harvesting solar energy was,

therefore very much desirable<sup>35</sup>. Due to the simple design and low manufacturing cost the polymer solar cells are widely investigated as a next generation solar cells<sup>36</sup>. Polymer solar cells usually can be fabricated with an active layer of polymer (donor) and a film of electron acceptor sandwiched between contacts. The conducting polymers like PANi, polythiophene and their derivatives such as poly (3-hexylthiophene) (P3HT) are commonly processed into nanoscale thin films for application in organic photovoltaics<sup>37</sup>. Various methods have been adopted for forming thin films of conductive polymers to be used in polymer solar cells like spin coating, solution processing, electrochemistry and thermal annealing. However all these methods suffer from certain drawbacks like spin coating technique is not able to utilize whole material and therefore not cost effective<sup>38</sup>. Electrochemical growth of conducting polymer thin films via potentiostatic, galvanostatic or voltammetric routes does not offers deposition of film over non conducting substrates efficiently as it uses electricity for thin film deposition<sup>39</sup>. New methods are being adopted by researchers for growing thin films of conducting polymers such as solution based method. This method has certain advantages over conventional methods as it allows growth of film on any substrate under ambient conditions and requires less energy and cost<sup>40</sup>.

Researchers are fabricating ITO free solar cells based on efficient conducting polymers like poly (3-hexylthiophene-2, 5-diyl): [6, 6]-phenyl-C61-butyric acid methyl ester (P3HT: PCBM). All the layers of the devices from the lowermost silver nanowire cathode to the uppermost conducting polymer electrode were deposited over plastic. The measured conversion efficiency was 2.3% and 2.0% under cathode-anode side illuminations. The efficiency was found to enhance in comparison to indium-tin-oxide based solar cells<sup>41</sup>. Poly (3, 4-ethylenedioxythiophene): poly (styrenesulfonate) (PEDOT: PSS) is widely used as the hole transport material in polymer solar cells. A graft copolymer, poly (styrene sulfonic acid) grafted with polyaniline (PSSA-g-PANI), is used as hole transport material in place of PEDOT: PSS as PSSA-g-PANI have unique high transparency in 450-650 nm wavelength and high electrical conductivity which results in high short circuit current and high open circuit voltage of polymer solar cells. PSSA-g-PANI exhibited conversion efficiency of 4% which is 20% higher than that of device with PEDOT: PSS<sup>42</sup>. Conducting polymer poly (2-methoxy-5-(2'-ethyl-hexyloxy)-p-phenylene vinylene (MEH-PPV) with PbS nanocrystals were used to fabricate solar cells the efficiency obtained was not good but cells are found to be stable. In order to enhance the conductivity of PANi various additives have been incorporated in the matrices.

Carbon nanotubes (CNTs) have attracted a lot of interest as secondary material to be added in organic solar cells as CNTs have highly  $\pi$ -conjugative system and hydrophobic sidewalls consisting of  $sp^2$  carbons, which enable them to be easily incorporated in the organic solar cells. Many solar cells have been fabricated using polyaniline with CNTs. A dye-sensitized solar cell based on polyaniline base (EB), single-walled carbon nanotubes, organic dyes (rhodamine B and/or riboflavin), zinc oxide (ZnO), and indium tin oxide (ITO) was fabricated<sup>43</sup>.

Conductive polymers are also being employed in the fabrication of dye sensitized solar cells (DSSCs) a third generation solar cells another promising solution to global energy and environmental problems because of its clean, low-cost, high efficiency, good durability, and easy fabrication. However, low efficiency of DSSCs is still an important issue. To enhance the efficiency of DSSCs researchers are adopting different strategies like researchers fabricated solar cell with polyaniline-graphene complex counter electrode (CE). They reported that due to easy charge-transfer between PANi (N atoms) and graphene (C atoms) by a covalent bond, electrical conduction and electrocatalysis of PANi-graphene complex CEs is more in comparison to PANi only counter electrodes. The DSSC employing PANi-8 wt% graphene complex CE gives an impressive power conversion efficiency of 7.78%, which is higher than 6.24% from PANi-only and 6.52% from Pt-only CE-based DSSCs<sup>44</sup>. Likewise another group fabricated bifacial DSSC based on a transparent polyaniline (PANi) counter electrode. The photoelectric properties of polyaniline were further enhanced by adding 4-aminothiophenol (4-ATP). The sunlight irradiation simultaneously on both sides causes excitation of more dye molecules which caused more generation of carriers, which results in the enhancement of short circuit current density and therefore increase in overall conversion efficiency. The overall obtained conversion efficiency was 8.35%, which is ~24.6% more compared to the DSSC irradiated from the front only<sup>45</sup>.

#### 4. CONCLUSION

Conductive polymers proved to be a potential building material for the development of sensors or electrochemical devices such as solar cells. They are inexpensive, can be miniaturized and easily fabricated. As they are highly porous, so can easily be penetrated by gases that can profoundly change their electronic properties and these properties of conductive polymers make them efficient for gas sensing. The gas sensors made up of conductive polymers exhibited highest sensitivity even at low concentrations of gases like ammonia, carbon monoxide, and carbon dioxide at room temperature. The use of conductive polymers

in fabrication of organic solar cells opens up a new perspective in photovoltaics technology as the cells fabricated with use of conductive polymers showed improved efficiency. The conducting polymers have reached the stage where they can be accepted as a potential material for the current market.

#### 5. ACKNOWLEDGMENT

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#### निष्कर्ष

प्रवाहकीय पॉलीमर सेंसर या विद्युत उपकरणों की तरह के सोलर सेल्स के विकास के लिए शक्तिशाली निर्माण सामग्री जैसे साबित हुए हैं। ये सस्ते हैं, लघु रूप में हो सकते हैं और उन्हें आसानी से बनाया जा सकता है। अपने छिद्रित रूप के कारण उन्हें गैसों के द्वारा आसानी से प्रवेश कराया जा रहा है ताकि उनके इलेक्ट्रॉनिक गुणों को गहराई के साथ बदला जा सके और प्रवाहकीय पॉलीमर के ये गुण संवेदन गैस के लिए कुशल बनाते हैं। प्रवाहकीय पॉलीमर से बने गैस सेंसरों ने उच्चतम संवेदनशीलता का ही नहीं बल्कि कमरे के तापमान पर अमोनिया, कार्बनमोनो. आक्साइड और कार्बन डाईआक्साइड जैसी गैसों की कम सांद्रता का भी प्रदर्शन किया। कार्बनिक सौर कोशिकाओं के निर्माण में प्रवाहकीय पॉलीमर का उपयोग फोटोवोल्टेक्स प्रौद्योगिकी के क्षेत्र में प्रवाहकीय पॉलीमर के उपयोग के साथ बनायी गयी सेल्स की कार्यकुशलता में सुधार के साथ एक नया दृष्टिकोण खोलता है। प्रवाहकीय पॉलीमर वास्तविक अनुप्रयोग के चरण में पहुंच गया है और मौजूदा बाजार में अधिक से अधिक स्वीकृति के लिए उत्पादन परीक्षण के इंतजार में हैं।

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## ढंकता हुआ पढ़ाई [PEO: CH<sub>3</sub>COOLi]: एमएमटी प्रणाली गर्म प्रेश तकनीक द्वारा संश्लेषित Dielectric Studies of [PEO: CH<sub>3</sub>COOLi]: MMT System Synthesized by Hot Press Technique

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### सारांश

मौजूदा लेख पॉलीथीन ऑक्साइड पी.ई.ओ. में पारद्युतिक गुणों के अध्ययन से संबद्ध है—पॉलीमर इलैक्ट्रोलाइट आधारित गर्म प्रेश तकनीक द्वारा एम एम टी भराव कणों का प्रसार करने के बाद संश्लेषित। पॉलीमर इलैक्ट्रोलाइट फिल्म आधारित पॉलीमर ऑक्साइड के विद्युत और थर्मल गुण गर्म प्रेश विधि द्वारा एम.एम.टी. पाउडर के साथ मिले हुए होते हैं। गर्म प्रेश विधि द्वारा तैयार फिल्म के लिए चालकता तापमान में वृद्धि पर 10<sup>-3</sup> s/सेमी की रेंज में पायी गयी। पारद्युतिक व्यवहार का विश्लेषण पारद्युतिक परमिटिविटी का उपयोग करते हुए ( $\epsilon'$  and  $\epsilon''$ ) और ( $\tan \delta$ ) स्पर्श्या नुकसान पर किया गया। यह पाया गया कि पारद्युतिक परमिटिविटी ( $\epsilon'$  and  $\epsilon''$ ) कम आवृत्तियों की दिशा में तेजी से बढ़ी और अधिकतम स्पर्श्या नुकसान उच्च आवृत्तियों की तरफ शिष्ट हो गये।

### ABSTRACT

The present paper deals with the study of dielectric properties in polyethylene oxide (PEO) - based polymer electrolytes subsequent to dispersal of Montmorillonite (MMT) filler particles synthesized by hot press technique. Electrical and thermal properties of PEO-based polymer electrolyte film are found to be enhanced with the addition of MMT powder by hot press method. The conductivity for film prepared by hot press method was found to be in the range of 10<sup>-3</sup> s/cm at increasing temperature. The dielectric behaviour is analyzed using the dielectric permittivity ( $\epsilon'$  and  $\epsilon''$ ) and tangent loss ( $\tan \delta$ ). It is found that the dielectric permittivity ( $\epsilon'$  and  $\epsilon''$ ) rises sharply towards low frequencies and maxima of tangent loss shifts towards higher frequencies.

**Keywords:** PEO-based polymer electrolyte, hot press technology, MMT dielectric properties

### 1. INTRODUCTION

Polymer nanocomposite electrolyte has received special attention during last many years due to their significant theoretical as well as industrial application in the development of electrochemical devices (like solid state batteries, fuel cells, solar cells, sensors and electro chromic display devices)<sup>1-3</sup>. This is a prominent class of materials for the electrode/electrolyte application because of their mechanical and thermal stabilities, easy to fabrication of thin film of desirable, shape/sizes and their ability to form proper electrode-electrolyte contacts<sup>4</sup>. Polyethylene oxide (PEO)-based polymer electrolytes using alkali salts, plasticizers and inorganic fillers has been extensively studied. Though PEO with single helical structure supports the fast ion transport but it suffers from the major drawback of low ionic conductivity at room temperature due to its crystalline phase<sup>5</sup>. Several efforts have been made in this direction to improve the ion transport, structural

and mechanical properties of these PEO based polymer electrolyte by adding different inorganic, ceramic and organic fillers<sup>6-8</sup>. The ionic conductivity of the solid composite polymer electrolyte is strongly governed by the route of preparation, concentration of filler, type of salt and its concentration. The choice of natural Montmorillonite (MMT) as a filler in this work is attributed to its additional advantages such as it acts as a nucleating agents for the crystallization of PEO. It also increases the melting temperature of polymer electrolyte film by forming high-melting complexes attributed due to the interaction between MMT and the polymer chains<sup>9</sup>.

Polymer electrolyte films are formed, in general, via solution-cast and sol-gel routes. However, recently, an alternate hot-press technique has been developed for casting completely dry polymer electrolyte films. This technique promises several advantages over the conventional solution-cast method and has been

recognized as a rapid, least expensive and dry procedure to prepare solvent free polymer electrolyte films. In this paper we report the results of nanocomposite polymer electrolytes prepared via hot press technique respectively. The effects of the MMT clay and hot press method on the properties of NCPE (Nanocomposite polymer electrolyte) film such as structural morphology were studied by optical microscopy. Electrical conductivity and dielectric behavior of electrolyte was studied by impedance spectroscopy at room temperature.

### 1.1 Experimental

Synthesis of film by hot pressing method: Polyethylene oxide [(PEO) (M.W.  $\sim 6 \times 10^5$ , ACROS organics)] based nanocomposite electrolyte films were prepared by admixing proper stoichiometric ratio of PEO with Lithium acetate ( $\text{CH}_3\text{COOLi}$ ) salt and the nanosize powder of MMT. This MMT powder was synthesized by ball milling process (Retsch PM 100) the raw material was put in planetary ball milling machine for 48 hours at a rotation speed of 300 rpm. The composition of polyethylene oxide/Lithium acetate/MMT powder was thoroughly mixed by planetary ball milling machine (Retsch PM 100) in Tungsten Carbide vessel with tungsten carbide balls at 300 rpm at 5 hours for 16 hours to obtain a homogenous mixture of powders. The powders were first heated in the oven at 60-65°C for 10 min. and a rubbery lump obtained. This rubbery lump was pressed in the hot press die to obtain a homogenous film.

Structural behavior of 99 {90 PEO- 10 LiAc}: 1 MMT system synthesized by hot press technique was studied with the aid of optical microscopy. The optical micrographs of the film were recorded using computer controlled LEICA DMLP polarizing microscope and the electrical conductivity and dielectric response was evaluated from complex impedance plot obtained using computer controlled Hioki (Japan) LCZ HI Tester (model 3520-3532).

## 2. RESULTS AND DISCUSSION

### 2.1 Optical Microscopy

Figure 1 shows the surface morphology of 99 {90 PEO- 10 LiAc}: 1 MMT film prepared by hot pressed technique at 80X magnification. The decrease in the surface roughness which is responsible for crystalline fraction of the material and no apparent pattern of PEO spherulites is observed under the microscope. This can be attributed to the intercalation of MMT and lithium acetate proton donor respectively resulting in the reduction of crystallinity of host polymer (i.e., polyethylene oxide) and subsequent enhancement in the overall amorphous fraction in the materials. The film prepared by hot press method is found to be smoother as no evaporation of water takes place which

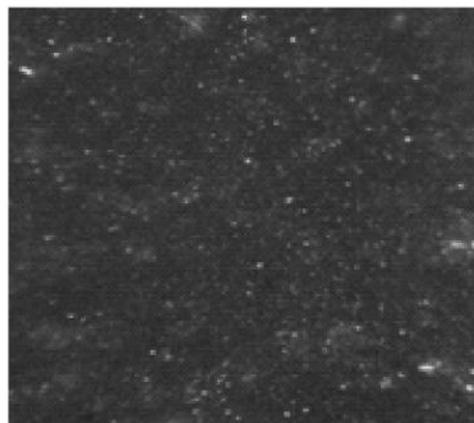


Figure 1. Optical micrographs of nanocomposite polymer electrolyte film 99 {90 PEO- 10 LiAc}: 1 MMT prepared by hot press method.

indicates that the polymer electrolyte prepared by hot pressing method no solvent is used.

### 2.2 Temperature dependent conductivity

The variation of ionic conductivity with temperature for 99 {90 PEO- 10 LiAc}: 1 MMT nanocomposite polymer electrolyte film prepared by hot press method is shown in Fig. 2. From the Fig. 2 it is clear that the bulk electrical conductivity follows Arrhenius nature. The initial very slow increase in conductivity is due to the unavailability of absorption of protonic species after the film formation. After 60°C the conductivity smoothly increases with temperature as polymer matrix gone through the phase rearrangement and it provides the better conduction atmosphere for the mobile species obtained from the dissociation of salt.

### 2.3 Conductance Spectra

Frequency dependent real part  $\sigma'$  ac electric conductivity of 99 {90 PEO- 10 LiAc}: 1 MMT electrolyte film prepared by hot press technique is shown in Fig. 3. It is found that the high frequency

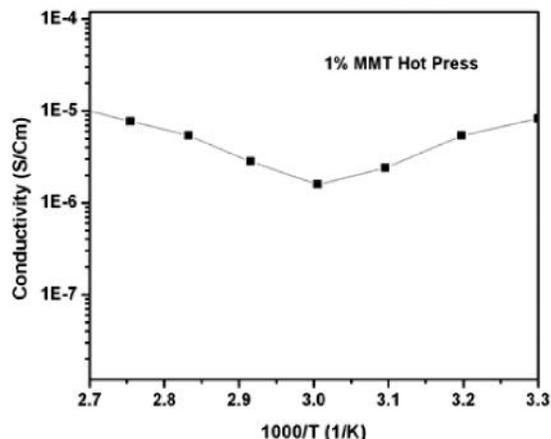


Figure 2. Variation of electrical conductivity with temperature for hot pressed film.

spectra of the electrolyte follow the Jonsher's Power Law fit to their high frequency experimental values<sup>10</sup>. Figure 3 shows the a.c. conductivity of nanocomposite polymer electrolyte film at the range of  $10^{-3}$  s/cm at increasing temperature. At the lower temperature not much increase in conductivity is observed due to the absence of solvent in the matrix of polymer film prepared by hot press technique. After the melting temperature ( $\sim 66$  °C) of PEO, the conductivity starts increasing for the film this can be explained on the basis of semicrystalline to amorphous phase transition. The dissociation of salt at higher temperature is also responsible for increasing conductivity at higher frequencies.

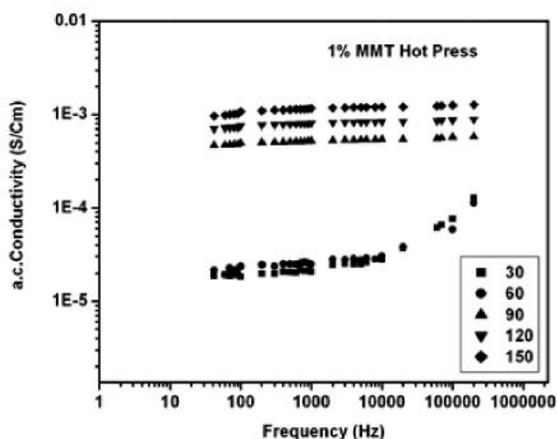


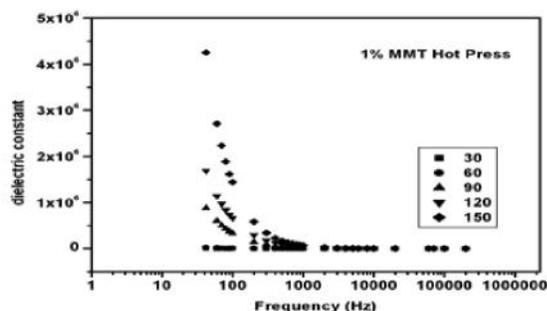
Figure 3. Frequency dependent ac conductivity of hot press film.

#### 2.4 Dielectric Analysis

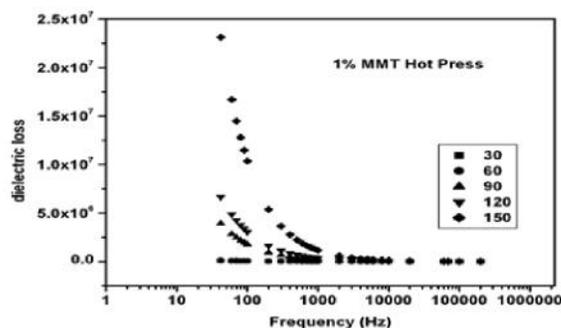
The variation of dielectric constant in Figs. 4 (a) & 4(b) shows the spectra of dielectric constant ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) of the hot press film of 99 {90 PEO- 10 LiAc}: 1 MMT electrolyte system with frequency respectively. It is obvious from the figures that dielectric constant increases with increase in temperature due to the higher charge carrier density. Both the parameters i.e. dielectric constant ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) for the film shows a decreasing pattern with increasing frequencies. The dielectric

constant ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) of the complex increases more at lower frequency. This is due to the electrical relaxation, which may be attributed to the lag between frequency of oscillating dipoles and applied field. The larger increase in  $\epsilon'$  value at lower frequencies is due to high contribution of charge accumulation between electrode-electrolyte interfaces called electrode polarization which leads to the double layer capacitances<sup>11</sup>. At higher frequencies, the fast periodic reversal of the electric field leads to the decrease in the long range drift of excess ion diffusion in the direction of the field so that the charge accumulation for the formation of EDL decreases, and consequently there is decrease in the  $\epsilon'$  values. The dielectric loss for the film was in range of ( $10^{-7}$ ) at lower frequency which can be attributed to the more free motion of ions in the film. A strong dielectric dispersion was observed in both the films with increasing temperature which reflects a Non-Debye relaxation in composite electrolyte systems. The observed behavior can be explained if the system is assumed to be formed of molecular dipoles below the melting temperature these dipoles remain frozen and as soon the temperature increases the dipoles become thermally active and this thermally activated space charge may be contributing to polarization process which leads to the observed increase in the dispersion process.

The tangent loss of the hot pressed film of 99 {90 PEO- 10 LiAc}: 1 MMT electrolytes is shown in Fig. 5 respectively. It can be seen that tan theta increases with increasing frequency, passes through the maximum value and thereafter decreases. For the film the relaxation peaks are found to be in the frequency range of  $10^2$ – $10^4$  Hz and it seems to shift to low frequency range. The maxima of tan  $\delta$  shifts towards the higher frequencies and the height of the peak increases with increasing temperature. This is attributed to the increment in number of charge carriers for conduction, which decreases the resistivity of the samples. The relaxation peak shifts towards higher



(a)



(b)

Figures 4. Variation of dielectric constant and dielectric loss of 99 {90 PEO- 10 LiAc}: 1 MMT hot pressed film.

frequencies with increasing temperature, which indicates that the charge carrier is thermally activated.

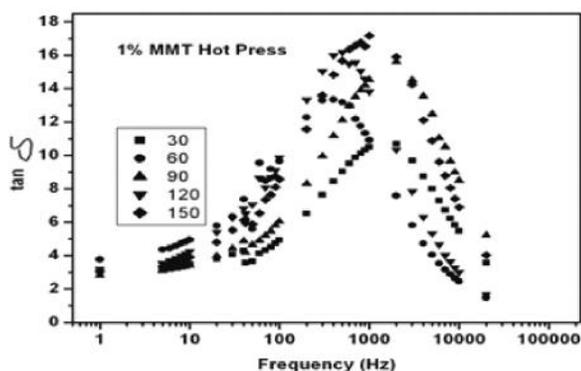


Figure 5. Frequency dependent tangent loss of hot press film.

### 3. CONCLUSION

A study has been carried out on polymer electrolytes films of 99 {90 PEO- 10 LiAc}: 1 MMT prepared by hot press method. The results show that the properties of PEO based polymer electrolyte film is enhanced by the addition of the MMT powder then the filler free polymer electrolytes. The ionic conductivity of hot pressed film is found in good agreement with respect to conductivity which indicates that ionic transport takes part in the hot pressed synthesized polymer electrolyte system. These results suggest that film prepared by hot press is a viable candidate for all solid state batteries and fuel cells and can be used as polymer electrolyte in dye sensitized solar cells.

### 4. ACKNOWLEDGMENT

We are thankful to BRNS, Bombay, India for providing financial assistance (BRNS/34/33/2012) for the research work.

### निष्कर्ष

गर्म प्रेस विधि द्वारा तैयार एम.एम.टी 99 {90 PEO- 10 LiAc}: की बहुलक इलैक्ट्रोलाइट्स फिल्मों पर एक अध्ययन किया गया है। इसके परिणामों से पता चलता है कि पॉलीमर ऑक्साइड आधारित पॉलीमर इलैक्ट्रोलाइट फिल्म के गुणों को एमएमटी पाउडर के अलावा भराव मुक्त पॉलीमर इलैक्ट्रोलाइट्स द्वारा बढ़ाया गया है। गर्म प्रेस फिल्म की आयनिक चालकता अच्छी दृष्टि में चालकता के साथ पायी गयी इससे यह संकेत मिलते हैं कि आयनिक परिवहन गर्म प्रेस संश्लेषित बहुलक इलैक्ट्रोलाइट्स प्रणाली में हिस्सा लेता है। इन परिणामों से ये सुझाव मिलते हैं

कि गर्म प्रेस द्वारा तैयार फिल्म सभी ठोस बैटरी और ईंधन की कोशिकाओं के लिए एक व्यवहार्य उत्पत्ति है और डाई अवगत सोलर कोशिकाओं में बहुलक इलैक्ट्रोलाइट्स के रूप में इस्तेमाल की जा सकती है।

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# त्रुटि के दौरान मैटलैब/सिमुलिंक में एसवीसी द्वारा पवन फार्म की स्थिरता सुधार विश्लेषण Stability Improvement Analysis of Wind Farm by SVC in Matlab/Simulink During Fault

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## सारांश

इस लेख पत्र में ग्रिड-साइड गड़बड़ी अर्थात् तीन फेज वाली शार्ट सर्किट त्रुटि के बाद ग्रिड वोल्टेज को स्थिर करने के प्रयोजनार्थ पवन फार्मों के साथ स्टैटिक वार कम्पेन्सेटर (एसवीसी) के उपयोग का अध्ययन किया गया है। स्क्वियरेल केज इंडक्शन जेनरेटरों (एससीआईजी) पर आधारित पवन फार्मों की प्रणाली स्थिरता की जांच की गई है। असंगतिपूर्ण प्रचालन की प्रकृति के कारण, स्क्वियरेल केज इंडक्शन जेनरेटरों (एससीआईजी) पर आधारित पवन फार्मों की प्रणाली अस्थिरता मुख्यतया त्रुटि के दौरान प्राप्त की गई अत्यधिक रोटार स्लिप के कारण त्रुटि के बाद एससीआईजी द्वारा अत्यधिक प्रतिक्रियात्मक विद्युत अवशोषण के कारण उत्पन्न होती है। एसवीसी के कार्यनिष्पादन का विश्लेषण करने के लिए, एक इंडक्शन जेनरेटर आधारित पवन फार्म पर विचार किया गया है। विद्युत प्रणाली में सम्मिलित एसवीसी की पूर्ण डिजिटल प्रतिकृति को मैटलैब/सिमुलिंक परिवेश में निष्पादित किया जाता है और प्रस्तावित टोपोलॉजि की व्यवहार्यता को सत्यापित करने के लिए परिणामों को प्रस्तुत किया जाता है।

## ABSTRACT

This paper studies the use of a Static Var Compensator (SVC) with wind farms for the purpose of stabilizing the grid voltage after a grid-side disturbance viz., a three phase short circuit fault. System stability of wind farms based on squirrel cage induction generators (SCIG) are investigated. Due to the nature of asynchronous operation, the system instability of wind farms based on SCIG is largely caused by the excessive reactive power absorption by SCIG after fault due to the large rotor slip gained during fault. To analyze the performance of SVC, an induction generator based wind farm has been considered. The complete digital simulation of the SVC incorporated into the power system is performed in the MATLAB/SIMULINK environment and the results are presented to validate the feasibility of the proposed topology.

**Keywords:** Induction generator, wind farm, SVC, system stability, flexible AC transmission systems (FACTS)

## 1. INTRODUCTION

With the synchronous wind generators as research object, this paper analyzes the problems of voltage stability and the generation mechanism of the reactive power compensation during the wind farms connected operation. The wind farms supply the active power to the grid when the wind turbines are connected to the grid, but at the same time, the reactive power is absorbed from grid, which would bring the reactive burden to the grid. Therefore, it is necessary to compensate the reactive power for grid-connected wind farm to eliminate the effects of voltage fluctuations which is caused by reactive power loss in grid and would lead to tripping operation of turbines. And the sufficient amount of reactive power compensation is needed to improve the safety and stable operation of the power grid.

Currently, the method of connecting the asynchronous generator and capacitor banks in parallel permits is mostly used for wind farm reactive power compensation. However, with the rapid development of power electronics technology, this traditional reactive power compensation shows some obvious drawbacks and connecting the flexible AC transmission system (FACTS) to the wind farm to improve the operation characteristics becomes a necessity. And in this paper, the method with Static synchronous compensator (SVC) is proposed to compensate the reactive power in dynamic process to improve the operation condition of wind farm<sup>3</sup>.

## 2. AN OUTLINE OF FACTS DEVICES

Eventually FACTS devices found applicability in the wind power industry. It was found that providing earlier wind power plants with some external reactive

compensation devices such as SVC or STATCOM, the grid compliance can be met, and thus the wind power plants could remain connected to the power system without stability risks<sup>4</sup>.

### 3. A Static VAR Compensators (SVC)

SVCs being dated from early 70s, have the largest share among FACTS devices. They consist of conventional thyristors which have a faster control over the bus voltage and require more sophisticated controllers compared to the mechanical switched conventional devices. SVCs are shunt connected devices capable of generating or absorbing reactive power. By having a controlled output of capacitive or inductive current, they can maintain voltage stability at the connected bus<sup>4</sup>.

Figure 1. shows these configurations: the Thyristor Controlled Reactor (TCR), the Thyristor Switched Reactor (TSR) and the Thyristor Switched Capacitor (TSC) or a combination of all three in parallel configurations. The TCR uses firing angle control to continuously increase/decrease the inductive current whereas in the TSR the inductors connected are switched in and out stepwise, thus with no continuous control of firing angle<sup>4</sup>.

Usually SVC's are connected to the transmission lines, thus having high voltage ratings. Therefore the SVC systems have a modular design with more thyristor valves connected in series/ parallel for extended voltage level capability<sup>4</sup>.

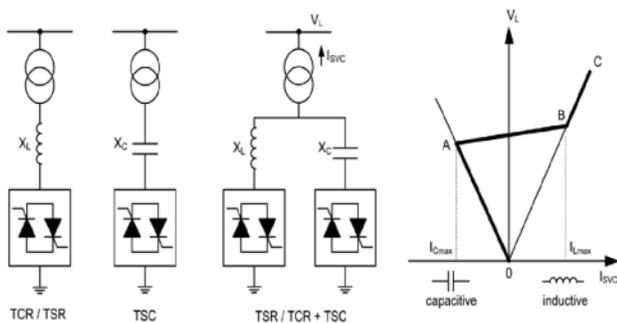


Figure 1. SVC configurations and its i-v characteristics.

To provide the needed reactive power generation/consumption in the network SVCs adjust the conduction periods of each thyristor valve. For an SVC consisting of one TCR and one TSC, assuming that both reactor and capacitor have same pu ratings then the following scenarios can occur:

- Reactive power is absorbed when the thyristor valve on the reactor leg is partially or fully conducting and the capacitor leg switch is off.
- Reactive power is generated when the thyristor valve on the reactor leg is in partial or no conduction mode and the capacitor leg switch is on.

- No reactive power is generated/absorbed if both the thyristor valve is not conducting and the capacitor switch is off.

The voltage-current (V-I) characteristic of an SVC with the two operating zones is shown in Fig.1. A slope around the nominal voltage is also indicated on the V-I characteristic, showing a voltage deviation during normal operation, which can be balanced with maximum capacitive or inductive currents. As the bus voltage drops, so does the current injection capability. This linear dependence is a significant drawback in case of grid faults, when large amount of capacitive current is needed to bring back the bus nominal voltage<sup>4</sup>.

The technology of SVC with thyristor valves is becoming outdated mainly due to the slow time responses, of injected current dependence on bus voltage and low dynamic performance.

### 4. TEST SYSTEM

The single line diagram of a test system employed in this study is shown in Fig. 2 . The network consists of a 33 kV, 50 Hz, grid supply point. A wind farm of 110 kW is integrated with a power grid of 33 kV by a three phase transformer of 400V/33 kV, 110 kVA. There are two loads in the system; one load of 50 kW which is connected to 33 KV grids through another step down transformer of 33 kV/400 V, 250 kVA and another load of 2 kW at 6 km away from each other. The 33 KV, 6 km long line is modeled as line. Used generator in this model is squirrel cage induction generators and stator windings are directly connected to the grid. This grid is used to study and analyze machine and wind farm stability. Dynamic compensation of reactive power is provided by a SVC located at the point of wind farm connection. Here we study using MATLAB simulation:

1. Induction generator stability conditions study without using SVC.
2. Induction generator stability conditions study with using SVC.

In this study, initially, induction generators required reactive power is considered by capacitor bank connected to 400V terminals at 400 KVAR rate. It's obvious that in system different conditions more reactive power demand is provided by grid. A three- phase short circuit occurred at 1.0 seconds to 3.5 seconds.

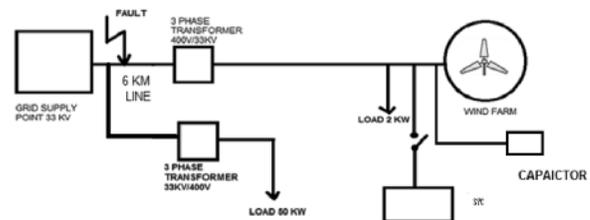


Figure 2. Single line diagram of test system.

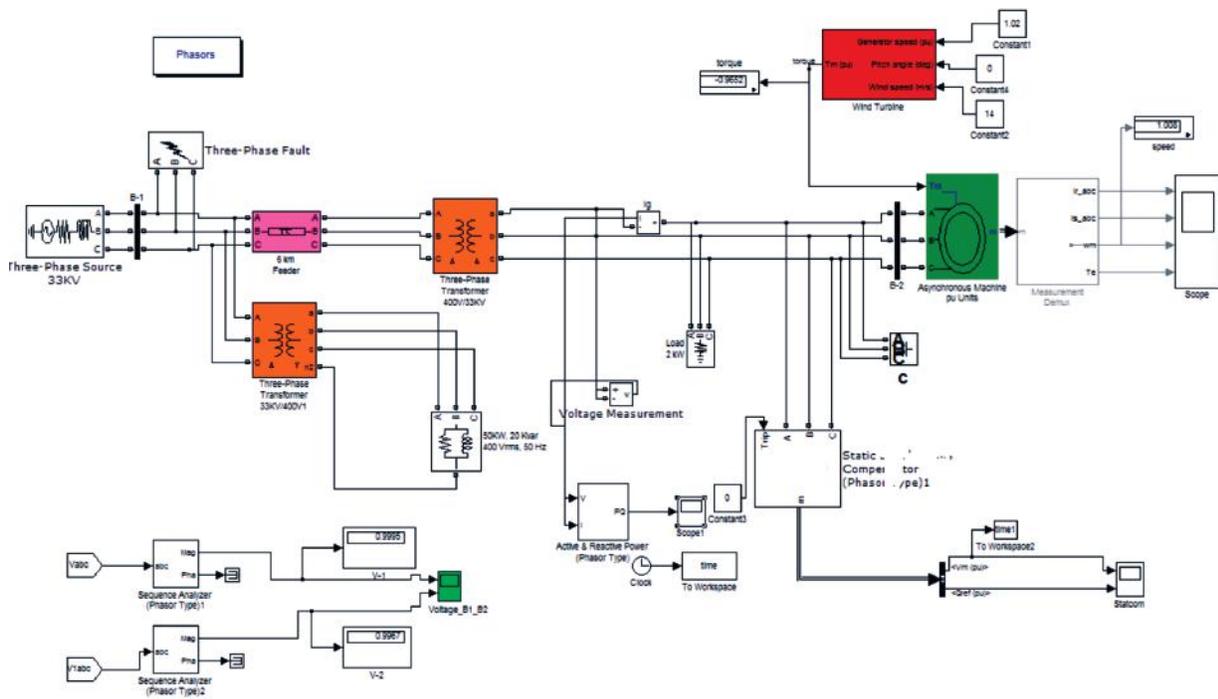


Figure 3. Simulink model of wind farm with SVC.

When we consider the above model under fault condition the system becomes unbalanced and uncontrolled in case of normal operating condition the output waveform as shown in Fig. 4 during fault condition without use of SVC.

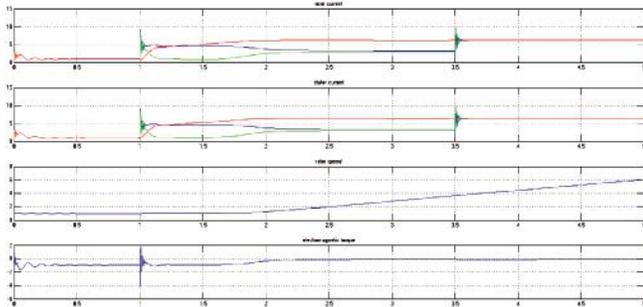


Figure 4. Output waveform under fault condition when capacitor bank in use.

Figure 5, shows the voltages at Bus-1 and Bus-2 (voltage vs time) during the operation of without SVC located at the point of wind farm connection.

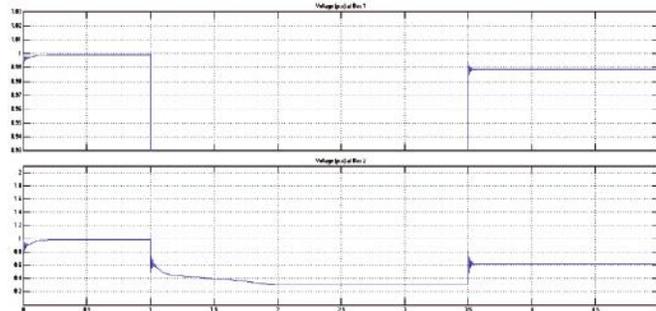


Figure 5. voltages at bus-1 and bus-2 without svc.

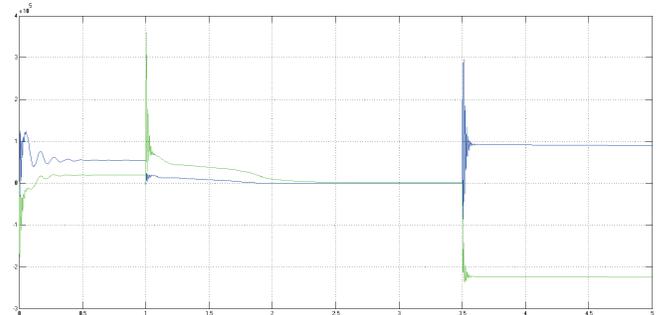


Figure 6. active and reactive power at bus-2 without SVC.

To overcome the difficulties arrived in case of power control by only use of capacitor bank, the following model is structured using SVC (Fig.7).The comparative result, i.e., rotor current vs time, stator current vs time, rotor speed Vs time and electromagnetic torque Vs time (sec) has been shown in Fig. 9 for the system.

Figure 8, shows the voltages at Bus-1 and Bus-2

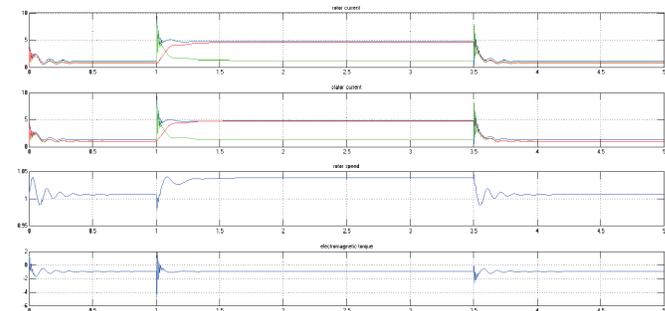


Figure 7. Power flow output waveform under fault condition when SVC in use.

(voltage vs time) during the operation of with SVC located at the point of wind farm connection. It is shown that the voltage at Bus-2 drops to very low value of 0.62 pu due to insufficient reactive power but this voltage improved to 1.0 pu when SVC is incorporated in the system. Thus the voltage and hence power quality improvement/ stability with static compensator on grid Integration of wind energy system is improved.

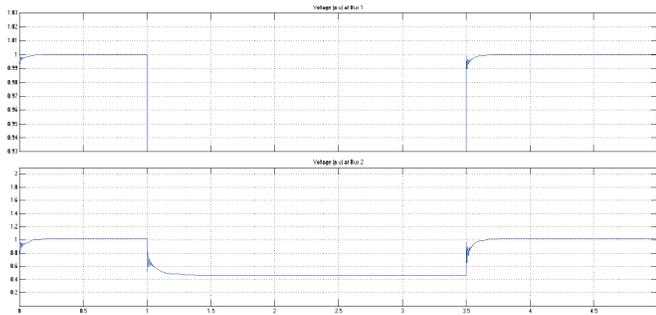


Figure 8. Voltages at bus-1 and bus-2 with SVC.

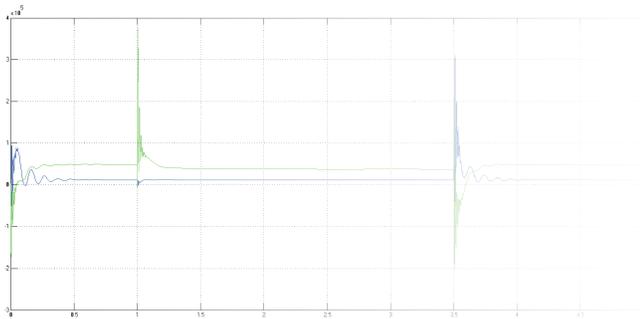


Figure 9. Active and reactive power at bus-2 without SVC.

The following results as given in Table 1 has been observed:

Table 1. Parameters of simulated induction generator

Rated power	110 KW
Stator voltage	400 V
Rs (stator resistance)	0.01481 pu
Rr (rotor resistance)	0.008464 pu
Ls (stator inductance)	0.04881 pu
Lr (rotor inductance)	0.04881 pu
Lm(mutual inductance)	2.241 pu
Number of pole pairs	2
Inertia constant	0.258
SVC	110 KVA

## 6. CONCLUSION

In our study we consider the squirrel cage induction generator based wind turbine. We consider the four parameters, i.e. rotor current, stator current, rotor speed and electromagnetic torque and the effect of

three phase fault is consider by using MATLAB Simulation. As we know the important characteristics of induction generator that it gives active power to grid and absorbs reactive power from the grid. So to fulfill the needs of reactive power the most suitable candidate of FACTS devices is SVC. Results clearly show that SVC improves the stability of the wind farm system.

## निष्कर्ष

अपने अध्ययन में हमने स्क्वियरेल केज इंडक्शन जेनरेटरों (एससीआईजी) पर आधारित पवन टर्बाइन पर विचार किया। हमने इसके चार मानदंडों पर विचार किया, अर्थात् रोटार करंट, स्टैटर करंट, रोटार गति और विद्युतचुंबकीय टोर्क और तीन फेज त्रुटि के प्रभाव पर मैटलैब सिमुलेशन का प्रयोग कर विचार किया गया। जैसाकि हम जानते हैं कि इंडक्शन जेनरेटर की एक महत्वपूर्ण विशेषता यह है कि यह ग्रिड को सक्रिय शक्ति प्रदान करता है और ग्रिड से प्रतिक्रियात्मक शक्ति अवशोषित करता है। अतः, प्रतिक्रियात्मक शक्ति की जरूरतों को पूरा करने के लिए, एफएसीटीएस युक्तियों का सर्वाधिक उपयुक्त पात्र एसवीसी है। परिणाम स्पष्टतया दर्शाते हैं कि एसवीसी पवन फार्म प्रणाली की स्थिरता को बढ़ाता है।

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# आवेशित कण की त्वरण और विद्युत चुम्बकीय क्षेत्र के अंतर से बनाए गए विद्युत जनरेटर का डिजाइन

## Design of Power Generator Made by Acceleration of Charged Particle and Differences of Electromagnetic Field

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### सारांश

आधुनिक दुनिया में, बिजली हमारे जीवन के लिए आवश्यक है। मुझे एक लम्बे समय तक चलने वाला एवं उच्च टार्क कार्यक्षमता वाला ऊर्जा स्रोत बनाने में रुचि है। क्योंकि हर बार उपयोग के बाद हमें दुबारा तेल भरना पड़ता है। इससे तेल की मांग बढ़ती है। और वाणिज्यिक अंसतुलन होता है। साइक्लोट्रॉन उपकरण और अभिवृद्धि डिस्क ने इस आलेख के लिए प्रेरणा दी। विद्युत चुम्बकीय क्षेत्र के बल की विभिन्नता अथवा किसी विशेष क्षेत्र में मजबूत गुरुत्वाकर्षण क्षेत्र कम गुरुत्वाकर्षण क्षेत्र के धूमकेतु, क्षुद्रग्रह, ग्रहों और तारों को आकर्षित करता है। यह इस प्रक्रिया की वजह से एक अभिवृद्धि डिस्क बनाता है। साइक्लोट्रॉन उपकरण आवेशित कण को तीव्र कर स्थिर मजबूत विद्युत चुम्बकीय क्षेत्र लाइनों के साथ उच्च आवृत्ति के साथ रेसोनेन्स चुंबकीय क्षेत्र लाइनों के मध्य सर्पिल मार्ग के माध्यम से पहुंचता है। यह आलेख मजबूत विद्युत चुम्बकीय क्षेत्र के साथ कम स्थिर चुम्बकीय क्षेत्र और स्पिन चुम्बकीय कण की मदद से स्पारल गति को प्राप्त करना संभव है कि चर्चा करता है। यह गैसीय अवस्था में जनरेटर के रोटर को विशाल परिसंचरण प्रदान करता है। किसी विशेष क्षेत्र में, मजबूत विद्युत चुम्बकीय क्षेत्र को कम विद्युत चुम्बकीय क्षेत्र के नियंत्रण में रखता है।

### ABSTRACT

In the modern world, the electricity is an essential for our lives. There is a need to make a energy source for long time duration with high torque performance because we need to refilling the fuel every time of usage it's increase the demand of fuel and economical imbalances. The Cyclotron device and Accretion disc was inspiration to this article. The force variation of electromagnetic field otherwise in particular region the strong gravitational field attracts the low gravitational field of comets, asteroids, planets and stars too. This thing creates an accretion disc due to the infalling process of matter. The Cyclotron device creates the acceleration of charged particles among the strong static magnetic field lines with high frequency of electromagnetic field lines of resonance through the Spiral Path. This article discusses about the strong electromagnetic field with low static magnetic field can be used to achieve the spiral motion with the help of spin magnetic moment its give a enormous circulation to the rotor of the generator in the gaseous state. In particular region, the strong electromagnetic field keeps under the control to the low electromagnetic pulses or field.

**Keywords:** Spiral motion, acceleration of charged particle, perpetual motion, magnetic repulsive pump, spin magnetic moment, power generator, EMF – Electromagnetic field

### NOMENCLATURE

H	Magnetic field Intensity
B	Magnetic field
m	Mass of the particle carrying charge
v	Velocity of charge particle
v <sub>S</sub>	Perpendicular component of velocity
B <sub>S</sub>	Static magnetic field.
B <sub>E</sub>	Electrode magnetic field

T	Time period of revolution
p	Pitch of helical path
μ	Permeability
E	Electric field strength
V	Volume of fuel gas
T	Temperature of fuel gas
q	Electric charge
P	Power density per volume
φ	Magnetic flux

$\omega$	Angular frequency
$\epsilon_r^{\wedge}$	Imaginary part of the complex relative permittivity of the absorbing material
$\epsilon_0$	Permittivity of free space
$r_g$	Gyroradius
$m$	Mass of the particle

## 1. INTRODUCTION

Generally the power generator uses refilling fuel as petrol, diesel, biogas, and hydrogen etc. I would like to build the particle accelerator as a power generator for long life time duration usage. I want to run the generator rotor using the acceleration of charged particles in spiral motion and infalling of atoms technique. The recent studies have shown the particle acceleration focus on the world major issues of progress.

I believe, the circumstance of a low static magnetic field exerts a spiral motion on the strong effect of differences of electromagnetic field otherwise on any applying forces there will be opposite reactive force likewise the fast moving charged particles carrying the magnetic flux similarly, the continuous motion of magnets also carry the electric field. So, the magnetic and electric field is dependent on each other. Then the strong electromagnetic field force (Static Magnetic Lines) pulls the high frequency of Dee's electromagnetic field force. There will be an opposite reaction rise to electric field then the resonance gives the acceleration of charged particles thus creates a spiral path.

## 2. PRINCIPLE OF OPERATION

The Cyclotron device and accretion disc form is working on same theory. The Strong Electromagnetic Field (Gravity & Static Magnetic Lines) keeps under the control of Low electromagnetic field. The strong EMF attracts the high velocity of low EMF forces due to the collision of low EMF forces to bring an acceleration of charged particles form an accretion disc. The high velocity equals to the high frequency of low EMF (Dees) in cyclotron thus thing brings the spiral path.

According to this theory, the differences of electromagnetic field bring the spiral path due to the acceleration of charged particles. The Helium atom is moving much faster than other particle in temperature. The Helium, Hydrogen and mixture of gas compound ratio using as a fuel. The gas fuel ratio has been under the R&D work. The gas fuel carries the spin magnetic moment to form a low electromagnetic field pulses. The propagator produce the strong electromagnetic field and acceleration of charged particles.

The low static magnetic field has support through the spin magnetic moment of gas fuel and longitudinal spiral path motion due to the compressed gas having a

very tight molecule of atoms. The alternating electric field creates the Strong EMF in Dee's and the acceleration of charged particles brings the spiral motion around the propagator pulls the low EMF (Spin magnetic moment) of gas atoms due to the infalling process. The centralized rotor will rotate by a spiral motion. The rotor shaft connects with Generator and gives an electric output. This system gives too much heat so we can use thermocouple generator to improve the performance and output level.

## 3. THE MAJOR COMPONENT & FUNCTIONS

- Power Production Unit
- Fuel Tank
- Generator

### 3.1 Power Production Unit

The Power Production unit is a major component on this system. It depends upon the fuel of gas, Marx generator and Magnetic repulsion pump mechanism. The Helium, Hydrogen and mixture of specific gases in combined ratio form used as a fuel. Helium is a very good conductor of electricity it's having a heating capability at the level of Plasma. In a room temperature, helium atoms may be moving much faster than other particles. In this process, the fuel gas maintained the gaseous state of temperature range as 500°C to 1200°C. However, once the applied electric field approaches the breakdown value, free electrons become sufficiently accelerated by the electric field to create additional free electrons by colliding, and ionizing, neutral gas atoms or molecules in a process called avalanche breakdown.

The heated gas fuel contains enough mobile electrons and positive ions to make it an electrical conductor. In the process, the Marx Generator and op-amp gives high frequency of voltage and high ampere current as the output. This output current passes through high frequency oscillator to convert the dc pulse into ac current then applying input to the electromagnetic propagator.

Each particles are accelerated by a flow of electric current still the acceleration value of charged particles is between the variation through the atoms fall into disc rotating motion to form a spiral motion.

The power production unit is work by a three major Principles such as, the mechanical energy converted into to electrical energy, Spiral motion and thermocouple mechanism. The Spiral motion was achieved by a differences of electromagnetic field and spin magnetic moment of atoms.

According to the magnetic mirror effect, anytime the charged particle is reflected from a high density magnetic field to low density magnetic field. This effect was handled by an angle of approach and applying limited velocity.

In this progress the voltage takes the responsibility of velocity limit. The Rotor Blade having 30° angle of arc shape is taking the responsibility of angle of approach. So the magnetic mirror effect also support to the rotor motion.

According to the Maxwell's Equation – II from Faraday's law in a differential or Point form, the electromotive force around a closed path is equal to the magnetic displacement (flux density) through that closed path. So the electric voltage around a closed path is equal to the magnetic current through the path that is creating a helical motion of rotation.

According to,

$$v = \frac{d\theta}{dt}$$

$$= -\frac{d}{dt} \left( \iint_s B \cdot ds \right)$$

But,

$$v = \oint E \cdot dl$$

$$\oint E \cdot dl = -\frac{d}{dt} \left( \iint_s B \cdot ds \right)$$

$$B = \mu H$$

$$\oint E \cdot dl = -\iint \frac{\partial B}{\partial t} \cdot ds$$

$$\oint E \cdot dl = -\mu \iint \frac{\partial H}{\partial t} \cdot ds$$

According to the Charlie law of volume states that, when the pressure on a sample of a dry gas in held constant, the Kelvin Temperature and the volume will be directly related.

Constant Pressure,  $V \propto T$

We can maintain at the rate of constant pressure and Temperature Level to the fuel that kind of atmosphere conditions might be improve the useability period of fuel.

According to my concern about the Fig. (1), the spiral motion is considered as a glass of water rotating by a stick in the motion of same direction and variance level of applying forces. Likewise the gas fuel act as a water and the applying frequent voltage of electrons can be able to control the velocity of acceleration of charged particles level. The rotor disc connects with shaft is run by a generator so mechanical energy converts into electrical energy. Thermoelectric generator generates the electricity due to the temperature differences. The Power Production unit contains four level of layers such as,

- High magnetic field layer
- Ceramic layer
- Heat shield
- Non-Magnetic stainless steel layer

In this Fig. 1, the magnetic repulsive force using as pump motion its push the highly compressed gas passes through a closed system of wheel motion instead of we can use by a similar model of Gas Turbine generator model. The high frequency of alternating voltage will be creating the linear and stable spiral motion The Marx Generator is able to produce a high voltage of DC Supply. This high voltage of electrons gives strong electromagnetic field then the spin magnetic moment carried out by a gas fuel act as a low electromagnetic field as a result, the spiral motion was achieved by a infalling process of gas otherwise the strong EMF attracts with low EMF it's given a equal and opposite magnetic field to create a spiral motion. The Disc revolution (rpm) is depends upon the pressure level of gas and intensity of electrons in the spiral motion.

### 3.1.1 High Magnetic Field Layer

- It's having two different types such as,
- Uniform Magnetic Field
- Non- Uniform Magnetic Field

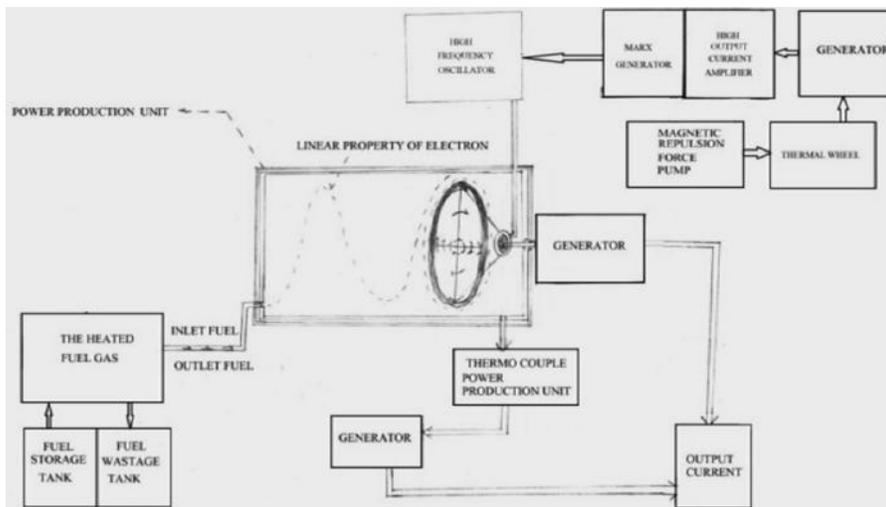


Figure 1. Block diagram of vehicles model power generator.

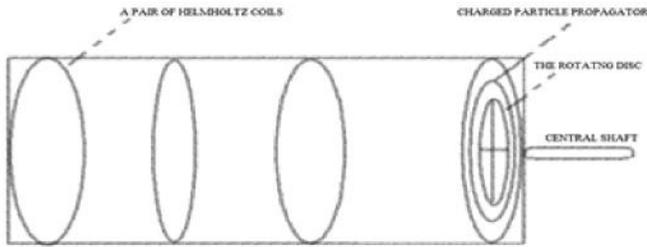


Figure 2. Helmholtz coil model of uniform magnetic field layer.

**4. MOTION OF A CHARGED PARTICLE IN UNIFORM MAGNETIC FIELD**

Motion of a charged particle in magnetic field is characterized by the change in the direction of motion due to the ac current. The motions of charged particles create a form of spiral motion.

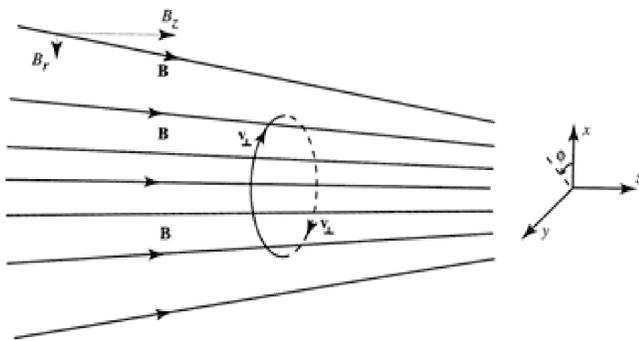


Figure 3. Drift of A particle in a magnetic mirror configuration.

**4.1 Helmholtz Coil**

A Helmholtz coil is a device for producing a region of nearly uniform magnetic field. It consists of two solenoid electromagnets on the same axis.

Besides creating magnetic fields, Helmholtz coils are also used in scientific apparatus to cancel external magnetic fields, such as the Earth’s magnetic field. 10 stage of marx generator will be produced at 600 kV of DC current.

**5. HELICON – NON UNIFORM MAGNETIC FIELD**

A helicon is a non-uniform magnetic field device. This discharge is an excitation of plasma by helicon waves induced through radio frequency heating. The presence of this magnetic field creates a helicon mode of operation with higher ionization efficiency and greater electron density. We can able to control the RF heating range then this design adopts to work out well. For Dielectric heating , generated power density per volume is given by,  $P = \omega \epsilon_r'' \cdot \epsilon_0 \cdot E^2$  .

Helicons have the special ability to propagate through pure metals, given conditions of low temperature and high magnetic fields. Most electromagnetic waves in a normal conductor are not able to do this, since

the high conductivity of metals acts to screen out the electromagnetic field.

**5.1 Magnetic Repulsive Pump**

The magnetic repulsive pump is working as a perpetual motion device. This force gives the input through a closed system of wheel motion systems. The magnetic repulsion pump has a two bar magnet connecting with Pistons in between placed at third bar magnet create a continuous motion due to the gradient path and low temperature. The Magnetic Repulsive Force pushes the Piston simultaneously in left and right vice versa act like a perpetual motion. So the Cold inert gas passes through a high pressure level (HPL) to low pressure level (LPL) but this system running under much more heat so we use specific combination of inert gases for pressure and reliable wheel motion. The magnetic repulsion force varied by a following reason such as,

- Heat
- Distance of Track Plate
- Piston weight
- Friction of Carriage

The heat will reduce the magnetic flux so it will affect the repulsion force level in the pumping motion so we use non magnetic stainless steel coating with pure indium material used to cover magnets and chamber it’s helps to reduce heat effect. The low temperature lubricants use to avoid the friction heat of carriage of magnet show that below Fig. 4.

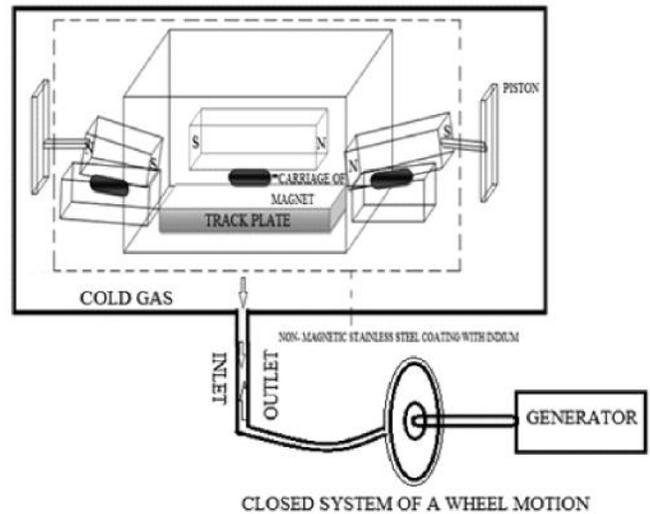


Figure 4. A Magnetic repulsion pump

The distance of track plate is increased its reduced the speed of piston movement because of the perfect distance and light weight heavy magnetic field create a extreme piston motion in the chamber that can be able to give the high pressure to the wheel.

The piston is connecting with each magnet back

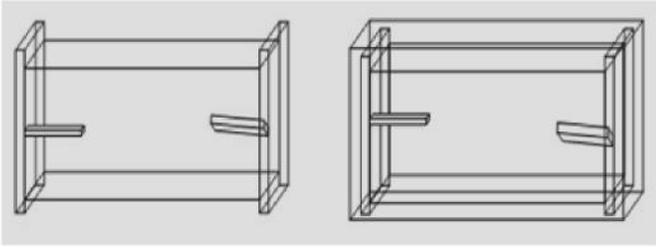


Figure 5. A piston positions in the chamber.

end then its weight must be less than 60 to 80 % of magnet weight so we construct the piston in 20 to 40 % of weight. That kind of weight less piston can be able to move rapidly at the same time the non-magnetic stainless steel chamber fit with Piston. The piston crown surface is much higher than stainless steel chamber but that is fit with outer chamber as its result, the outlet gas pressurized level will be increased.

The magnetic repulsive pump has a unique valve for inlet and outlet. These valve transfers the cold gas and the single valve and tube of stainless steel connect through the Closed System of wheel motion systems.

$$\text{Distance} \propto 1 / \text{Efficiency}$$

### 5.2 Charged Particles of Propagator

A Marx generator is an electrical circuit. Its purpose is to generate a high-voltage pulse from a low-voltage DC supply. The circuit generates a high-voltage pulse by charging a number of capacitors in parallel, then suddenly connecting them in series. The high output current op-amp is output given to the input of Marx generator is connecting at the high frequency of oscillator. We can create a high voltage and high current output it's make an enormous output.

The propagator has a high conductivity of electrode. It's fixed with parallel to static magnetic field in one end of chamber. The electromagnetic field is 3 dimensional. The low static magnetic field  $B_s$  is perpendicular to the electrode magnetic field  $B_E$ .

$$B_s \perp B_E$$

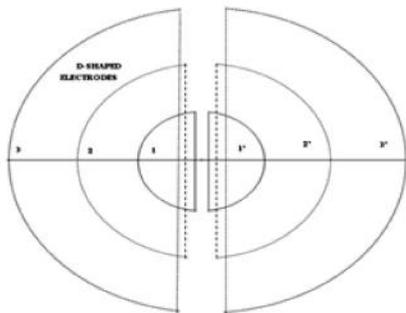


Figure 6. The propagator.

The 6 Dee's of electrode used for the electromagnetic propagator. The cyclotron is working principle used by the propagator model. The acceleration of charged particles is accelerating by an alternating current.

The 6 Dee' of 3 combos was using by the Propagator. Each combo of Dees is placed at face to face with narrow gap. The narrow gap distance is varied by a millimeter level in each combo of Dees. The alternating current passes through a 2 section of Dees in the manner of 1, 2, 3 and 1', 2', 3'. The each section having an individual serial connection and the delay system depends upon the current flow crossing range of Dees in 1, 2 3 and 1', 2', 3'. The spiral path exerts a force on the propagator and infalling process of spin magnetic moments of atoms support by the low static magnetic field. The power generator design having a compressed gas, heat, pressure and spin magnetic moment they re-encounter the accelerating voltage many times that's the reason to we use low static magnetic field. This article's ultimate goal is, in the gaseous state applying the electricity try to achieve the infalling process of spiral motion. I would like to construct this design. The rotor must be coated with Mercury. The Mercury (Hg) improves the electromagnetic field acceleration.

The rotor design and angle of etches value depends at the gyroradius value.

$$r_g = \frac{mv_{\perp}}{|q|B}$$

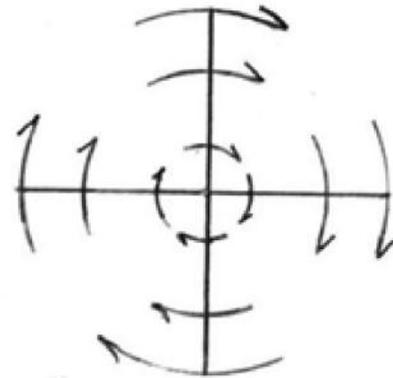


Figure 7. The design of rotor.

### 5.3 Ceramic Layer

A ceramic material is the any inorganic crystalline material, compounded of a metal and a non-metal. It is solid and inert. Ceramic materials are brittle, hard, and strong in compression, weak in shearing and tension. They withstand chemical erosion that occurs in an acidic or caustic environment. In many cases withstanding erosion from the acid and bases applied to it. Ceramics generally can withstand very high temperatures such as temperatures that range from 1,000 °C to 1,600 °C (1,800 °F to 3,000 °F). This

kind of high temperature superconductivity of ceramic materials used in this system that does improve the performance such as,

YBaCuO superconductors

Bi-, Tl- and Hg-based high-Tc superconductors

This Ceramic layer connects with thermocouple mechanism for variance of temperature to generate electricity. Thermoelectric generators are devices that convert heat (temperature differences creates an electric potential or an electric potential creates a temperature difference) directly into electrical energy, using a phenomenon called the Seebeck effect. The maximum efficiency is depends upon the constant temperature value so we can maintain the temperature range as a higher and stable, its output value is also high.

#### 5.4 Heat Shield

A heat shield is designed to shield a substance from absorbing excessive heat from an outside source by either dissipating, reflecting or simply absorbing the heat. It is often used as a form of exhaust heat management.

However, the appearance of a new generation of carbon fiber consisting of glass-ceramic matrices resulting from the polymerization of inorganic polymers presents some interesting options for Formula One teams. These inorganic polymers are derived from alumino-silicate-based geopolymeric systems and, as such, differ significantly from both organic polymers and conventional ceramic matrices. The result is a lightweight alternative to metals and other materials for heat shields, ducts and other components exposed to temperatures of between 300 and 1000°C. So the device is easy to handle and maintained by an atmospheric heat. We can improve the performance level of this system by using these materials as a heat shield; the Reinforced carbon-carbon (RCC) - 1,260 °C (2,300 °F), LI-900 Silica ceramics -1260 °C and Flexible Insulation Blankets (FIB) - 649 °C (1,200 °F).

#### 5.5 Non-Magnetic Stainless Steel

The stainless steel is a relatively poor conductor of electricity, with a few percent of the electrical conductivity of copper. Ferritic and martensitic stainless steels are magnetic. Austenitic stainless steels are non-magnetic.

A non-magnetic stainless steel having a very low heat resistance then it's coating with 99.9% of pure indium. This indium is used to maintain the stainless steel temperature at lower level.

#### 5.6 Fuel Tank

The fuel tank is having a two separate chamber.

First one acts as storage tank and second chamber acts as a wastage tank. This fuel tank is connecting with a heated fuel gas chamber. This chamber made a highly heated fuel gas with the help of fuel tank.

#### 5.7 Generator

Electric generator is a device that converts mechanical energy to electrical energy. A generator forces electric current to flow through an external circuit. The source of mechanical energy is a rotating disc using SCW reaction. Generators provide nearly all of the power for electric power grids.

#### 6. FUTURE WORK

The acceleration value of charged particles variation in-between the particles through the matter fall into black hole to form a spiral disc form this kind of energy device will be used as a power absorber.

An interaction between the electromagnetic field of laser pulses and radio waves and dark matter of connections will be able to lift the object this system will be using to rescue rope and many commercial applications. We will create reliable power absorption using a helium and hydrogen atoms pass through a static field and activate around the another atoms emissive energy in space its combined by a sonic waves that output act as virtual particle accelerator will be using in a rocket propellant in space and the variation of particle pressure level of absorber model will be control the atmospheric damage of bomb, Rockets, etc.

#### 7. CONCLUSION

In this paper bullet proof shields design is proposed by avoid the physical damage of soldiers and vehicles improve the chance to survive in battle field The Power Generator is an excellent choice of energy source to run the vehicles.

#### निष्कर्ष

इस आलेख में बुलेट प्रूफ ढाल का डिजाइन प्रस्तावित किया गया है जिससे सैनिकों और वाहनों को भौतिक नुकसान से बचा कर लड़ाई के मैदान में जीवित रहने के लिए मौकों को बेहतर बनाया जा सके। पावर जेनरेटर वाहन के ऊर्जा स्रोत में शानदार विकल्प है।

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## एक बिजली व्यवस्था में डी-स्टैटकॉम का इस्तेमाल से बिजली की गुणवत्ता के सुधार पर एक साहित्यिक सर्वेक्षण

### A Literature Survey on Improvement of Power Quality in a Power System Using D-Statcom

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#### सारांश

इस आधुनिक युग में, बिजली इलेक्ट्रॉनिक्स उपकरणों के विकास और मांग के साथ बिजली की गुणवत्ता के मुद्दे चुनौतीपूर्ण होते जा रहे हैं। यह समस्या बिजली इलेक्ट्रॉनिक उपकरणों के असमान व्यवहार के कारण उत्पन्न हो रही है। ये उपकरण बिजली की गुणवत्ता के मुद्दों को नियंत्रण और निपटने में प्रभावित हो रहे हैं। फ़ैक्ट उपकरणों में विकास से, अलग क्षेत्र में अलग रणनीति से हम कुछ हद तक बिजली की गुणवत्ता के मुद्दों को हल कर पा रहे हैं। यह आलेख विभिन्न प्रकार के डिजाइन और कोनफिग्युरेशन उदाहरण सीएसआई आधारित, वीएसआई आधारित, पीडब्ल्यूएम आधारित पर पूर्व प्रकाशित साहित्य की समीक्षा करके डी-स्टैटकोम के उपयोग से बिजली की गुणवत्ता में सुधार की चर्चा करता है।

#### ABSTRACT

With the development and demand of power electronics devices in this modern age the power quality issues are becoming challenging. This problem is arising due to the nonlinear behavior of the power electronic devices. These devices affect the controlling and handling of power quality issues. The advancement in FACTS devices, with different strategies in different area we are getting some improvement in solving power quality issues. This paper discusses the impact and depth that how to enhance the power quality by using D-STATCOM by reviewing the past literature published on the various types of design and configuration, i.e, CSI based, VSI based PWM based, etc.

**Keywords:** power quality, voltage stability, D-STATCOM, VSI, VSC

#### NOMENCLATURE

STATCOM: Static Synchronous Compensator  
FACTS : Flexible AC Transmission System  
SPWM : Sinusoidal Pulse Width Modulation  
VSC : Voltage Source Converter  
CSI : Current Source Inverter

#### 1. INTRODUCTION

Electrical energy is very convenient form of energy to change into various forms of energy for different purposes as lighting, heating, cooling and for number of applications. Therefore the consumption of electricity increasing day by day throughout the world, hence nowadays there is needed to focus on power quality issues to solve the economic challenges with the power system throughout the world. The term power quality describes by the magnitude and waveforms of the voltage and current in power system, for standard power quality means voltage should be within the limit and waveform should not be distorted.

#### 2. NON-LINEAR LOADS

Distorted waveforms, i.e, harmonics occur in AC power systems when the sinusoidal waveform distorted by nonlinear loads, and it occur in the power system if the resistance is not constant and varying during each sinusoidal waveform<sup>10</sup>, resulting in both positive and negative half cycles. Therefore these pulses or waveform can produce additional pulses to the original waveform.

In this modern age the almost all equipment or load is made up of semiconductor devices, which are less sensitive of voltage fluctuations<sup>11</sup>, but it may get damage therefore there is need for better power quality improver technology and devices, nowadays because of advancement of FACTS controllers somewhat got success in this area of power system, in which of controllers one is DSTATCOM which is using to compensate the reactive power by which the power quality is improved somewhat.

### 3. DSTATCOM

It is a FACTS device which is installed for the support of electricity networks which have poor power factor and voltage regulation also, commonly it is used for the stabilization of voltage and to improve power factor of that network. It is a voltage source converter based device.

## 4. LITERATURE BACKGROUND

### 4.1 Operation of a DSTATCOM in Voltage Control Mode

This paper<sup>1</sup> presents the various operating principles of DSTATCOM which is used to maintain the voltage of a distribution bus. For this case study a three phase four wire system is considered. The inverter supplied by two dc capacitors realizes the DSTATCOM. In distribution systems there are many compensating devices. But in radial system due to the unbalanced load in any part of the system the consumer at that bus suffers the distorted voltage which results in harmonics and voltage instability. In such a case the DSTATCOM reduces the harmonics and balances the bus voltages. In this method the DSTATCOM is connected at the PCC and the DSTATCOM is used in voltage control mode at this bus. The DSTATCOM is realized by a two level neutral clamped VSC and a filter is used in parallel with VSC. There is a switching variable say “u” having values -1 and +1. There are two dc storage capacitors whose voltages are always maintained as constant. When the switch is closed the voltage of the inverter is positive maximum and when the switch is open the output is negative maximum. The switching variable u is obtained from the hysteresis action around zero. The dc storage capacitors supply the DSTATCOM such a way that the average of the real power entering the PCC from source to satisfy the total load and losses in the DSTATCOM. The lower limit of the voltage is decided by the angle and the upper limit is decided by the voltage rating and the dc capacitors. By assuming that voltage across each capacitor is V then after adding the total voltage across the dc link will be 2V. If this value deviates from the reference value then it means there are losses in the system.

Then we add the total capacitor voltages and compare with the reference value. This is considered and error signal and given as input to the controller. The controller generates the corresponding signals such that the voltage is balanced. The simulation results are observed in unbalanced cases. The voltages in case of unbalanced and distorted source voltage are observed as phase a: 360 V (peak) and 15 % third harmonic, phase b: 432 V (peak) and 16 % third harmonic, phase c: 288 V (peak) and 8 % third harmonic. THD in phase

A of source voltage is 15 %, in terminal voltage of phase A is 0.95 %, in remaining two phases it is 1 %. The simulation results showed that the DSTATCOM is able to common point (PCC) against disturbances both in load side and source side.

### 4.2 Application of DSTATCOM compensators for Mitigation of Power Quality Disturbances in low Voltage Grid with Distributed Generation

This paper<sup>2</sup> discusses the capability of the DSTATCOM to compensate the PQ problems occurred due to the loads and the DERs. Different types of DG technologies are being used now a days. By grouping all DVRs into the grid causes certain difficulties regarding power quality. To solve this problem a typical overhead rural network is taken and studied and the results obtained are implemented accordingly. Radial low voltage grid is supplied from a distribution transformer 20/0.4KV of nominal power 63 KVA. Medium voltage section is isolated but generally acts as a radial one. High voltage network has a meshed configuration and is represented by two transmission lines which are supplying the distribution system. Load devices distributed along LV feeders are as follows: Loads 2÷5 – three-phase, balanced, of total constant power equal 30 kW and 12 KVAR Load 1 - single-phase (connected in phase C) of maximum power equal 4 kW and 1,5 KVAR. The best results can be obtained when the compensator is installed near to the disturbing device.

Therefore this study is based on the design that the DSTATCOM is placed or connected parallel to the DERs. DSTATCOM is built around a 3-phase 6-pulse voltage source inverter, connected to the network by a dc capacitor through a reactor. The inverter consists of switches which are fully controllable. The DSTATCOM injects a set of three unbalanced currents into the network and hence the current in the network becomes sinusoidal. The media here used in the simulation is PSCAD/EMTDC program environment. Short circuit power on the high voltage side of the transformer is assumed as 100 MVA,  $\pi$  type circuit is considered. After analyzing it is observed that the time of results aggregation was reduced to 0.5 seconds and period of observation also reduced to 30 seconds in case of PQ deviations and in case of compensation of dips coming from the supply side by the assumption of fault duration time to be 0.2 seconds, it results in the protection operation. By carrying the simulation and observing the results in various cases it is proved that DSTATCOM is efficiently overcoming the PQ problem.

### 4.3 Impacts of AC Generators and DSTATCOM Devices on the Dynamic Performance of Distribution Systems

As we are using the machines like induction machines and synchronous machines along with the DSTATCOM there are certain influences of these on the dynamic behavior of the power system. This paper<sup>3</sup> deals with the influence of this equipment on the dynamic behavior of the distribution network. The DSTATCOM is modeled as a voltage controller and power factor controller and the results are analyzed. The DSTATCOM connected in shunt with the distribution network consists of a 3 phase VSI in turn connected through a coupling transformer. By implementing this configuration the reactive power can be generated or absorbed by this device and also this power is controllable as we are using VSI. Usually the rotating reference frames offers high accuracy than the stationary reference frames. So the voltage controller here employs dq0 rotating reference frame. Three phase currents are induced by the DSTATCOM into the network to satisfy the reactive power in the network. This controller uses a PLL to synchronize the converter output with zero crossings of the fundamental component of the phase-A terminal voltage. In this configuration there are four PI controllers among which one is to control terminal voltage through reactive power exchange with the ac network and another is to maintain the dc voltage constant by exchanging a small amount of active power with the ac network. The other two controllers determine the voltage reference signals to the PWM signal generator of the VSI, once the dq0-to-abc transformation is done. The induction generator was represented with a three phase model and synchronous generator is represented by a eighth order three phase model in the d-q reference frame. When a three phase to ground fault is applied at one of the bus at 0.5 seconds time the induction generator injected 25MW into the network when the fault is eliminated after 9 cycles. The results proved that though the system is stable without DSTATCOM, with DSTATCOM voltage controller and with DSTATCOM power factor controller the terminal voltage is regained to 1p.u. only with the presence of DSTATCOM. If there is no DSTATCOM the terminal voltage after fault is 0.942p.u. The induction generator and synchronous generator were studied under different fault conditions and by the experimental results the performance of each machine with the DSTATCOM is better than without the DSTATCOM.

### 4.4 Neural Network Based Control of Reduced Rating DSTATCOM

This paper<sup>4</sup> presents the study of DSTATCOM represented by a VSI when it is connected to a resistive-inductive load connected to the distribution

systems. The technique used for switching of the VSI is hysteresis current control technique. For this a hysteresis controller is used. The inputs to the hysteresis controller are given by the neural network based reference current generator. The duty of the PI controller is to maintain constant dc bus voltage and ac voltage regulation. By connecting an ac capacitor at the load side the rating of the DSTATCOM is reduced. The load current consists of two components, they are active component for positive sequence current and reactive current for negative sequence current. The control algorithm calculates some value based on the switching function which gives the positive sequence of the current to be induced in phase with the voltage waveform. The voltage should be undistorted. If in case the voltage is distorted the value of the current to be induced being as a function of voltage gets disturbed which reduces the efficient working of the DSTATCOM. While coming to the generation of reference signals proper estimation of the reference signals is to be done. For this the weights are averaged and equivalent weight for positive sequence and negative sequence current components are computed in the decomposed form. These reference currents are used to switch the VSI of the DSTATCOM via a hysteresis current controller. This is done by forcibly inducing the reference currents to follow these reference three phase currents. Once after this is finished then the output signal given by the PI controller responsible to maintain the bus voltage (dc) is added to the average weight. For ac voltage regulation the output of the PI controller is multiplied with unit templates which are quadrature with the phase voltage and then added to the component of the reference current that is calculated using the neural network. To show the dynamic behavior of the DSTATCOM controlled in this manner the load is increased at time of 0.12 seconds and decreased at time instant of 0.30 seconds and observed that the DSTATCOM is able to respond to the changes in the load within an half cycle.

### 4.5 Analysis, Simulation and Control of DSTATCOM in Three-phase, Four-wire Isolated Distribution Systems

In this<sup>5</sup> paper the performance of the DSTATCOM connected to an alternator having a rating of 42.5 KVA rating which is feeding four wire linear loads. To meet the ever growing requirement of quality power supply the development of small, dispersed generation is needed. But the use of these dispersed generations there will be some problems arising which are known as power quality problems. though there are many number of compensators the four leg compensators for compensation of neutral current is being of great deal nowadays. On one side, the isolated generation

systems are satisfying the power requirements and on other side they are introducing problems those are different from those of grid connected systems. To achieve the required result or to overcome the problems the DSTATCOM is connected as a shunt compensator. The alternator here feeds power to a linear resistive-inductive load. The DSTATCOM consists of four legs (3 phases and one neutral), VSC constructed with IGBTs and a dc bus capacitor. The output coming from the converter is connected with the PCC with the aid of the interfacing inductors. The DSTATCOM here is proposed with indirect control scheme which uses to PI controllers one of which regulates the dc link voltage and the other regulates the ac terminal voltage. In this scheme only one PI controller is sufficient for the power factor control and load balancing. If the need is of voltage regulation also then there will be a need of additional PI controller more than the ac terminal voltage. Using three-phase ac voltages ( $V_{ta}$   $V_{tb}$   $V_{tc}$ ) and dc bus voltage ( $V_{dc}$ ) of DSTATCOM, The three-phase reference supply currents ( $I_{sar}$   $I_{sbr}$   $I_{scr}$ ) are computed. The reference signal consists of two in phase current component, quadrature with the supply voltage component. The basic equations of control algorithm are formed on the basis of the above reference values to generate control signals. For power factor correction and load balancing it, when load is changed from three-phase (19.7 kW) to two-phase at  $t=0.1$ sec (13.1 kW) it is observed that the supply currents are balanced, sinusoidal and in phase with the voltages between the time  $t=0.1$  s to 0.14 s. similarly under voltage regulation case also the results are observed such that the DSTATCOM is succeeded in regulating the ac terminal voltage. Thus with the application of the DSTATCOM with the isolated systems the power quality problems can be solved.

#### **4.6 Control Design and Simulation of DSTATCOM with Energy Storage for Power Quality Improvements**

This paper<sup>6</sup> discusses the dynamic performance of a DSTATCOM which is coupled with an energy storage system in improving the distribution systems power quality. Here the DSTATCOM is modeled as voltage controller, power factor controller and an active power controller. By adding this energy storage system through a proper interface the controller becomes more flexible. They can be superconducting magnetic energy storage (SMES), super capacitors (SC), flywheels and battery energy storage systems (BESS). The VSI structure used here makes use of a three level pole structure which is otherwise called as a neutral point converter. By use of energy storage the neutral point is capable of maintaining the balance of the dc capacitors

without using any additional control. After connecting this arrangement to the utility grid the THD of the output voltage of the inverter in aid of a sine wave filter is less than 5 % at a full rated UPF load. While coming to the control modes of the DSTATCOM in this arrangement, there are three control modes namely external level control, middle level control and internal level control. The external controller is designed for voltage control mode, power factor control mode and active power control mode. This control technique takes the responsibility of determining the active power exchange and the reactive power exchange that has to be done between the power device and the utility system. The reference values set by the external level are tracked by the expected output with the help of the middle level control. For this purpose the DSTATCOM is modeled as a voltage source which is connected in shunt to the network through an inductance  $L_s$  and resistance  $R_s$ . These two parameters represent the equivalent leakage inductance and the transformer winding resistance losses. The equivalent magnetizing inductance of the step-up transformers is represented by  $M$ . the two capacitors are assumed to be having the capacitance of  $C_d/2$ . The switching losses of the VSI and power loss in the capacitors also have a considerable impact. For generating the switching signals to the VSI according to the sinusoidal PWM control mode the internal level control is essential. After designing all these control modes with the DSTATCOM the simulation is performed and the results are as follows for a 2MW/0.5MVAR. a set of loads equivalent to 0.25 MVAR are automatically disconnected at  $t= 0.2$  s, and re-connected after at  $t=0.3$  s at one of the bus. It is observed that until the load is reconnected the voltage is maintained at 0.98p.u. This paper concludes that the DSTATCOM is showing the effective results in various control modes and is recommended to be employed for all these three control modes namely power factor control, voltage control and active power control.

#### **4.7 Power Quality Improvement using DSTATCOM and DVR**

This paper<sup>7</sup> presented the problem occurring because of nonstandard voltage, current or frequency solved by DSTATCOM by using with DVR in the electrical distribution system. Mainly the power quality problem comes due to varying industrial loads and critical commercial loads and to maintain the voltage within the limit and to reduce harmonics this technique used. This research describes the techniques to correct the voltage mitigation, various type of outages, voltage sag/swell. The DSTATCOM and DVR both are based on VSC principle, the combination of these two devices improving the power quality of the distribution electrical

network. Here DVR injects a voltage in series of the network and a current is injected by DSTATCOM into the system for the correction of voltage sag/swell, interruption as per the load variation. DVR is series voltage controller, in this research it used in series with the load. The main aim of the controller to maintain the voltage level, it can only measure the r.m.s voltage at the load side. By using this test system the r.m.s voltage is maintained up to 98 %.

#### 4.8 Integration of Super capacitor with STATCOM for Electric Arc Furnace Flicker Mitigation

This paper<sup>8</sup> describes the integration and control of super capacitor as energy storage system in a DSTATCOM with voltage controller to enhance the power quality. For the compensation of the reactive power which produced by arc furnace, the DSTATCOM/super capacitor supply unbalanced and varying currents of the arc furnace, which results the sinusoidal waveform. Therefore this sinusoidal current indicates that the voltage waveform at PCC is sinusoidal. The regulated PCC voltage enables the flow of higher real power into the arc furnace, therefore the voltage mitigation reduced by the DSTATCOM/ super capacitor system. This feature is developed due to the supplying fluctuating active power ability, but it can be supplied by any energy storage technology but the super capacitor is better is size and control design practically.

#### 4.9 Integrated Three-Leg VSC with a Zig-Zag Transformer Based Three-Phase Four-Wire DSTATCOM for Power Quality Improvement

In this paper<sup>9</sup> the DSTATCOM is incorporated with a zig-zag transformer for voltage regulation, power factor correction along with the load balancing which means the reactive power is said to be compensated. At the point of common coupling the neutral current compensation is also done by the elimination of harmonics while using this arrangement. The DSTATCOM is modeled with an inductor corresponding to leakage inductance, resistor corresponding to distribution transformers resistance, a combination of capacitor and resistor representing the ripple filter for filtering high frequencies. The reactive current is injected by the DSTATCOM to cancel the reactive power component of the load current and then the source current is reduced to just the active power component of current only. Dynamically these currents are adjusted to maintain unity power factor under the varying load conditions. Here the DSTATCOM is modeled for the operation of DSTATCOM is focused for zero voltage regulation. In this mode the injection current by the DSTATCOM makes the voltage at the PCC and the source voltage

to be in the locus of a same circle. Usually, the linear loads and the nonlinear loads, balanced and the unbalanced loads are connected at the PCC. This makes the zig-zag transformer to provide a path for the zero sequence currents and fundamental currents. A third winding is provided with the transformer for connecting the DSTATCOM in shunt at the PCC. The VSC proposed in the DSTATCOM uses IGBTs three phase inductor and one dc capacitor. The zig-zag transformer also provides an isolation to the DSTATCOM in addition to suitability of selecting an off the shelf VSC in such applications. For the neutral current compensation, harmonic elimination, load balancing, power factor correction, line voltage regulation the design is based on the selection of the dc bus voltage ( $V_{dc} = 2\sqrt{2}V_{LL} / (\sqrt{3}m)$ ), selection of dc bus capacitor ( $C_{dc} [(V_{dc2}) - (V_{dc12})] = 3V(aI)t$ ), selection of ac inductor ( $L_f = \sqrt{3}mV_{dc} / (12\text{afsicr}(p-p))$ ), selection of ripple filter ( $R = 8\Omega$ ,  $C_f = 5\mu\text{F}$ ). While coming to the design of zig-zag transformer voltage across each winding is selected as one third of the line voltage i.e, 150 V and the secondary line voltage is selected as 200 V. Therefore the voltage for each star connected winding comes out to be 120 volts. Besides these there is a need for generating the reference source currents for the control of VSC in DSTATCOM and one such technique used here is reference frame theory. After modeling and simulating the models the results showed that the performance is as expected for the neutral current compensation along with reactive power compensation. Besides these results the modes of operation of DSTATCOM for voltage regulation and power factor correction are satisfactory. For compensating the zero sequence fundamental and harmonics currents zigzag transformer is found to be the effective one and the bus voltage of the DSTATCOM is regulated to the required or reference value.

## 5. CONCLUSION

By literature survey we came to know that by using DSTATCOM with different configuration, the power quality issues like voltage mitigation, sag, swell, harmonics, etc., gets reduced and thus the power quality of that circuit is improved.

## निष्कर्ष

साहित्य सर्वेक्षण करके हम यह पाते हैं कि डी-स्टेटकोम को विभिन्न विन्यास के साथ उपयोग करके बिजली गुणवत्ता के मुद्दे जैसे वोल्टेज शमन, झटके, उतार, चढ़ाव कम हो जाता है और इस प्रकार सर्किट की बिजली की गुणवत्ता में सुधार होता है।

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# सरक्युलरली पोलराइज्ड मल्टी बैंड स्विचेबल माइक्रोस्ट्रिप स्लोटिड पैच एंटीना Circularly Polarized Multi Band Switchable Microstrip Slotted Patch Antenna

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## सारांश

यहाँ मैं मल्टी बैंड और स्विचेबल सरक्युलरली पोलराइज्ड स्लोटिड माइक्रोस्ट्रिप पैच एंटीना के डिजाइन का प्रस्ताव कर रहा हूँ। एंटीना माइक्रोस्ट्रिप फीड लाइन से जाग्रत होता है। प्रस्तावित एंटीना में स्कावर पैच में रिंग स्लॉट के साथ स्कावर पैच है, और सरक्युलर पैच के रिंग स्लॉट के चारों ओर डायोड के जुड़े रहने से पोलराइज्ड विकिरण करंट गड़बड़ी के कारण उत्पन्न किया जा सकता है। पिन डायोड रिंग स्लॉट में करंट पथ की दिशा बदलता है। तीन पिन डायोड उल्टे हाथ और सीधे हाथ के बीच सरक्युलर ध्रुवीकरण की दिशा को बंद कर देता है। रैखिक ध्रुवीकरण को दोनों पक्ष के डायोड को बंद करके और केंद्र डायोड को ऑन करके हासिल कर सकते हैं। मुख्य मापदंड का विद्युतचुंबकीय सिमुलेशन सॉफ्टवेयर पर विश्लेषण किया गया है। ऑपरेटिंग आवृत्तियों 1.55 गीगा हर्ट्ज, 3.8 गीगा हर्ट्ज हैं और 4.77 गीगा हर्ट्ज है और प्राप्त परिणामों संतोशजनक रहे हैं।

## ABSTRACT

Design of multi-band and switchable circularly polarized slotted microstrip patch antenna has been proposed. The antenna is excited by microstrip feed-line. The proposed antenna has square patch with the ring slot in the square patch, and the circular polarization radiation can be generated by current perturbation due to diodes connected across the ring slot to the circular patch. The p-i-n diodes across the ring slot alter the direction of current path. Three p-i-n diodes simply switch the circular polarization direction between the left handed and right handed. Linear polarization can also achieved if both side ways diodes are OFF and centre diode is ON. Key parameters have been analyzed on electromagnetic simulation software. The operating frequencies are 1.55GHz, 3.8GHz, and 4.77 GHz and results obtained are satisfactory.

**Keywords:** Microstrip slotted patch antenna, Circular polarization (CP), polarization switching, left hand circular polarization (LHCP), right hand circular polarization (RHCP)

## 1. INTRODUCTION

Aim of antenna design is to transmit large amount of information to longer distance. So the research in wireless communication is growing toward the reduction of antenna size and to get the higher transmission bandwidth of antenna. Many applications require integrated multifunctional terminals<sup>1-2</sup>. The concepts of frequency reconfigurable and polarization reconfigurable have been developed. The pursuit of antenna banks with compact form factors has led to research into reconfigurable antenna with variable bandwidth<sup>3</sup>, radiation characteristics<sup>4</sup>, and polarization<sup>5</sup>, and for achieving this multiple bands cascaded antennae are designed. In the cascaded antenna large number of antenna are connected to form a single antenna and the switching is done to get the required frequency band. Such mobile terminals must operate while acting as antennae banks because each service requires a different frequency band This structure increases the

information transfer rate but one problem is also there that is size of antenna, to implement large size of antenna in small devices is not possible, so further the research is done in reducing the size of antenna. Polarization diversity with switchable circular polarization (CP) is also used to reduce fading in wireless local area networks (WLANs)<sup>6</sup>, as a modulation scheme in radio frequency identification (RFID) systems<sup>7</sup>, and to increase the security complexity in military wireless. The dual-band antenna is simply obtained by connecting the square and circular patch, but still there is a need for higher information transmission, and for this purpose, polarization switching, concept is introduced. In polarization switching large amount of information can be transmitted through a single feed port without interference. This is achieved by orthogonal polarization modes that are left hand circular polarization (LHCP) and right hand circular polarization (RHCP). A switchable CP slot antenna with a p-i-n

diode switch for different polarizations has also been reported<sup>8</sup>. It is also possible to achieve switchable CP microstrip antennas with shorting walls that are switched to the ground plane via p-i-n diodes<sup>9,10</sup>. But by connecting the two patches at one more position, it will generate a new band without increasing the size of antenna.

In this paper, a multi-band polarization switchable antenna has been proposed. The structure is single feed, simple and compact, producing multi-band, circular and linear polarization. The orthogonal modes for circular polarization are generated by p-i-n diodes connecting rectangular and circular patches. The polarization switching is obtained by switching the p-i-n diodes. Different polarization has been discussed, which are obtained by switching the diodes.

**2. ANTENNA STRUCTURE**

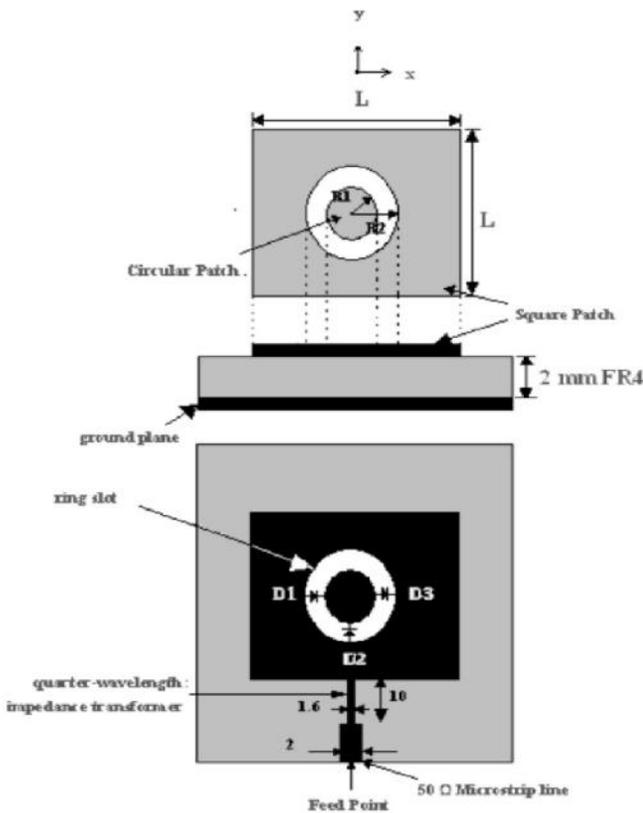
Figure 1 shows the geometry of the proposed multiband and dual-switchable circular polarization microstrip slotted patch antenna. Proposed antenna has three-layer structure, bottom layer is a ground plane of thickness 0.01mm, on which there is a second layer of dielectric substrate FR4 of thickness 2 mm and dielectric constant is 4.9. Third layer is a patch which is square shaped with a ring slot. The square patch length is  $L$  mm. At the centre of the square

patch, there is a ring slot of outer radius  $R2$  and the inner radius  $R1$ . Figure 1 shows the construction of the square patch with a ring slot inside it. This ring slot separates the two structures—one is square patch, and other is circular patch which is inside the square patch. The separation between the square patch and circular patch which is inside it, is 2mm or the width of ring slot is 2mm. This proposed antenna produces linear polarization well as circular polarization by introducing diode patch and inner circular patch in left side, and diode  $D3$  is connected between square patch and inner circular patch in right side and diode  $D2$  is at down side. The polarization diversity is obtained by switching different p-i-n diodes at different times. Linear polarization is obtained when P-I-N diode  $D2$  is forward-biased and  $D1$  and  $D3$  are reversed-biased. To get circular polarization two currents are fed at 900 generating orthogonal components. The LHCP is obtained when left p-i-n diode, i.e.,  $D1$  is forward-biased along with  $D2$ , because of current direction. Similarly RHCP is obtained when the right p-i-n diode ( $D3$ ) is forward-biased along with  $D2$ , reverse biasing the  $D1$ . The antenna structure is three bands, polarization switching is obtained in only one band which is generated by circular patch. It is seen that axial ratio varied from 40 dB to 1 dB.

Figure 1 shows p-i-n diodes  $D1$ ,  $D2$  and  $D3$ . These p-i-n diodes provide connection between the square patch and the circular patch. The diode  $D1$  is connected between the square patch and the circular patch.

**3. RESULTS**

The proposed antenna is designed for multibands 1.55GHz, 3.8GHz and 4.77 GHz). The square patch ( $L=40$ mm) on the top of the FR4 substrate with  $\epsilon_r=4.4$  and height  $h = 2$ mm. one ring slot in the square



**Figure 1. Geometry of multiband and dual switchable circular polarization microstrip slotted patch antenna Dimensions: 80\*80 mm<sup>2</sup>**

**Table1. Summary of antenna polarization**

		P-I-N diodes biasing	Polarization
D2	:	ON	
		(Forward biased)	Linear Polarization (LP)
D1,D3:		OFF	
		(Reverse biased)	
D2,D3:		ON	
		(Forward Biased)	Right Hand Circular
D1	:	OFF	Polarization (RHCP)
		(Reverse Biased)	
D1,D2:		ON	
		(Forward Biased)	Left Hand Circular
D3	:	OFF	Polarization (LHCP)
		(Reverse biased)	

patch with dimensions outer radius ( $R_2=7$  mm) and inner radius ( $R_1=5$  mm), width of ring slot is 2mm, the three p-i-n diodes are located across the slot in order to control the current path. The  $\lambda/4$  impedance transformer is used for impedance matching between patch and  $50\Omega$  feed line.

TABLE I shows the summary of the antenna polarization. With the above said dimensions, the resonate frequencies for the linear polarization (when diode D2 is forward-biased and remaining two are reversed-biased) are 2.1 GHz and 5.1 GHz. The band generated by the circular patch can be switched to the circular polarization by switching on either D1 or D3 we will get three bands at this point. The bands generated by circular patch can be RHCP or LHCP according to the position of p-i-n diode forward-biased.

Figure 2 shows the simulated results of proposed antenna when diode D1 and diode D3 are ‘OFF’ and only diode D2 is ‘ON’, in this case, antenna radiate at two frequency bands 2.1GHz and at 5.1GHz. In this case the proposed antenna is linearly polarized.

Figure 3 shows the simulated results of proposed antenna at right hand circular polarized mode and left

hand circular polarized mode. In LHCP case diode D1 and diode D2 are in ‘ON’ state and diode D3 is in OFF state, there are three frequency bands at which the antenna radiates

Figure 4 shows the simulated far-field pattern of proposed antenna. In RHCP, three far-field patterns are observed at three different frequencies. At frequency 1.55GHz, the main lobe magnitude is 6.2dBi and the main lobe direction is 0.0 deg. At frequency 3.8GHz, the main lobe magnitude is 3.7 dBi and the main lobe direction is 30.0 degree and at 4.77GHz frequency, the main lobe magnitude is 7.6 dBi and the main lobe direction is 5.0 deg.

Figure 5 shows the simulated far-field results at LHCP mode. At frequency 1.55GHz; the main lobe magnitude is 6.3dBi, at frequency 3.8 GHz. The main lobe magnitude is 3.7 dBi, and main lobe direction is at 30.0 deg., at frequency 4.77 GHz, the main lobe magnitude is 7.2 dBi and main lobe direction is at 5.0 degree.

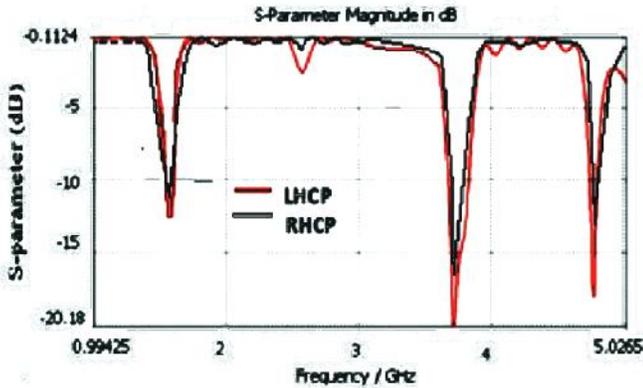


Figure 2. Simulated s-parameter of the proposed antenna when (D1=OFF, D2=ON, D3=OFF).

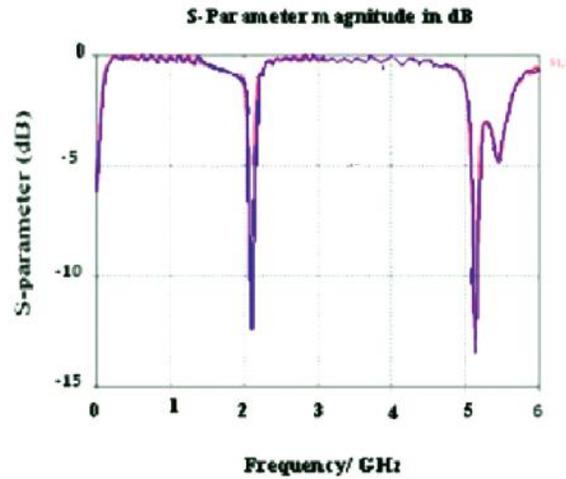


Figure 3. Simulated s-parameter of proposed antenna when (D1=ON, D2=ON, D3=OFF (LHCP)) and when (D1=OFF, D2=ON, D3=ON (RHCP)).

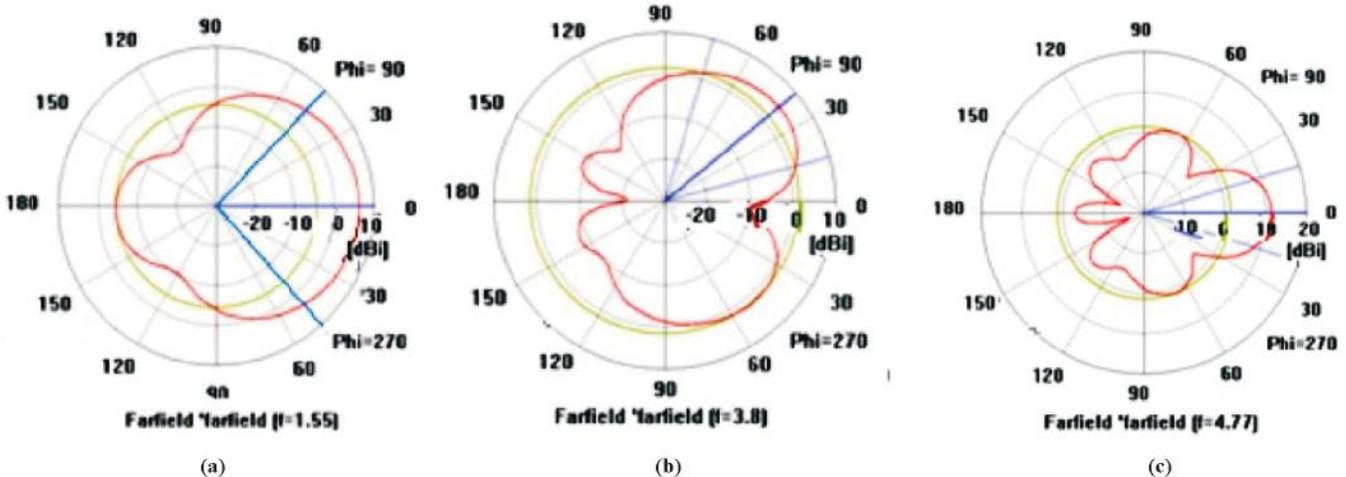


Figure 4. Simulated far-field Pattern of RHCP at (a)  $f=1.55$ GHz, (b)  $f= 3.8$ GHz and (c)  $f= 4.77$ GHz.

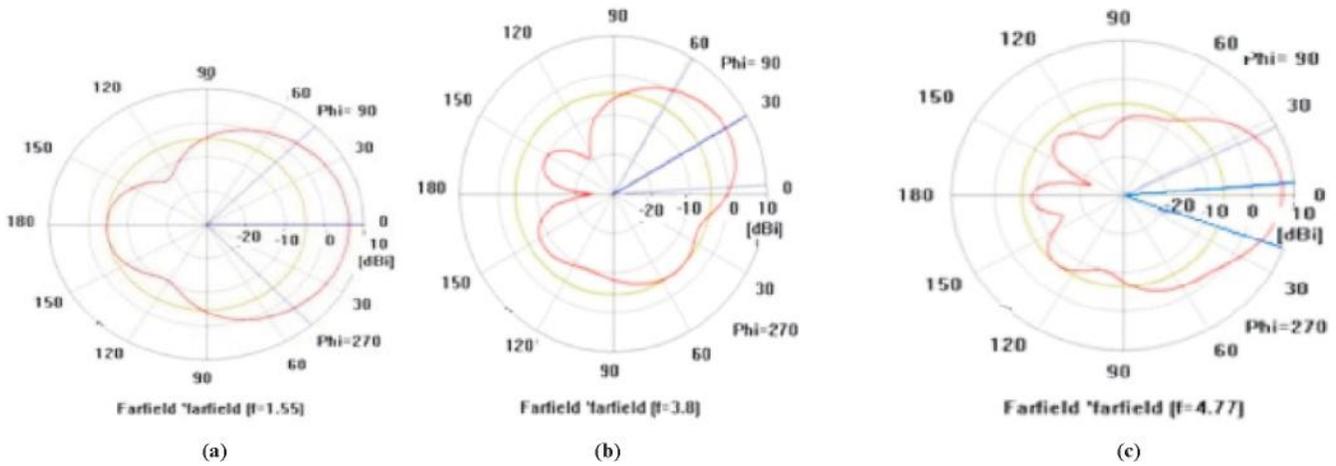


Figure 2. Simulated Farfield Pattern of LHCP at (a)  $f=1.55\text{GHz}$ , (b)  $f=3.8\text{GHz}$  and (c)  $f=4.77\text{GHz}$ .

#### 4. CONCLUSIONS

In this letter, a simple microstrip square patch with slotted ring inside the patch is proposed for dual-band linear polarization and triple-band circular polarization diversity. The circular polarization diversity is controlled by switching the current path in the patch using p-i-n diode configurations that is RHCP and LHCP. The experimental results show that the antenna is linearly polarized at 2.1GHz and 5.1 GHz, and CP at three frequencies, 1.54GHz, 3.8GHz and 4.77 GHz. The multi-band switchable antenna will find applications in wireless communication in civilian as well as defence sector.

#### निष्कर्ष

इस लेख में, पैच के अंदर स्लॉटिड रिंग के साथ एक साधारण माइक्रोस्ट्रिप स्कावर पैच दोहरी बैंड रेखीय ध्रुवीकरण और ट्रिपल बैंड परिपत्र ध्रुवीकरण विविधता के लिए प्रस्तावित है। परिपत्र ध्रुवीकरण विविधता को पिन डायोड विन्यास का उपयोग कर पैच में करंट पथ के स्विच द्वारा नियंत्रित किया जाता है जो कि आरएचसीपी और एलएचसीपी है। प्रयोगात्मक परिणाम से पता चलता है कि एंटीना 2.1 गीगा हर्ट्ज और 5.1 गीगा हर्ट्ज पर रेखीय ध्रुवीकरणीय और सीपी तीन आवृत्तियों 1.54 गीगा हर्ट्ज 3.8 गीगा हर्ट्ज और 4.77 गीगा हर्ट्ज पर होता है। मल्टी बैंड स्विचेबल एंटीना असेनिक और रक्षा क्षेत्र में बेतार संचार में काम आता है।

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## आरगो (एआरजीओडब्ल्यू) तरंग पथक आप्टिकल मानदंडों की संवेदनशीलता The sensitivity of Optical Parameters of ARGOW waveguides

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### सारांश

वर्तमान काम में, आरगो (anti resonant guided optical waveguides) आप्टिकल मानदंडों की संवेदनशीलता तरंग पथक मोड का अध्ययन किया जाता है। भार कोण निर्भर परावर्तीकरण का मूल्यांकन किया जाता है। तरंग पथक मोड पर समानांतर और सीधे ध्रुवीकरण प्रभाव की भी गणना की जाती है। अलग अपवर्तनांक के तरल पदार्थ के लिए आप्टिकल मापदंडों का पता लगा गया है।

### Abstract

In the present work, the sensitivity of optical parameters of anti resonant guided optical waveguides (ARGOW) waveguiding modes is studied. Incidence angle dependent reflectance is evaluated. The parallel and perpendicular polarization effect on waveguiding mode is also calculated. The optical parameters have been explored for liquids of different refractive index.

**Keyword:** Anti resonant guided optical waveguides, ARGOW, optofluidics

### 1. INTRODUCTION

The new researches in the area of Optical waveguides and their interface with microfluidics are continuously contributing towards the evolving field of Optofluidics<sup>1-3</sup>. ARGOW waveguides has been one of such recent example in which light were first time guided through liquid successfully<sup>4,5</sup>. In these waveguides a large interaction range through liquid could be achieved. This waveguiding configuration were further applied for microchip based online monitoring system<sup>5</sup>, Fluorescence Spectroscopy<sup>6</sup> for detection of biomolecules<sup>7</sup> etc. The success of ARGOW waveguides lies in the fact that for a critical angle light can guide into the liquid whose refractive index is less than the surrounding substrate material. It is found that near critical angle reflected intensity of light changes dramatically<sup>4</sup>. How sensitive are these changes in relation to variation in incidence angle is still not very clear. The present work explores it. The sensitivity of optical parameters of ARGOW waveguides has been studied in detail using the reflectance calculation. The polarisation effect for different angles is also reported.

### 2. SCHEMATIC DESIGN AND THEORETICAL CALCULATIONS

Figure 1 shows the schematic design of ARGOW waveguides. The system is made of glass (refractive

index  $n_g=1.46$ ) attached with microchannel in which water (refractive index  $n_l=1.34$ ) is flowing as shown in Fig. 1. represent the refractive index of air, i.e. 1. Blue arrow shows the reflected light while orange arrows shows the guiding light into microchannel at different incident angles. To understand the basic physics of ARGOW waveguiding modes, percentage reflectance were calculated at the critical angle. The value of critical angle was calculated at the fifth decimal place<sup>4,5</sup>. Then the variation in percentage reflectance was calculated by increasing the incidence angle at glass-micro channel interface. Percentage reflectance was calculated for both TE and TM modes. The increment in the incidence angle was done at a fifth decimal place.

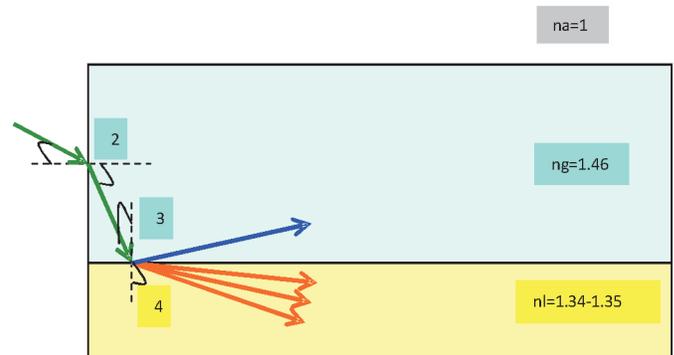


Figure 1. Schematic diagram of ARGOW waveguides.

In the above scheme the critical angle  $\theta_c$  for which light starts to leak into microchannel is calculated to be 66.607730. The corresponding angle  $\theta_4$  is found to be 89.987720. Figures 2 and 3 shows the percentage reflectance for the different value of incident angle  $\theta_3$  starting from the critical angle. The significance of the figure is variation in the angle that is made at decimal fifth place. The emphasis in Fig. 2 has been to understand the sensitivity of angle variation by making changes at fifth decimal place. Whereas, Fig. 3 provide more comprehensive result covering the angle between 620 and 670. Moreover, Fig. 4 is drawn between refractive index of liquid and per cent reflectance.

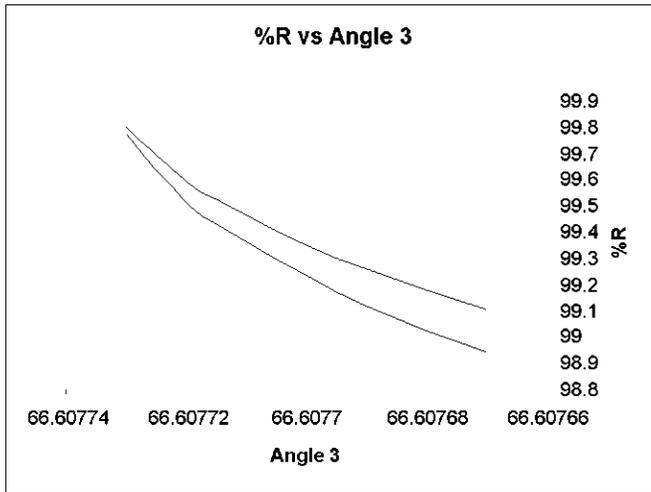


Figure 2. Variation in reflectance with variation in angle 3 at decimal fifth place.

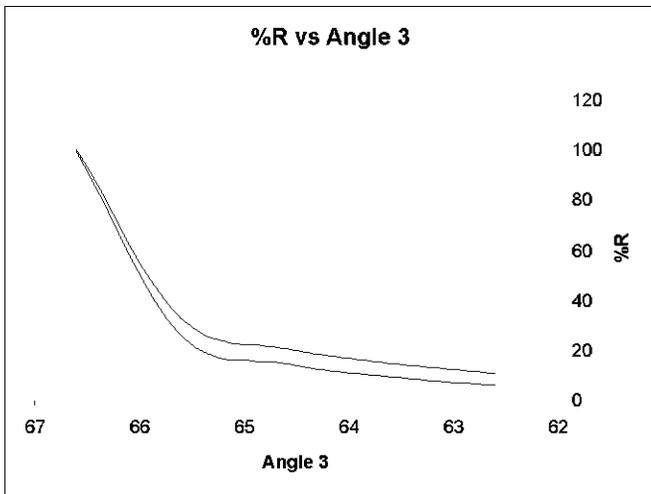


Figure 3. Variation of % reflectance vs angle 3 in the much wider range.

### 3. RESULTS AND DISCUSSION

Figure 2 makes it clear that variation in the incident angle  $\theta_3$  at the fifth decimal place can change the per cent reflectance by about 1 per cent. Also at

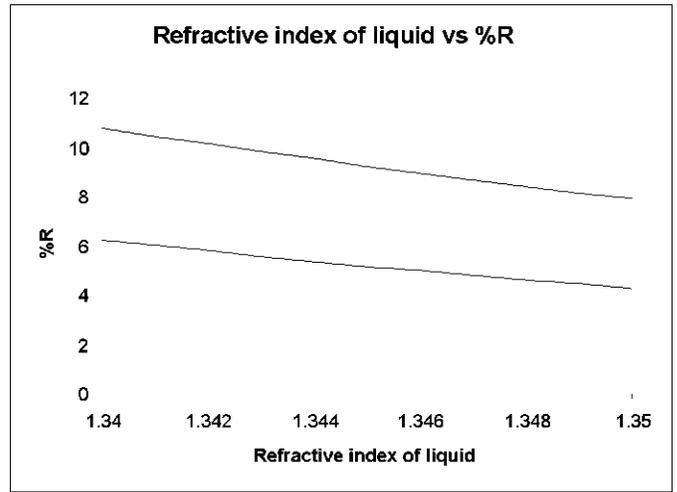


Figure 4. Percentage reflectance variation with refractive index of liquid.

critical angle for waveguiding the per cent reflectance for parallel and perpendicular polarization is almost same. But as we increase the angle slightly the gap between two becomes wider.

Figure 3 makes much wider comparison of incidence angle  $\theta_3$ . Two kinds of slopes are evident for both parallel and perpendicular polarization. The maximum change in per cent reflectance (almost from 100 per cent to 20 per cent) occurs between 67.5 and 66.50. But it is not so steep if angle  $\theta_3$  is further increased.

If the angle  $\theta_3$  is fixed at the critical angle value for the above defined waveguiding system ( $n_s=1.46$ ,  $n_l=1.34$ ,  $n_a=1$ ) and if the refractive index of the liquid is changed by .01, the variation in per cent reflectance is about 2-3 per cent for both parallel and perpendicular polarization.

### 4. CONCLUSIONS

These observations suggests some very useful conclusions:

- (i) In the Optofluidics waveguides the critical angle is very sensitive to the refractive index of substrate and liquid materials. And it needs to be very carefully defined as minor error can change the proportion of transmitting light into the liquid significantly.
- (ii) There is no linear relationship between incidence angle  $\theta_3$  and per cent reflectance variation.
- (iii) per cent reflectance variation is susceptible to refractive index variation of liquid that can be very helpful to prepare microchip based refractometer if properly optimized.

### निष्कर्ष

इन टिप्पणियों से कुछ महत्वपूर्ण उपयोगी का पता चलता है -

1. आप्टो फ्लूइडिक्स तरंग पथक में महत्वपूर्ण कोण अपवर्तनांक और तरल पदार्थों के लिए बहुत संवेदनशील हैं। और बहुत सावधानी के साथ परिभाषित किया जाना चाहिए क्योंकि मामूली त्रुटि भी तरल संचारण के अनुपात को बदल सकती है।
2. घटना के कोण 3 और परावर्तीकरण भिन्नता प्रतिशत के बीच कोई रेखीय संबंध नहीं है।
3. प्रतिशत परावर्तीकरण भिन्नता तरल अपवर्तनांक भिन्नता के लिए अतिसंवेदनशील है, यदि इसे उचित रूप से अनुकूल बनाया जाए तो माइक्रोचिप आधारित रैक्ट्रोमीटर तैयार करने में बहुत मदद मिल सकती है।
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