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Introduction

“Publish or Perish” is one of the most widely used axiom in the field of publication. If people wants to learn and nurture, publishing is an imperious activity to be followed by any academicians, research scholars or industrialist. In line with that, ICT Academy of Kerala has started a very significant & erudite venture of publishing an Engineering, Technology & Employability Journal under the name “Convergence” with ISSN 2454 – 5848 every year. It is a peer reviewed multi-disciplinary journal which aims to provide new perspective on Engineering, Technology & Employability. This year the Journal includes research articles from academicians and research scholars, who have presented their papers in the ICT Academy International Conclave (ICSET – 2016) on “Shifting Sands: Insight Driven India” on various topics of Engineering, Skills & Technology. Convergence is a publication platform where novel and narrative flair of Academicians, Industrialist, Research scholars and other luminaries in the field of Engineering, Technology & Employability.

The research works of any individuals can submit their narrative work to the Chief Editor, ICT Academy of Kerala, L-9, Thejaswini, Technopark, Trivandrum – 695581, Kerala. Email: editorial@ictkerala.org.

Details concerning the preparation and submission of manuscripts can be found on the inside cover of each issue.

Wish you all a happy and informative reading!



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SKILLED YOUTH: EMPOWERED NATION

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Abstract: India is a developing country with the dream of achieving self sufficiency and to standup with all developed countries. The development of a nation is in the hands of younger generation. Proper planning and utilization of resources, man power, knowledge wealth and economy can together push up Indias position to heights. Several missions to promote people towards the fulfilment of vision 2020 of India are on the way to success. Government of India has implemented many schemes for the progress of Indian youth. This paper proposes a novel idea that can be embedded along with the existing planning for nation building by empowering youth. A group of skilled youth can empower nation and it is the prime key towards development.

Keywords: Developed country, man power, vision 2020, younger generation

INTRODUCTION

India is the worlds largest democracy. It has been 69 years since the midnight of independence and Indians are in a gradual stepping towards development. Now India is a proud member among developing nations in all aspects [1]. There was a gradual growth in all areas such as economic sector, industrial sector, service sector, education sector and agricultural sector.

A nations progress mainly lies in its wealth. The wealth is not only money but man power ready to develop a self idealized daily needed products. One of the important factors of economic concern is Gross Domestic Product (GDP). India's economy, has expanded to Rs 70 lakh crore from mere Rs 2.7 lakh crore in 69 years of independence and the nation's foreign exchange reserves have crossed \$300 billion, giving the economy a hard shock. Around 7.6% increase in GDP is expected in every year [2]. Figure 1 shows the GDP Growth Rate survey of 2015-16.

Since 1950s, there was a steady progress in agriculture sector. The agricultural sector grew at about 1% per annum in the first half of the 20th century. Varieties of crops were cultivated and export/import businesses were also in the beginning stage. This was one of the major factors of growth during the post-Independence era. The statistical surveys marked the growth rate nudged about 2.6 percent per annum. Thus

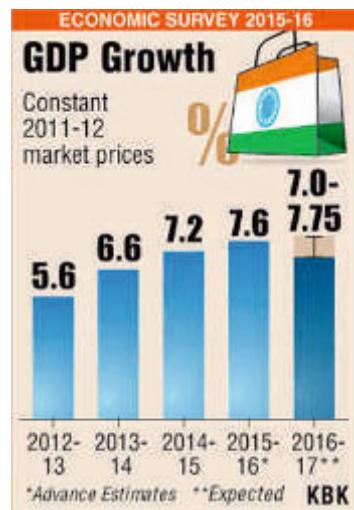


Fig. 1: GDP Growth Rate (Courtesy: KBP)

the dependency on many of the imported food grains dimmed and internal fields fruited more. Both organic farming and business found their flow during this period.

An agricultural revolution happened only because of factors such as a consistent investment in research, land reforms, expansion of scope for credit facilities, and improvement in rural infrastructure. The country has developed strong in the agriculture - biotechnology sector. The country is likely to become a

major producer of genetically modified/engineered crops. The yields were doubled by this biotechnological enhancement. Different academic courses were also started to make farmers aware about the crops and the environment in which they grow.

India's contribution towards science and technology also a key instrument in the development. Many young skilled graduates of less than 30 years age were trained by around 3000 colleges affiliating to 200 universities on all parts of India.

Tele services and information technology had been a major development in the service sector of nation. This reduced the time for communication, transportation and correspondence.

Technological advancements unbelievably reduced the man effort and made the growth faster. Machine speed was in-comparable with man labor. Several multinational companies continued to outsource their tele-services and IT services to India. The acquisition of expertise in information technology has led to the birth of thousands of new jobs, which in turn increased domestic consumption and automatically, more foreign direct investments happened to meet the demands.

In the present scenario, the services sector employs 23% of the Indian workforce and this process of development started by early 1980s. In the 1960s, the service sector employed only 4.5% of the total working population. According to the Central Statistical Organization, the services sector accounted for 63% of Indian GDP in 2008 and the figure continues to grow [3]. The remaining part of the paper is planned as follows: Section II refers to self sustained missions. The section III considers the skilled India mission. Further the section IV presented the empowered nation. Finally concluding section V makes remarks.

II. SELF SUSTAINMENT MISSION

Green Revolution was a great attempt in making India self sufficient in food. The leaders of independent India has inherited a country facing shortage in food, where thousands of natives died every year due to famines. Providing food security to the starving millions across the country was one of the most important challenges that the government faced.

The consistent efforts of leading scientists like Dr M. S. Swaminathan, brought up the agricultural sector with an estimate of Rs 45,000 crore, which was spent

mainly on improving irrigation in the first four decades after independence. Gradually, the Indian farming sector began to improve yields and got closer to solving the chronic food shortages in the country. This was one of the major steps towards self sustenance which revolutionized the farming sector.

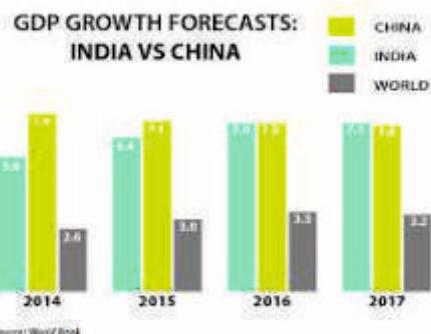


Fig. 2: GDP Future Forecasts (Courtesy: Worlds Bank)

India and China are two nations going hand in hand in population, development and nation wealth. In account of GDP, India is in competition with China to cover up China's growth rate in upcoming years [4]. This will be a remarkable achievement among world's noted economic hike. The predicted future forecast is shown in the figure 2. The further studies gave importance to the development in science and technology. Hard working laborers were necessary for agricultural sector, skilled workers were the backbone of industrial and service sector and for the future developments, younger generation has to be trained. A self disciplined primary education was mandatory in that account.

The percentage of labor force without job is defined by unemployment rate. In India, rate is still high. This has to be reduced. As per the statistics of 2015, 7.3% is the unemployment rate [5]. The statistical data for unemployment rate is shown in Figure 3.

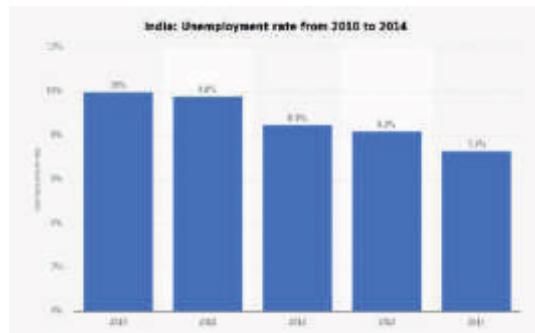


Fig. 3: Unemployment Rate of India (Courtesy: India's statistical)

Around 10 million Indians with graduate, post-graduate professional and technical degrees were looking for work, which accounts 15% of all Indians with the highest levels of education certificates were seeking job as of 2011. India's highest graduate unemployment rate was noted in Kerala state, with a statistical measure of over 30 per cent. In order to reduce this rate, youth must be empowered to accept all jobs without considering the risk and standard. The possibility of a nation which fails even with sufficient resources is well analyzed in [6].

III. SKILLED INDIA MISSION

An outcome based education system gives a basement for strong knowledge. Education attended by a student and skills developed by him are different. Two words that describe a person's level of competence are knowledge and skill. Knowledge refers to learning concepts, principles and information regarding a particular subject by a person through books, media, encyclopedias, academic institutions and other sources, whereas Skill refers to the ability of using acquired information and applying it in an appropriate context. In other sense, knowledge refers to theory and skill refers to successfully applying that theory in practice and getting expected or unexpected results. For the development of the nation, skilled youth are to be trained well from their primary education itself. Great way of imparting skills in practice was done by trial and error methods.

Many unexpected results were generated. Sometimes, certain skills may be inherent in a person. For some other instance, some people are born carpenters. But skills can take a person only to a certain limited level. To work ahead, it is important that a person has to bring out the requisite knowledge as well. Sometimes a person with engineering degree can handle good on artistic works. Knowledge and skill differs in a great sense. In the same manner, some people may have theoretical knowledge but may just not be able to use it at the right time and at the right place. Everyone must have a working attitude to follow proper procedure without any dilutions. Then only a good standard product will be produced.

In order to improve the skills of youth, a National Skill Development Mission was approved by the Union Cabinet on 01.07.2015, and officially launched by the Honble Prime Minister on 15.07.2015 on the occasion of World Youth Skills Day. This Mission has been

developed to create convergence across diverse sectors and States of India in terms of skill training activities. Seven sub-missions have been proposed initially to act as building blocks for achieving overall objectives of the Mission [7] as follows:

- 1) Institutional Training
- 2) Infrastructure
- 3) Convergence
- 4) Trainers
- 5) Overseas Employment
- 6) Sustainable Livelihoods
- 7) Leveraging Public Infrastructure.

The Skill India mission, which is being launched on the World Youth Skills Day, has been launched simultaneously also by state governments. All states will launch the mission to create awareness among youth about the importance of developing skills for a bright future.

Data from the Census of 2011 and 68th round data collection of the National Sample Survey Organization (NSSO) revealed that an estimated count of 10.4 crore fresh workers would enter the labor market and require skill training by 2022 and 29.8 crore of the existing labor force will require additional training for skills that will cover up the previously mentioned period. Accordingly, the government implemented a plan to skill around 40.2 crore workers by 2022 and a number of schemes including the new National Skill Development and Entrepreneurship 2015, Pradhan Mantri Kaushal Vikas Yojana and a new scheme on skill loan will be launched. The most inspiring features of the mission has attracted the youth for these skill training programmes.

A. Objectives of 'Skill India'

The main objective of skill India programme is to create opportunities, space and scope for the development of the talents of the Indian youth and to develop more of those working parent sectors which have already been put under skill development for the last years and to identify new infant sectors for skill development. The new programme aims at providing training and skill development to 500 million youth of our country by 2020, covering each and every village. Various schemes are proposed to achieve this objective [7]. This can be considered as an important goal for vision 2020.

B. Features of 'Skill India'

The main features of skill India lies in the empowerment of the youth for reducing the unemployment rate. The mission entrusted on the following features such as [7]:

Main emphasis is to train the younger generation in such a way that they get employment and also improve entrepreneurship skills.

Mission provides training, support and guidance for all kind of jobs that were of traditional type like carpenters, cobblers, welders, blacksmiths, masons, nurses, tailors, weavers etc. Indian culture lies in its traditional values.

More importance will be given on newly introduced start up groups for real estate, construction, transportation, textile, gem industry, fashion designing, banking, tourism and various other sectors, where skill development is inadequate.

The skill development programmes should be on Inter-national standards so that the youths of our country can not only meet the domestic demands but also of other countries like the US, Japan, China, Germany, Russia and those in the West Asia.

Creating a hallmark called Rural India Skill is a remarkable feature of the Skill India programme, so as to standardize and certify the training process.

Need based programmes would be initiated for categorized age groups which can be like personality development skills, language and communication skills, life and positive thinking skills, management skills, behavioural skills and employability skills.

The methodology of Skill India course would be a novel innovative idea, which would include all leisure activities like games, group discussions, brainstorming sessions, practical experiences, case studies etc.

IV. EMPOWERED NATION

A nation is not its land and buildingsit is its people. If we want to empower the nation following important areas need to focus.

- 1) Empower the people: Empowerment is not amassing of material wealth or technology. It is a process to build the awareness among the youth and their importance. This need a proper evaluation of inner balance and human resource training. This is how a human being or an entire culture sinks to its depths.

- 2) Make/Made in India: The youth should able to design and develop the products based on their expert skills. So this will increase the foreign exchange.
- 3) Quality products: Manufacturing a product and to compete with the global market there is need to improve the appearance as well as quality of the final product should be outstanding.
- 4) Time bond projects: The success of project depends on its time bond execution and in a competitive budgets.
- 5) Research works & Patent: The institution should focus more on research and patent works. This will add values to more product development
- 6) Industry-Academic Member of Understanding (MoU): Every institution should be associated to industry for creation of syllabus more focused to institution-industry interaction based. This will build more skilled experts for national development.
- 7) Training & Development: Training and development should be consider as a paramount factor to build the youth to focus towards the goal of the youth.

A future vision about India is dramatically framed in Vision 2020 of Dr. A P. J. Abdul Kalam. Moreover India is fighting to achieve that goal [8]. Vision 2020 does not belong to any single party, government or individual. It is a national vision or simply Indians vision. This must be considered as national phenomena which have its heart lies in the attitude of individuals towards development.

India government is undertaking many such attempts to take out the best from each skilled individual by missions such as skilled India mission etc. The mission is promoting youth to find and take up any job without any standard bar. Normally 21st century people prefer only white collar jobs, which is not acceptable for a developing country like India. So nations build up will be fruitful only by empowering the young skilled youths.

The ignited minds of the youth should utter always with the spirit of 'I can do it and there should be a belief that 'India will become a developed nation [9]. Once an ignited group is done, all missions can be successfully fulfilled.

V. CONCLUSION

This paper is a glimpse towards the strategies of nation after independence for achieving self sustainment in all fields by following great words of Dr. A. P. J. Abdul Kalam, who dreamt of a fully developed India by 2020. Globalization has changed the face of our nation in a positive sense and still need to do more. But sometimes, over dependency on lavish lifestyle overshoots the maximum skill outage of talented Indians. Indian power ultimately stands on the will power of youth. Once the empowerment is initiated and executed successfully, the signature of India will soon find place in the list of developed countries.

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REFERENCES

- [1] Bipan Chandra, India Since Independence, a book published in 2008.
- [2] World bank survey report 2015-16.
- [3] Statistical Survey result from Ministry of Statistics and Programme Implementation.
- [4] Indian Union Budget 2016.
- [5] Statista, an online statistics portal.
- [6] James A. Robinson,Daron Acemoglu, Why Nations Fail: The Origins of Power, Prosperity and Poverty, ISBN:0307719219, book published in March 2012.
- [7] Ministry of Skill development and entrepreneurship, 2015.
- [8] A. P. J. Abdul Kalam, India 2020: A Vision for the New Millennium, ISBN 0-670-88271-2 book published in 1998.
- [9] A. P. J. Abdul Kalam, Ignited Minds+, a book published in 2002.

IT ADOPTION AND INNOVATION IN INDIA – NOW, AND THE ROAD AHEAD

Shyam Sankar S. & Dr Manoj Changat

Abstract: Over the last two decades, the Indian IT industry has gradually emerged as a leader in the global IT sourcing market. The growth of the Indian IT industry has also resulted in India building a considerable skill base in the IT sector. How much has India, as a nation, tried to use these skills for solving its own myriad problems? This paper attempts to draw inferences on the state of IT adoption and IT innovation in India. IT adoption and IT innovation are very low compared to the IT exports from India. New government initiatives like Make in India, Digital India, and Start-up India have potential to improve the state of IT adoption in India. But the IT innovation scene is bleak and will continue to be so unless there is government intervention to encourage IP-driven research.

Index Terms: Indian IT industry, IT innovation

INTRODUCTION

India is internationally acclaimed as an IT giant. This is emphasized by the growth of the Indian IT industry and the revenue it generates. Indian software services revenues show impressive year-on-year growth. From having the image of a poor third-world country to being the most sought-after IT services provider, the growth of India driven by the Indian software industry has been remarkable. Over the last two decades, home grown Indian IT services companies have become world leaders in providing quality IT services. India has slowly built a strong skill base in IT. According to NASSCOM's 'The IT-BPM Sector in India: Strategic Review 2015', the IT sector is the largest private sector employer in India. The IT sector also contributes handsomely to the nation's GDP.

The above factors point to a nation that should be a leader in the IT segment. But while India has marched ahead to become the undisputed leader in providing software services, how has it used its strengths for its own benefits? Is IT seen only as an industry that exports services and brings in revenue and provides employment? Where does India stand in terms of applying IT for solving the myriad of problems facing its society? This paper explores these questions by looking at the current state of the IT adoption and IT innovation and forecasting the same for the next five years.

II. THE INDIAN IT INDUSTRY – A PEEK

India in the 1970s was a very young country still trying to find its feet, having become a democratic republic in 1950. The government had begun the computerization efforts quite early. And these were

spearheaded by IBM [26]. But the vision for the financial growth of the nation had still not stabilized. Restrictive economic policies were the norm of the day. Though a handful of local software companies had cropped up to cater to a few government offices and departments, domestic software projects were very limited and exports were restricted due to the prevailing economic policies. Instead of exporting software, opportunity arose in the form of export of skilled manpower for augmenting the staff of software development teams in a few US companies. TCS, set up in 1968, was one of the first Indian IT companies to place engineers abroad. While the US faced shortage of skilled manpower to meet the demand of their computer industries, India was producing engineering graduates who were faced with lack of job opportunities, and this skilled manpower was available at an extremely low cost. With a workforce made up of engineering graduates who had a fair grasp of the English language, the handful of Indian IT companies catered to this demand for staff augmentation. [2]. Economic reforms introduced in 1991 by the government of the day opened up the economy. The economic conditions became favorable for executing projects in India. Slowly, IT companies started mushrooming and IT projects started getting outsourced to India. TCS, Infosys, CTS, Wipro, and HCL were some of the companies that led the way. The Indian IT industry started growing, becoming a major job provider as well as becoming a major contributor to the nation's economy. From having the image of a poor third-world country to being the most sought-after IT services provider, the growth of India driven by the Indian software industry has been remarkable.

A. The Evolution of the Indian IT Industry

According to the National Policy on Information Technology 2012 (NPIT 2012) released by the Department of Electronics and Information Technology (DeitY), Government of India, the Indian IT sector became a USD 100 billion industry in 2011-12 [4].

In the IT services sector, Indian companies have been steadily moving up the value chain. The beginning of the Indian IT industry can be traced back to the 1970s when Indian companies started providing skilled manpower as part of staff augmentation. The next step in the evolution was the taking up of maintenance projects. And over the last two decades, the evolution has been almost complete with Indian IT services companies providing the full range of end-to-end software development project services covering the entire spectrum of requirements engineering, design, application development, independent testing services, system integration, and also process consulting. Cost arbitrage was a major factor in India garnering the major share of the global IT sourcing market. Other factors such as young Engineering graduates with a fair level of English-speaking skills and support from the government in the form of policy initiatives too played their part.

B. The Current State of the Indian IT Industry – In Fine Fettle

To understand the current state of the Indian IT industry, this paper gathers data from NASSCOM's annual Strategic Review reports (2004 to 2015) of the Indian IT sector [9 - 20]. NASSCOM is a trade body for the Indian IT-BPM industry and publishes annual strategic reports on the industry performance.

The data culled from NASSCOM's annual reports ranging back to 2004 give a fascinating view of the growth of the Indian IT industry. They also paint a picture of a sector which is in the pink of health.

The total revenue of the Indian IT industry in 2015 is estimated to be USD 132 billion. It jumps to USD 146 billion when the ecommerce revenue is included. The phenomenal growth of the sector can be gauged from the fact that the total revenues in 1996 was USD 1.25 billion.

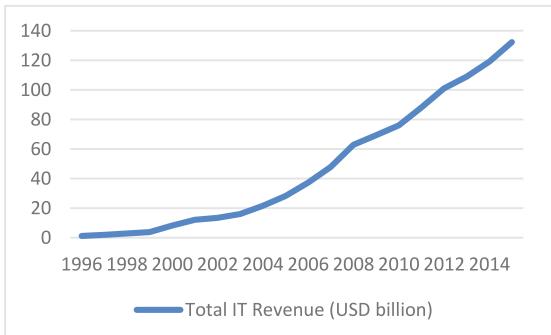


Fig. 1. Indian IT industry - Total revenues (USD billion)

The IT sector's contribution to the nation's GDP has also been steadily increasing - from 4.8% in 2006, in 2015 it stands at 9.5% [20].

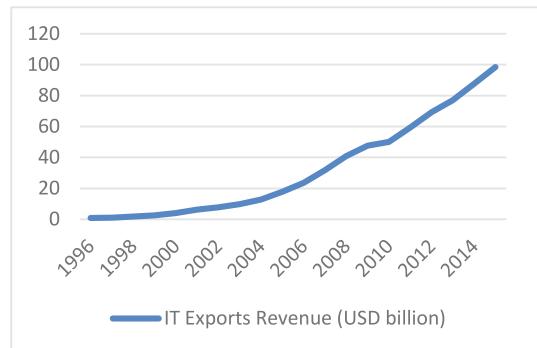


Figure 2: Indian IT Industry - Total exports revenue (USD billion)

IT services constitute the major chunk of the Indian IT sector. In 2015, the IT services export revenue is estimated to be USD 55.4 billion. In 2004, when the total IT exports was USD 12.8, the IT services export revenue was USD 7.3 billion.

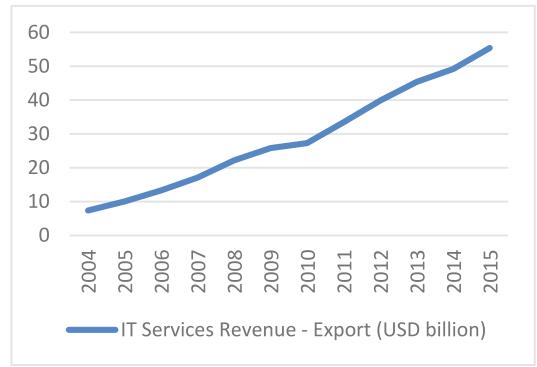


Figure 3: Indian IT Industry - Total IT services export revenue (USD billion)

India has also garnered a major share of the IT sourcing market over the years, maintaining more than 50% share of the global sourcing market over the past few years.

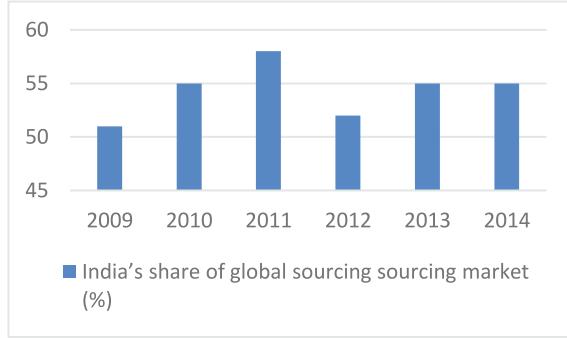


Figure 4: India's share of the global sourcing market (%)

As illustrated in the charts above, it has been a steady and phenomenal growth for the Indian IT industry over the years.

The impact of the IT sector in India should not be judged solely on the basis of the revenue figures. The IT sector has also emerged as a major driver in the economic growth of India. From providing employment to 0.28 million people in 2000, the IT sector now provides direct employment to 3.5 million people in 2015, making it the largest private sector employer in India according to NASSCOM's 2015 Strategic Review [20].

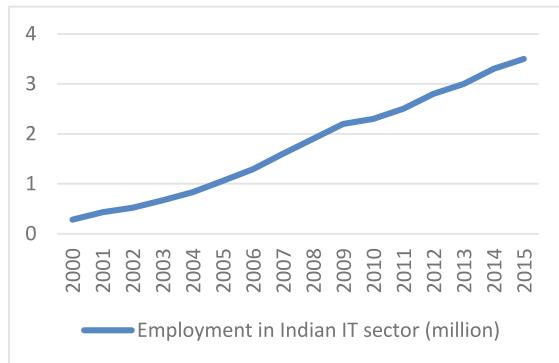


Figure 5: Employment in the Indian IT sector (in millions)

The IT sector's contribution to the nation's GDP has also been steadily increasing – from 4.8% in 2006, in 2015 it stands at 9.5% [20].

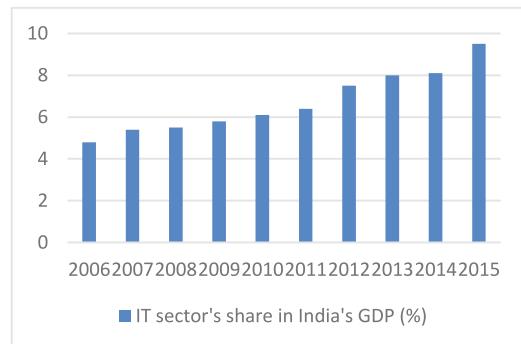


Figure 6: Indian IT sector's contribution to the nation's GDP (%)

All the above statistics fairly establish the healthy state of the Indian IT sector. The Indian IT sector has grown over the last two decades and has matured, having weathered two financial crises in 1999–2000 and 2007–2009. It is in this context that this paper tries to focus on the domestic IT adoption and the IT innovation scenario in India. It is only natural to assume that, in a country with such a strong IT industry, the domestic IT adoption would be widespread and IT innovation thriving.

III. IT ADOPTION IN INDIA – GROUND REALITIES

Though there can be many indicators for measuring the adoption of IT in India, this paper considers the following measures:

1. Domestic software services revenue
 2. Domestic software product development revenue
- [3] and [27] have discussed the importance of domestic software services and domestic product development as potential markets for the Indian IT industry. This paper looks at these measures to draw inferences on the extent to which India, as a nation, has used its IT skills.

A. Domestic Software Services and Product Development

The domestic IT market has been growing steadily over the years. To gauge the size and growth of the domestic market, and the domestic revenue figures are plotted against the corresponding export revenue figures. The data of domestic software services and product development revenues are taken from NASSCOM's annual Strategic Review reports (2004 to 2015) of the Indian IT sector.

The total domestic IT revenue has increased from USD 4.8 billion in 2004 to an estimated USD 21 billion in 2015.

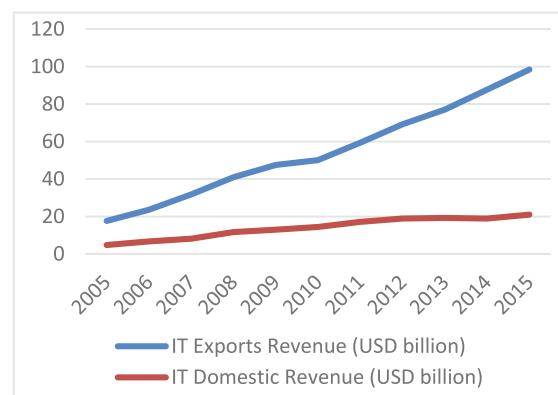


Figure 7: Indian IT revenues - export vs domestic (USD billion)

The domestic IT services revenue has increased from USD 3.1 billion in 2004 to an estimated 13.3 in 2015.

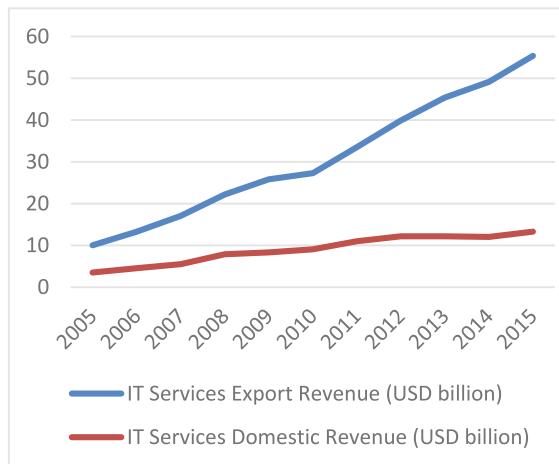


Figure 8: Indian IT services revenue - export vs domestic (USD billion)

In the same period the revenue of software products for the domestic market increased from USD 0.4 billion in 2004 to an estimated USD 4.1 billion in 2015.

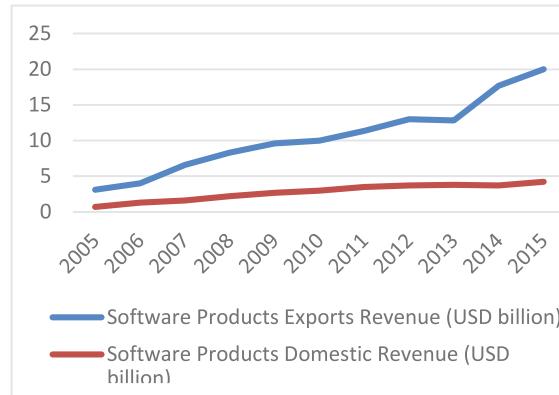


Figure 9: Indian software product development revenues - export vs domestic (USD billion)

As the figures illustrate, the domestic IT services revenues and domestic products development revenues, though growing, are quite small compared to the corresponding exports revenue. This points to very low adoption of IT in the various economic sectors in India.

IV. THE FORECASTS FOR YEAR 2020

If the same trend continues, what will be the scenario of IT adoption in the country compared to the exports in 2020? How will they fare when compared against the export scenario? The intent of this

forecasting exercise is not to predict accurately, but to get a rough estimate of what these figures would be in 2020, all other things remaining the same. This paper uses Linear regression model for forecasting the exports and domestic revenue figures. As consistent data for all indicators is available from 2005, time-series data starting from 2005 is considered for the forecasting exercise.

The linear regression model for forecasting is:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$$

where x is the independent value for which the corresponding forecast value of y is to be obtained.

This paper uses the R software and the 'fpp' package by Rob J Hyndman for the forecasting exercise.

The forecasts show that the IT sector will continue its phenomenal growth over the next 5 years. The total IT revenue for 2020 is forecast to be USD 182 billion.

The sector's contribution to the economy will go on increasing. Figure 11 shows the forecast of employment figures for the year 2020. From 3.5 million in 2015, it is forecast to rise to 4.7 million in 2020.

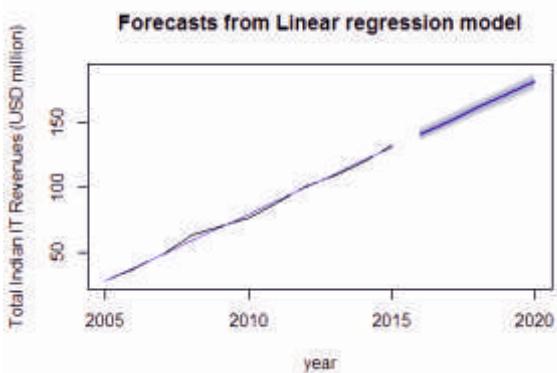


Figure 10: Indian IT industry - Total revenue forecast for year 2020

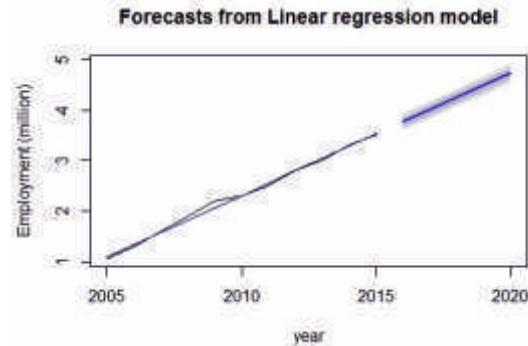


Figure 11: Indian IT industry - employment figures forecast for the year 2020

But if the trends of the export and domestic revenues continue, the IT adoption in India, represented by the domestic IT revenue, will continue to be low.

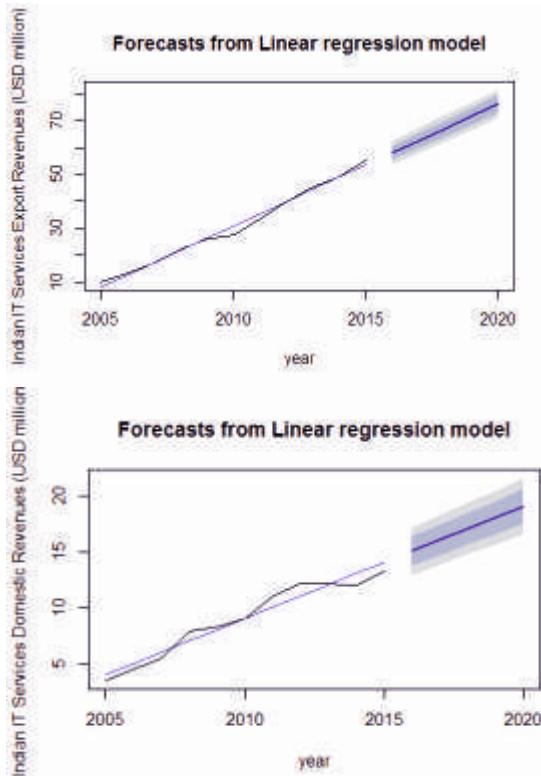
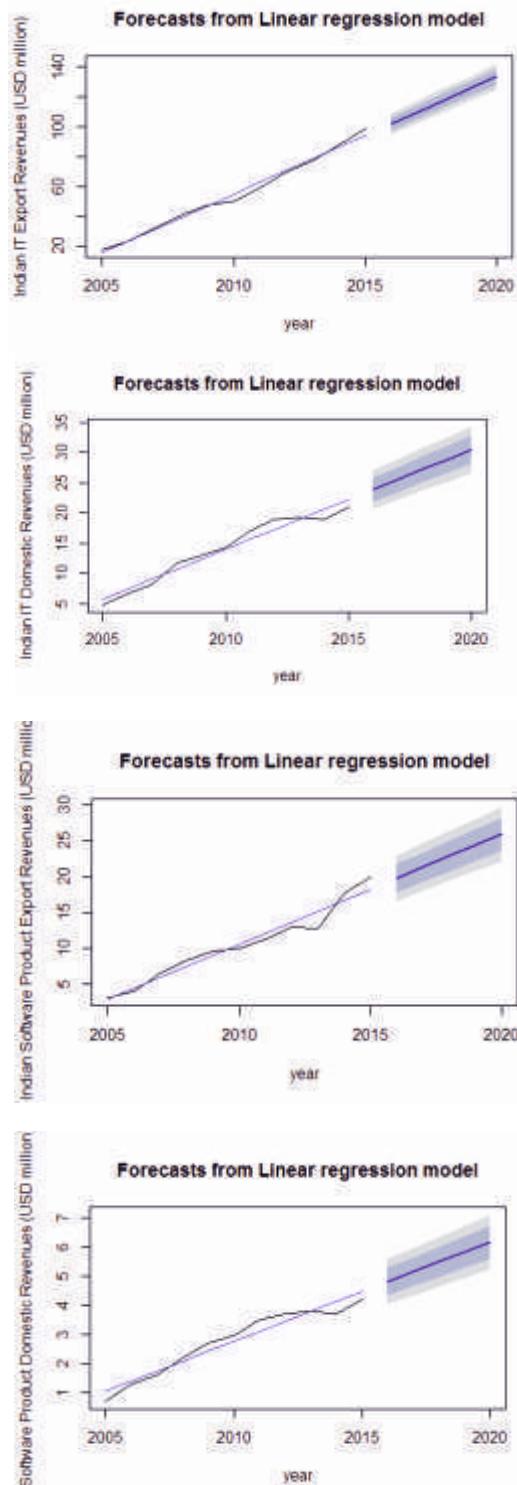


Figure 12: Indian IT industry - Export and domestic revenue of total IT industry, IT services, product development - forecast for year 2020

Table 1 lists the forecast values of the exports and domestic revenues for year 2020.

Table 1: Forecast values of export and domestic IT revenues – 2020

	Exports (USD billion)	Domestic (USD billion)
Total IT Revenue in 2020	133.47	30.49
IT Services Revenue in 2020	76.17	19.06
Software Products Revenue in 2020	25.95	6.17

For each of the categories – Total IT revenue, IT Services revenue, and Software products revenue – the exports and domestic forecast figures are plotted against each other. These show that the gap between the future growth of domestic and export revenues will keep on widening.

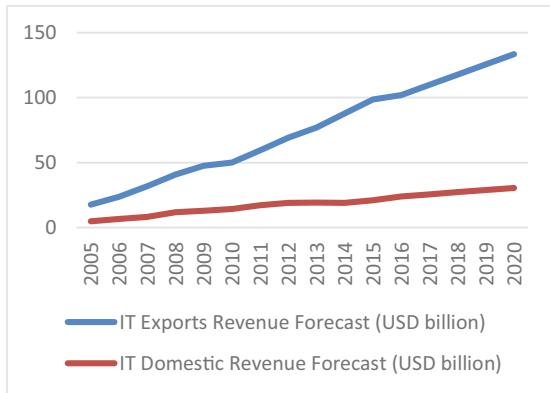


Figure 13: IT revenues - export vs domestic - forecast for the year 2020

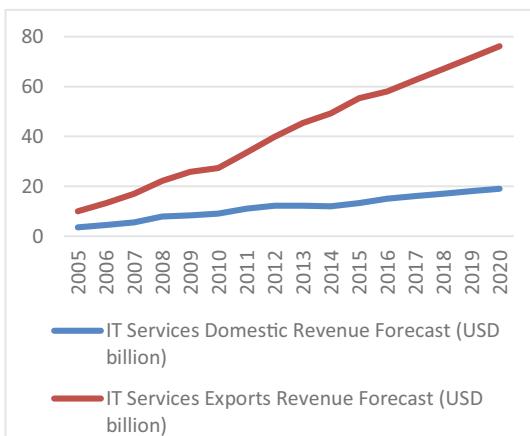


Figure 14: IT services revenue - export vs domestic - forecast for the year 2020

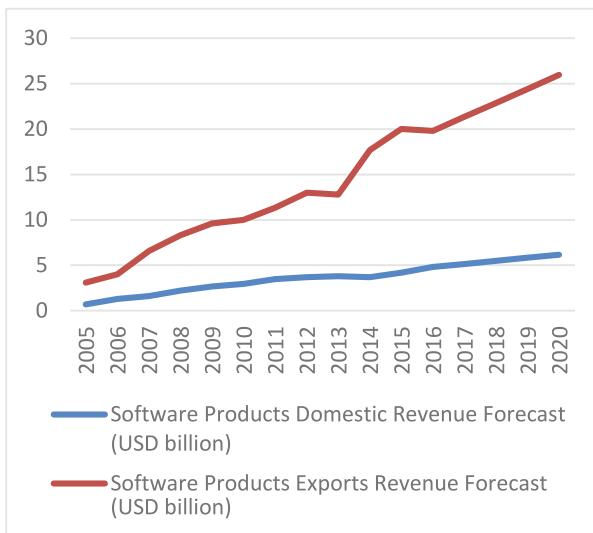


Figure 15: Software products revenue - export vs domestic - forecast for the year 2020

V. IT INNOVATION IN INDIA

According to NASSCOM's Strategic Review 2015, India holds the second position in the Engineering R & D and product development global sourcing market. But it is again an export-oriented segment, with exports contributing more than 90% of the segment's revenue [20]. So even the R&D is aimed at the exports market.

This paper attempts to understand the IT innovation scene in India using the historical data of the number of ICT patents filed over the years under PCT (Patent Cooperation Treaty). For the scope of this paper, ICT patents data is considered as an indicator of innovation.

A. ICT Patents

The time-series data of the ICT patents filed under PCT are obtained from the OECD stats database [23]. The patents figures are available only till 2011, but they still provide a satisfactory base for studying the growth of IT innovation scene in India.

The number of ICT patents filed from India in 1999 was 37 and that has gone up to 709 in 2011, as illustrated in Figure 16.

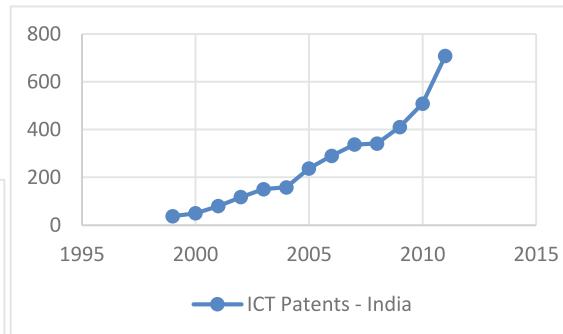


Figure 16: The growth of ICT patents from India

For understanding the state of IT adoption in India, the domestic software services revenue and the software product development revenue were compared against the corresponding export revenue figures to paint a clear picture of where they stand. Similarly, the Indian ICT patents numbers have to be compared against a benchmark to get a clear idea about what these numbers indicate. In 1999, when the number of ICT patents filed under PCT from India was 37, the corresponding number for China was 76, which is slightly higher than India's, but still below 100. This paper, therefore, uses the ICT patents data of China filed

under PCT, also obtained from the OECD stats database, as a benchmark to compare India's ICT patents data against.

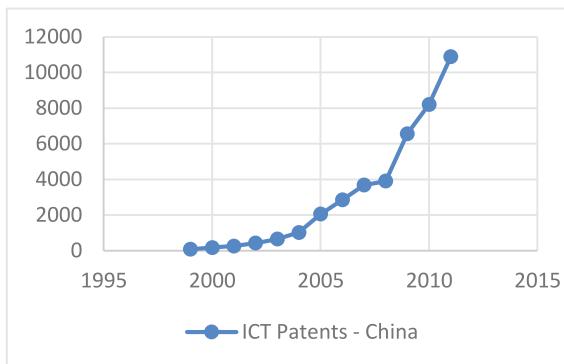


Figure 17: The growth of ICT patents from China

The patents data of both the countries are forecast for the year 2020. The ICT patents are forecast using Linear Regression model.

Since the trends are not strictly linear, the higher values of forecast for both the patent data are considered.

Table 2 and Figure 19 show the forecast figures of India and China ICT patents for the year 2020.

Table 2: Forecast data of ICT patents of India and China – 2020

	India	China
ICT Patents forecast for the year 2020	1195	20185

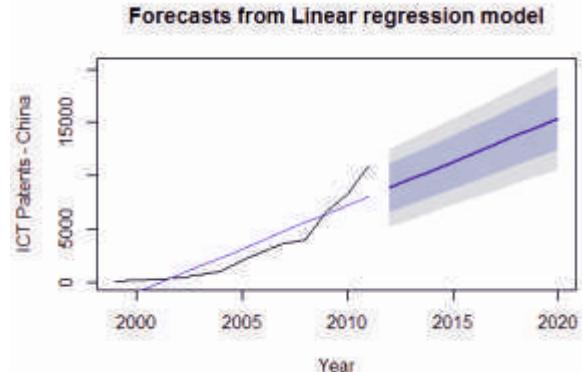


Figure 18: ICT patents - India and China - forecasts for the year 2020

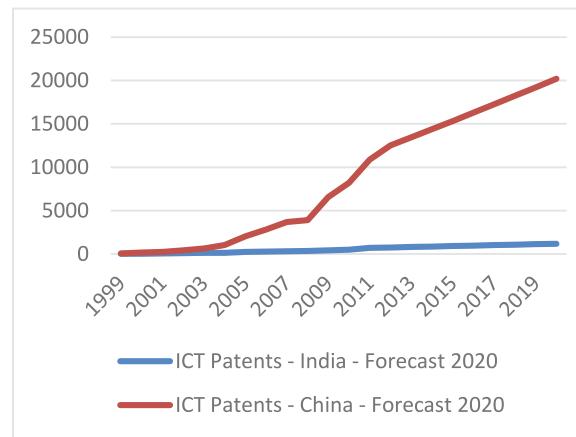
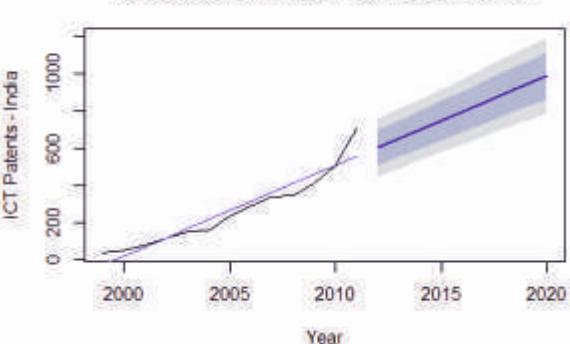


Figure 19: ICT patents - India vs China - forecasts for the year 2020

The plot of the forecast data of ICT patents from India against the forecast data of ICT patents from China points to a very under-developed ICT innovation scene in India. It is a troubling situation for a nation which is deemed a leader in the IT sector.

B. ICT Innovation – A Neglected Sector

The stunted growth in the number of ICT patents from India points to a lack of utilization of the nation's skills for addressing its own challenges as well as a lack of focus on innovation. India has built up a tremendous skills and knowledge base in the IT space over the last two decades. The Indian IT industry has grown from strength to strength, but there is no noteworthy innovation to show, leave alone paradigm-shifting ones. In this context, it is relevant to note the statement of N. R. Narayana Murthy, founder and former CEO and Chairman of Infosys Technologies Ltd., that there has not been a single invention from India in the last 60 years that became a household name



globally, nor any idea that led to 'earth shaking' invention to 'delight global citizens' [22]. Though the statement is aimed at the Indian society and innovation culture in general, it is especially relevant for the IT sector.

The Indian IT sector has the strength, skills, and all the attributes to become an IT innovator, but there is no real necessity for the Indian IT sector to abandon the services export business and turn its focus on innovation. With the cost arbitrage still playing a role despite costs in India having gone up over the last decade, and several major markets still untapped for IT outsourcing, the Indian IT industry will continue to be export-oriented. There are many geographical areas that are potential IT services markets that are yet to be tapped and these provide tremendous opportunities for the Indian IT services companies. As a result, for the IT sector to cater to the domestic market and to invest in IT innovation, government intervention is needed. The government has a very important role to play if India has to become a thriving innovation hub for ICT.

VI. ROLE OF THE GOVERNMENT

The importance of the IT sector in India's economic growth has not been lost on successive Indian governments irrespective of their political background. They have given great importance in facilitating the growth of the sector. The impressive growth of the Indian IT industry can in fact be attributed to a major government initiative. The Government of India set up the Software Technology Parks of India (STPI) in 1991. It coincided with the rolling out of economic reforms by the then government. The STPI was set up to promote the development and export of software from the country. The setting up of STPI and various STPI centers across the country in 1991 was a major catalyst in India's growth in the IT services sector. STPI provided infrastructural facilities such as High Speed Data Communication (HSDC) links, data centers and data hosting facilities, and also financial and tax benefits. This encouraged the setting up of export-oriented software units in the STPI centers. In 2013-14, there were 53 STPI centers operational across the country with 3676 software export units operating out of them. The overall exports from the STP units stood at USD 42.13 billion as of 2013-14 [28].

The National Policy on Information Technology 2012 gives a lot of emphasis on further strengthening the IT/ITES industry.

The very first mission statement in the NPIT 2012 reads: 'To consolidate India's position as the global IT & ITES hub and leverage IT to contribute significantly to GDP and employment.' One of the objectives of NPIT 2012 is to diversify the industry to Tier II and Tier III cities to overcome the cost escalation and infrastructural challenges that have started to plague the major IT hubs such as Bengaluru, Chennai, Hyderabad, Mumbai, Pune, and Delhi.

But, from the fact that the first mission statement in NPIT2012 is to strengthen India's position as global IT/ITES hub, it is clear that the government views the IT industry primarily as an avenue for employment generation and for bringing in foreign exchange through IT exports. That seems to be a logical first step for a country that is economically backward and wants to embark on a path of economic growth. But once a foundation for economic stability has been laid and the IT industry has matured a fair bit, it has to move on to the next objective of IT adoption and innovation to address the various problems that it faces. It has to aim at becoming a creator and innovator.

For this to happen, major government interventions are needed.

VII. GOVERNMENT AND IT INNOVATION

The government does not completely ignore R&D and innovation. The second mission statement in NPIT 2012 is: 'To create a sustainable ecosystem for R&D and innovation'. But, while number targets have been set for IT industry revenues and IT exports revenues, there are no specific or measurable objectives for R&D and innovation.

A. Some New Initiatives

The government has announced a slew of initiatives for the revival of economic growth of India. Among the many policies announced by the government are the 'Make in India' policy and the 'Digital India' initiative. Recently, a 'Start-Up India' mission has also been announced to encourage start-ups.

The 'Make in India' policy aims at reinvigorating the manufacturing sector in India. The 'Make in India' policy summary for 'New Initiatives' reads: 'The Make in India program includes major new initiatives designed to facilitate investment, foster innovation, protect intellectual property, and build best-in-class manufacturing infrastructure.' [8]

The Digital India initiative of the government is aimed at transforming India into a digitally empowered society and knowledge economy. The vision of the initiative focuses on three key areas – digital infrastructure as a utility for every citizen, governance and services on demand, and digital empowerment of citizens [5].

The 'Start-up India' mission announced by the Prime Minister in August 2015 aims to create an ecosystem that will provide a more supportive environment for start-ups across industry sectors [24].

VIII. DISCUSSIONS – THE WAY FORWARD

The 'Make in India' and 'Digital India' initiatives will help in creating an attractive domestic market for the Indian IT companies and will act as a catalyst for increased IT adoption in India. The Digital India initiative will see huge investments in technology by the government. The Make in India policy has the potential to create a huge domestic IT market allied to the growing manufacturing sector.

Already the state of the technology driven start-up scene in India is encouraging. According to 'Start-up India – Momentous Rise of the Indian Start-Up Ecosystem', a report on the technology start-up scene in India, launched by NASSCOM in October 2015, the number of technology start-ups in India was 42000 – 45000, making India the third largest technology driven start-up ecosystem globally. The report also adds that the start-up scene in India provides employment to 80,000 people [6, 7].

The Start-up India mission focuses on creating a supportive environment for Start-ups. This will give a further boost to the Start-up scene in India.

The growth in ecommerce in India in areas such as retail, travel, and hospitality is huge [20]. All these will help in proliferating IT in all the sectors of the Indian economy and will take it a long way towards making it a digital economy. This has the potential to change the linear trend seen in the growth of the domestic IT market and to narrow the gap with the exports.

The importance that the government places on IT for tackling India's many problems can be gauged from the recent visit of the Prime Minister to the Silicon Valley for rallying support for the Digital India initiative and his meetings with the top executives of IT giants like Microsoft, Apple, Google, and Facebook [1, 25].

But this again is a case of looking outside instead of looking inside.

'The power which resides in him is new in nature, and none but he knows what that is which he can do, nor does he know until he has tried.' – Self-Reliance, Ralph Waldo Emerson

None of these policies and initiatives address IP-driven research and innovation in IT. A separate policy for IP-driven innovation in IT on the lines of 'Make in India' policy that has been unveiled for the manufacturing sector is needed.

Government can set up Software/IT Innovation parks exclusively for IP-driven research and innovation on the lines of STPI. The STPI setup by the Indian government in 1991 provided a huge boost to the Indian IT industry and encouraged the setting up of Export oriented software services units. Similarly, the government has to play a role in kick starting and encouraging IP-driven research by setting up Innovation parks.

NPIT 2012 mentions industry-academia collaboration for R&D and innovation, but does not lay down any specific actionable targets. Innovation labs can be setup as collaboration between academia and industry to encourage students to take up IP-driven research work. Indian academic sector and IT industry cannot remain as silos with no interaction. A representative example is cited here: The Karyavattom campus of University of Kerala in Thiruvananthapuram and Technopark, which is the largest technology park in India, share a boundary. This close geographical proximity of a technology park and a university campus presents an ideal location for setting up an innovation lab as an industry-academia collaboration and the government should facilitate this. This can then be replicated across the country. The government should formulate policies to encourage the IT companies and the academic departments to collaborate on research projects.

The government can start Innovation incubation centers at various centers across the country. The government already has policies for encouraging startups. Incubation centers have been set up in many locations but most of them are business incubation centers. Some are technology incubation centers. There is a need for incubation centers for IP-driven research in IT.

One of the aims of the Digital India initiative is to implement a broadband infrastructure, a broadband highway covering all rural centers. This will provide the perfect connectivity infrastructure for setting up IT

innovation centers in rural areas. A major focus for setting up IT innovation centers should be the rural areas to encourage bottom-up innovation. Technological solutions for many of the problems faced by the rural areas might come from those who are encountering them on a daily basis.

IX. CONCLUSION

The Indian IT industry is in good health, growing impressively on a year-on-year basis and contributing handsomely towards the nation's economic well-being. This paper looked at the domestic software services and domestic software product development data to learn about the extent of IT adoption in India. The figures are quite low compared to the export data.

Next the paper looked at the IT innovation scene in India using the ICT patents data. This too is quite low for a nation that has the largest market share in the global IT sourcing market.

The inference drawn is that India views the IT sector primarily as an employment provider and an export oriented industry for earning foreign exchange.

New government initiatives such as 'Make in India', 'Digital India', and 'Start-up India' have the potential to change the landscape of IT adoption in India. The Indian Prime Minister visited the Silicon Valley in September 2015 to garner support for the Digital India initiative and to invite the technology giants to set up their centers in India. But again this is a case of looking outside rather than innovating.

The Indian IT sector would have come of age only when paradigm-shifting, IP-driven innovations happen in India. For this, the government has a major role to play to encourage IP-driven innovation by setting up Innovation parks and encouraging industry-academia collaboration.

Can the Indian IT sector script a bildungsroman?

REFERENCES

- [1] At Silicon Valley, PM Narendra Modi's Digital Dream Gets Many Shares, Likes. (2015, September 27). NDTV. Retrieved from <http://www.ndtv.com/ cheat-sheet/at-silicon-valley-pm-narendra-modis-digital-dream-gets-many-shares-likes-1223403>
- [2] Bhatnagar, S. (2006). India's Software Industry. In V. Chandra (Ed.), Technology, Adaptation, and Exports: How some developing countries got it right (pp. 54–56). Washington DC: World Bank. Retrieved from <https://openknowledge.worldbank.org/handle/10986/7118>
- [3] Bhattacharjee, S., & Chakrabarti, D. (2015). Indian IT outsourcing industry: Future threats and challenges – A reassessment. *Futures*, 67, 11–21. doi:<http://dx.doi.org/10.1016/j.futures.2014.12.014>
- [4] Department of Electronics & Information Technology, G. of I. (2012). National Policy on Information Technology, 2012 (NPIT 2012).
- [5] Digital India Programme. (2015). Retrieved October 2, 2015, from <http://www.digitalindia.gov.in/>
- [6] India Ranks Third Globally With More Than 4200 Startups: NASSCOM Startup Ecosystem Report 2015. (2015, October 13). INC42. Retrieved from <http://inc42.com/buzz/india-ranks-third-globally-with-4200startups/>
- [7] India ranks third in global startup ecosystem: Nasscom. (2015, October 13). The Economic Times. Retrieved from <http://economictimes.indiatimes.com/ small-biz/startups/india-ranks-third-in-global-startup-ecosystem-nasscom/articleshow/49341735.cms>
- [8] Make in India. Retrieved August 15, 2015, from www.makeinindia.com
- [9] NASSCOM. (2004). Indian Software and Services Exports clock revenues of USD 12.5 billion, registering growth of 30.5% in FY 2003-04. New Delhi. Retrieved from www.nasscom.in
- [10] NASSCOM. (2006). The IT Industry in India: Strategic Review 2006. New Delhi. Retrieved from www.nasscom.in
- [11] NASSCOM. (2008). Indian IT-BPO Industry: NASSCOM Analysis. New Delhi. Retrieved from www.nasscom.in
- [12] NASSCOM. (2010a). Global Sourcing Trends in 2010. New Delhi. Retrieved from www.nasscom.in
- [13] NASSCOM. (2010b). India Inc. - An Overview of the Indian IT-BPO Industry. New Delhi. Retrieved from www.nasscom.in

- [14] NASSCOM. (2011). The IT-BPO Sector in India: Strategic Review 2011. New Delhi.
- [15] NASSCOM. (2012). The IT-BPO Sector in India: Strategic Review 2012. New Delhi.
- [16] NASSCOM. (2013a). Indian IT-BPM Industry - FY2013 Performance Review, FY2014 Outlook. New Delhi. Retrieved from www.nasscom.in
- [17] NASSCOM. (2013b). The IT-BPM Sector in India: Strategic Review 2013. New Delhi.
- [18] NASSCOM. (2014a). Indian IT-BPM Industry Overview. New Delhi. Retrieved from www.nasscom.in
- [19] NASSCOM. (2014b). The IT-BPM Sector in India: Strategic Review 2014. New Delhi.
- [20] NASSCOM. (2015). The IT-BPM Sector in India: Strategic Review 2015. New Delhi.
- [21] NASSCOM-McKinsey. (2005). NASSCOM-McKinsey Report 2005: Extending India's Leadership of the Global IT and BPO Industries.
- [22] No invention, earth shaking idea from India in 60 years: NR Narayana Murthy. (2015, July 15). The Economic Times. Retrieved from <http://economictimes.indiatimes.com/news/science/no-invention-earth-shaking-idea-from-india-in-60-years-nr-narayana-murthy/articleshow/48085732.cms>
- [23] OECD. OECD.Stat: Patents by Technology. Retrieved September 1, 2015, from http://stats.oecd.org/Index.aspx?DataSetCode=PATENTS_IPC
- [24] PM Modi announces "Start-Up India" initiative to encourage entrepreneurship. (2015). Business Standard. Retrieved from http://www.business-standard.com/article/news-ani/pm-modi-announces-start-up-india-initiative-to-encourage-entrepreneurship-115081501403_1.html
- [25] PM Modi to Silicon Valley: Digital India "unmatched in history." (2015, September 28). The Indian Express. Retrieved from <http://indianexpress.com/article/technology/tech-news-technology/pm-modi-silicon-valley-google-microsoft-ceo-dinner/>
- [26] Rajaraman, V. (2015). History of Computing in India: 1955-2010. IEEE Annals of the History of Computing, 37(1), 24–35. doi:10.1109/MAHC.2015.10
- [27] Sharma, D. C. (2014). Indian IT outsourcing industry: Future threats and challenges. Futures, 56, 73–80. doi:<http://dx.doi.org/10.1016/j.futures.2013.10.011>
- [28] Software Technology Parks of India. (2014). Annual Report 2013-14. Retrieved from www.stpi.in

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CONTEXT AWARE COMMUNITY DETECTION SCHEME FOR IDENTIFICATION OF COMMUNITY IN MULTI-DIMENSIONAL NETWORKS

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Abstract: The modern science of networks has enhanced our understanding of complex systems and there are now growing interests in modeling these large complex systems as multi-dimensional networks such as the World Wide Web (WWW), social networks, co-citation networks and biological networks. In order to understand and study these kind of networks, community detection is done. There are several approaches for community structure identification from these kind of networks. But the approaches in literature could lead to generation of communities with noisy interactions. This paper presents a context aware community detection method based on DBSCAN (Density Based Clustering Algorithm for Applications with Noise) approach. The result and discussions based on the experiments enhance the work.

Keywords- Community, tensor, MultiComm, Linear Dirichlet Allocation, Context- Aware Relation, DBSCAN

INTRODUCTION

Detecting communities from large scale complex systems such as World Wide Web, social networks, co-citation networks, and biological networks is of great importance in the field of Computer Science, Sociology and Biology. Community detection involves finding a group of clusters which are interacting each other. Multi-dimensional networks are networks with multiple kinds of relations. Social networks, genetic networks, co-citation networks are examples of such networks. In these networks, each node is an item corresponding to a dimension or entity and each edge indicates a relationship between two nodes. For example, in social networks, finding a community structure means finding a group of users who interact on different entities like tags, photos, comments or stories. In case of a co-citation network, community structure represents a group of authors who interact on publication information such as titles, abstracts, keywords etc. Several approaches have been proposed based on several measures and concepts, such as modularity, edge-betweenness, label propagation, min-cut theory etc. Community detection in multi-dimensional networks is restricted to the dimensionality of the entity structure, selection criteria and the current requirements of the entities. Generation of communities leads to some noisy interactions among the structure.

So, there is a need to recover the community from noisy interactions among the entities. The community detection problem has many widespread applications and has hence proven to be very important.

This paper presents a context aware community detection system based on the DBSCAN. The rest of the paper is organized as follows. Section I introduces some of the related works in the area of community detection. The Proposed system is explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. COMMUNITY DETECTION METHODS

There are many works in the field of community detection for both uni-dimensional and multi-dimensional networks [1][2].

A. Modularity based Community Detection

Modularity based approaches are used for finding community structures in very large networks [3][4]. Modularity is a property of a network and a specified proposed division of that network into communities. Modularity means the measure of fraction of edges falling within communities subtracted by what one would expect if the edges are randomly placed. It provides a good quality measure to compare different community structures. A larger modularity value means stronger community structures [5][6].

B. Label Propagation based Detection

For finding overlapping communities [7][8] in large networks label propagation method [9][10] can be used. The concept of label propagation is as follows. Each node is initialized with a unique label and at every iteration of the algorithm, each node adopts a label that a maximum no of its neighbors have, with ties broken uniformly randomly. As the labels propagate through the network, densely connected groups of nodes having the same labels are grouped together as communities.

C. Random Walk Approach

Random walk process can be used to compute communities in large networks. Such an algorithm known aswalktrap was proposed [11][12][13]. Consider a discrete random walk on the graph G. At each time step, a walker is on a vertex and moves to a vertex chosen randomly and uniformly among its neighbors. The sequence of visited vertices is a Markov chain, the states of which are the vertices of the graph. At each step, the transition probability from vertex i to vertex j is P_{ij} . This is transition matrix P of random walk processes. The process is driven by the powers of the matrix P. In order to group the vertices into communities a distance r between vertices that captures the community structure of the graph is introduced. Distance must be large if two vertices are in different communities and small otherwise.

D. Adaptive Algorithms

Adaptive algorithms were developed for detecting community structures in dynamic social networks. Quick Community Adaptation (QCA) [14] is an adaptive modularity based method for identifying and tracing community structure in dynamic social networks. A dynamic social network is a special type of evolving complex networks in which changes are frequently introduced over time. For example, in Facebook and Twitter changes are usually introduced by users joining in or withdrawing from one or more groups or communities by friends and friends connecting together or by new people making friend with each other. This method has the power of quickly and efficiently updating network communities through a series of changes by using only the structures identified from previous network snapshots also has the ability of tracing the evolution of community structure over time.

E. Tensor based Community Detection

A framework known as MetaFac [15] extracts community structures from social media networks. In

this the community structure represents the latent social context of user actions. Metagraph Factorization is introduced to describe combination of relation and facets. Metagraph is a relational hypergraph for representing multi-relational social data. A hypergraph is a graph with edges (known as hyper-edges) are connected to any no of vertices. Interaction between different entities are represented as a set of tensors. Tensors are mathematical representation of a multi-way array. Decompose these tensors into matrices using KL-divergence. Thus the factorization matrices represent prior probabilities of different communities and conditional probabilities of each item in these communities. Based on them posterior probability of item belonging to a community can be computed and final results can be obtained.

Tensor based community detection was used in MultiComm [16] community detection in multi dimensional networks. Main contribution was the development of a framework to identify a seed-based community in a multi-dimensional network. So items involved in a community structure interact significantly inside the community but they are not strongly influenced by the items outside the community. In the proposal, a community is constructed starting with a seed consisting of one or more items of the entities believed to be participating in a viable community. Given the seed item, iteratively adjoin new items by evaluating the affinity between the items to build a community in the network. As there are multiple interactions among the items from different dimensions/entities in a multidimensional network, the main challenge is how to evaluate the affinity between the two items in the same type of entity (from the same dimension/entity) or in different types of entities (from different dimensions/entities). After solving a set of tensors, obtain the probability distributions of visiting each item in each dimension in the multi-dimensional network. These probability distributions can be viewed as an affinity vector because it indicates the affinity of the items in each dimension to the items in the current community. Based on their probability values, the candidate items in different dimensions that are closely related to the current items in the community can be determined. This affinity vector is also known as transition probability tensor. In order to determine the best community, a local modularity measure can be used.

III. PROPOSED SYSTEM

The methods of community detection in literature so far, have many limitations. Firstly, the community structure identification at the early times were applicable only in the case of uni-dimensional networks. The methods proposed to extract community from a uni-dimensional networks may not yield good performance for a multi-dimensional network. For large networks such as social networks, where the user changes are constantly evolving and changing, considering the uni-dimensionality is critical. Another problem that is to be noted is the efficiency and the accuracy of the methods used for the community detection. Different methods been proposed are based on the modularity, edge-betweenness, max-min etc. But all the methods work very differently in community discovery task. Thus accuracy is being affected. While considering the multi-dimensional networks, the no. of dimensions to build the community depends on it. Sometimes, the community detection may be limited to the dimensionality of the community. The community discovery methods may suffer noisy interactions in the networks. Evolution of communities across different time stamps have to be considered.

So, there is a need to recover the community from noisy interactions. Noisy interactions means some unwanted clusters. For that there is a need to develop a system which identifies the best community among multi-dimensional networks based on relevant selection criteria and dimensionality of entities, thereby eliminating the noisy interactions in a real-time environment.

A. Architecture of the system

Proposed system is a context aware relation extraction based community discovery scheme for the identification of the best community structure in multi-dimensional network. The architecture for the system is shown in fig. 1 and the methodology is as follows.

1. First step is to preprocess the data. Data here is the author documents, which is considered as multi-dimensional (paper, author, keyword, paper category, concepts etc.). Consider an academic publication network where come concepts are labelled to papers and each paper is associated with several keywords and authors. So there are four dimensions/ entities in this network, i.e., paper, concept, author, and keyword. Items in three dimensions i.e., author, keyword and paper are

related among themselves and items in three dimensions i.e., paper and concept are related to each other.

2. Next step is tensor modelling. Tensors are used to represent the multidimensional networks. For example, paper-author-keyword tensor, paper-author tensor etc. A tensor can be used to represent the interactions among the dimensions or entities.
3. After forming a set of tensors, obtain the probability distribution of visiting each item in each dimension in the multi-dimensional network. These probability distributions can be viewed as an affinity vector because it indicates the affinity of each items in the current community. Based on their probability values, the candidate items in different dimensions that are closely related to the current items in the community can be determined.
4. Next step is the implementation of MultiComm. In MultiComm, a community is constructed starting with a seed consisting of one or more entities/ items given by the user. Given the seed item, iteratively adjoin new items by evaluating the affinity between the items to build a community in the network.
5. A context-aware relation extraction method can be used for Relation Completion (RC) task [18].

B. Modules of the System

The main aim of the system is to find the best community structure from a multi-dimensional network. Proposed system is shortly called as MultiComm_Plus. The system consists of six parts-data collection, preprocessing, tensor modelling, affinity evaluation, context aware community detection and evaluation. Publication networks are very common nowadays. The system is a publication network system which provides a platform for authors for publishing their research or academics papers and also for generating the best community structure from the network. Publication network is considered as a multi-dimensional network because of the presence of multiple kind of relations and dimensions (entities). The different dimensions (entities) present are paper (documents), author, keywords, subject, contents and the relation represents the interaction between those entities, i.e., interaction between author and document, subject and document etc. Data collection part deals with the collection of test data, data here is the documents uploaded by the author. Preprocessing part

deals with the preprocessing of the test data using Latent Dirichlet Allocation method. It is a probabilistic model for collecting distinct data. Tensors are used to represent interaction among entities in a multi-dimensional network. During tensor modelling a tensor matrix and a tensor relation is obtained. Affinity evaluation for each document is obtained in the next part. Context aware community detection part do the actual community discovery using a density based spatial clustering method such as DBSCAN [19].

TABLE I. PERFORMANCE COMPARISON

Criteria	Normal Community Detection	MultiComm Based Community Detection	Context Aware Community Detection
No. of clusters in the community structure	60	70	87

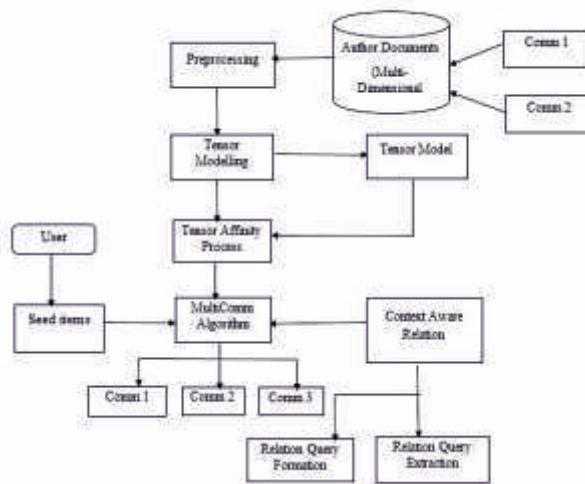


Fig 1. Architecture of the system



Fig 2. System Modules

IV. RESULT AND DISCUSSIONS

As an experiment, system is tested on 100 documents for a normal community detection method, MultiComm based community detection and context-aware community detection, the no. of clusters formed in community generation is different for each method. Table. I shows the performance comparison. It is to be noted that no. of clusters formed using the context-aware method is higher than that of other methods. Thus the proposed system has been proved to be efficient.

V. CONCLUSION

Community detection algorithms are widely used to study the structural and topological properties of real-world networks. Identification of the best community among the network based on the current scenario is a big challenge. Existing systems generates communities with some noisy interactions i.e., communities with unwanted clusters. So there is need to develop a system to overcome this limitation. MultiComm Algorithm can be enhanced with a context-aware relation extraction method by DBSCAN, so that generated communities can be recovered from noisy interactions.

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REFERENCES

- [1] Dhanya Sudhakaran, Shini Renjith, "Survey of Community Detection Algorithms to Identify the Best Community in Real-Time Networks", Vol-2, Issue-1, pp. 529-533, January 2016.
- [2] J Leskovec, K.J Lang, M.W Mahoney, " Empirical comparison of algorithms for network community detection", CoRR, abs/1004.3539, 2010.
- [3] J Leskovec, K.J Lang, M.W Mahoney, " Empirical comparison of algorithms for network community detection", CoRR, abs/1004.3539, 2010.
- [4] A Lancichinetti, S Fortunato, "Community detection algorithms: a comparative analysis", Phys Rev E 2009, 80:056117.
- [5] F.D Malliaros, M Vazirgiannis, "Clustering and community detection in directed networks: a survey", CoRR, abs/1308.0971, 2013.

- [6] J. Bagrow and E. Bolt, "Local Method for Detecting Communities," Physical Rev. E, vol. 72, no. 4, p. 046108, 2005.
- [7] J. Ruan and W. Zhang, "An Efficient Spectral Algorithm for Network Community Discovery and Its Applications to Biological and Social Networks," Proc. Seventh IEEE Int'l Conf. Data Mining (ICDM'07), pp. 643-648, Jan. 2007.
- [8] M. Newman, "The Structure and Function of Complex Networks," SIAM Rev., vol. 45, no. 2, pp. 167-256, 2003.
- [9] F. Luo, J.Z. Wang, and E. Promislow, "Exploring Local Community Structures in Large Networks," Web Intelligence and Agent Systems, vol. 6, no. 4, pp. 387-400, 2008.K. Elissa, "Title of paper if known," unpublished.
- [10] Steve Gregory, "Finding overlapping communities in networks by label propagation", New journal of Physics, October 2010.
- [11] Daxiang Ji, Yuqing Sun and Demin Li, " Improved Random Walk Based Community Detection Algorithm", International Journal of Multimedia and Ubiquitous Engineering Vol.9, No.5 2014, pp.131-142.
- [12] Pascal Pons and Matthieu Latapy, "Computing communities in large networks using random walks", ISCIIS, Springer, vol 3733, 2005, pp.284-293.
- [13] Xiaoming Liu, Yadong Zhou, Chengchen Hu, Xiaohong Guan, Junyuan Leng, "Detecting Community Structure for Undirected Big Graphs Based on Random Walks", www'14 Proceedings of 23rd international conference on WWW , 2014, pp.1151-1156.
- [14] Nam P. Nguyen, Thang N. Dinh, Ying Xuan, My T. Thai, "Adaptive Algorithms for Detecting Community Structure in Dynamic Social Networks", IEEE infocom, 2011.
- [15] Y. Lin, J. Sun, P. Castro, R. Konuru, H. Sundaram, and A. Kelliher, "Metafac: Community Discovery via Relational Hypergraph Factorization," Proc. 15th ACM SIGKDD Int'l Conf. Knowledge Discovery and Data Mining (KDD '09), pp. 527-536, 2009.
- [16] Xutao Li, Michael K. Ng, and Yunming Ye, "MultiComm: Finding Community Structure in Multi-Dimensional Networks", IEEE Transactions On Knowledge And Data Engineering, Vol. 26, No. 4, April 2014.
- [17] Zhixu Li, Mohamed A. Sharaf, Laurianne Sitbon, Xiaoyong Du, and Xiaofang Zhou, "CoRE: A Context-Aware Relation Extraction Method for Relation Completion", IEEE Transactions On Knowledge And Data Engineering, Vol. 26, No. 4, April 2014, pp. 836-849
- [18] Martin Ester, Hans-Peter Kriegel, Jörg Sander, Xiaowei Xu, "A Density-Based Algorithm for Discovering Clusters in Large Spatial Databases with Noise", Published in Proceedings of 2nd International Conference on Knowledge Discovery and Data Mining (KDD-96).

IMAGE PROCESSING BASED SIMULINK MODEL AND ANALYSIS OF MOBILE MODULAR FIXTURE ROBOT

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Abstract: The peculiarities of the product are flexibility of the design, reduced fixturing downtime, decreased cost and the fact that differently shaped objects can be clamped without any manual adjustments. The fixture with clamps are arranged radially around its work space; they are all independently controlled by lead screw mechanisms powered by DC motors. The M2F algorithm has been developed for the automation of the fixture with the help of image processing technique, using MATLAB platform. The micro controller is programmed in such a way that the whole process, including capturing the object and DC motor actuation, simultaneously leads the development and implementation of an automated fixture-design system. Image overlapping is the technique used for extracting the co-ordinate of the object, with the help of a reference image. Simulink model of the mobile modular fixture clamp motor is derived for dynamic analysis. Regression with ANOVA analysis is done to find the relation of delay and linear movement of the fixture clamp. A real time model is developed for the purpose of implementing the algorithm.

Keywords: Mobile modular fixture, Image processing, Robot, Regression analysis.

1. INTRODUCTION

Modular fixturing uses a number of simple locators and clamps that plug into a lattice of holes to hold the parts. This work is developed to analyze the automated modular fixture robot using image processing algorithms implemented in MATLAB to give mobility to the whole system. A brief on fixtures and modular fixtures is provided. Many approaches for computer assisted fixture planning have been developed over the last two decades to address different types of process constraints so comprehensive reviews are available. Most automated solutions for modular fixture synthesis are restricted to planar shapes where it is assumed that three locators and one clamp are sufficient to immobilize the shape. The assumption is valid for two dimensional fixture synthesis because it has been shown that four fixture locations are necessary and sufficient to guarantee complete part immobility for planar degrees of freedom. Stability analysis to restrict planar motions relies on understanding a three dimensional configuration space of forces and moments. For three dimensional motions the problem requires challenging stability analysis in six dimensional spaces.

One of the main reasons for choosing the mobile modular fixture robot is the flexibility of its design with possibilities to clamp many types of objects without manual adjustments. It is a process automatically carried out by taking the image of the object as the input and the electrical signals from the fixing clamps as the output. The clamp is arranged radially around the work volume with different designs and it is manipulated by lead screw mechanism with each one having one degree of freedom. A camera is placed above the work volume to capture the object image with the whole system controlled by microcontrollers. One specialty of this design is its provision for wheels, making it a movable fixture.

The mobile modular fixture can act as mobile robot, modular robot and fixture robot. The fixture contains eight clamps; they are arranged radially around the work space and all are independently controlled by lead screw mechanisms powered by DC motors. One vision sensor is placed above the workspace. On placing a work piece in the work volume, the sensor takes the image of the particular object and gives signals to the clamps. The task is achieved by overlapping of the control image to the

other with lead data to the extraction of co-ordinates. After image processing the profile of the object can be found by comparing with the workspace coordinates, when clamps guide all the coordinates in that work space to the profile coordinates. The proper clamps will then form the shape of the particular work piece. Any irregular shape can be clamped using this fixture. At the time of machining the whole system moves from one location to another for multitasking. The clamps act as modules in a modular robot and mobility is given by placing wheels. Finding the work piece properties are future tasks. The fixture improves the economy of production by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labor by simplifying how work pieces are mounted, and increasing conformity across a production run.

The need to reduce manpower, automate fixturing and image processing techniques led to the development of M2F algorithm. Converting M2F into a program and implementing in MATLAB to automate the whole system are the main objectives of this work. Phase one primarily focuses on design, algorithm and program part of the system and in phase two the focus is on manufacturing and automating the whole system, including interface with MATLAB. This is a new technique in fixturing and applying these concepts into grippers are future tasks. The ultimate aim of this work is to implement the concept of image processing techniques into fixture for grasping the object's full characteristics.

1.1 Previous work

Saigopal et al., [1] addressed the problem of rapidly synthesizing a realistic fixture that would guarantee stability and immobility of a specified polyhedral work-part. The problem of automated fixture layout was approached in two distinct stages. First, they determined the spatial locations of clamping points on the work piece boundary using the principles of force and form closure, to ensure immobility of the fixtured part under external perturbation. When clamps were allowed to exert arbitrarily high reaction forces on the part, the spatial arrangement of the clamping locations ensured the part as a form of closure. On generating force/form closure configurations, the chosen locations were matched against a user-specified library of reconfigurable clamps to synthesize a valid fixture

layout comprising clamps that were accessible and collision free with each other and its parts. Senthil et al., [2] developed the design task relating to the development and implementation of an automated fixture-design system. Such automated fixture-design system required a combination of an intelligent feature recognizer, a sophisticated design system, a good knowledge-representation scheme, and sound interfacing of these modules. A CAD model was used as an input to the system. A feature recognizer was developed to recognize the machining features represented in the CAD model. Rule/object-based approach was used to group the machining features into appropriate fixture setups, and to recommend suitable clamping, locating and supporting points.

Bartholomew et al., [3] proposed the automatic layout of fixture models on a CAD/CAM system for given applications through an interactive process. The final fixtured simulation was graphically represented as solid models on the screen of a computer-aided design system. This focused on the fixturing of planar polyhedral work pieces for face-milling operations and predicted the feasibility of a generalized expert fixturing strategy on CAD systems. The software developed as a result of this research decreased fixturing costs by a substantial amount and successfully reduced fixturing down-time to a mere fraction. Gandhi et al., [4] proposed the automated design and robotic assembly of these modular fixturing systems based on the integration of state-of-the-art methodologies from several distinctly different disciplines. The complexity of this challenging frontier problem was discussed and the interdisciplinary nature of the solution philosophy was emphasized. Peng et al., [5] introduced a novel virtual reality-based system for an interactive modular fixture configuration design. They used a multi-view based modular fixture assembly model to assist information representation and management. In addition, the suggested strategy was compatible with the principles of virtual environment and it was easy to reutilize the element model. Based on geometric constraints, they proposed a precise 3D manipulation approach to improve intuitive interaction and accurate 3D positioning of fixture components in virtual space. Thus, the modular fixture configuration design task could precisely be performed in virtual space.

Fleischer et al., [6] developed required accuracies regarding the alignment of the joining partners, a new approach based on component-inherent markings. Different tests were conducted in order to validate this approach. The test results demonstrated that the approach was suitable for the spatial alignment of components. James et al., [7] mentioned that applying Design For Manufacturability (DFM) could reduce manufacturing costs and increase quality. The complete, hands-on DFM resource helped combine product design with better, simpler manufacturing operations, new materials, updated processes such as metal injection molding, laser machining, wire EDM machining, abrasive water jet machining, gas counter pressure, co injection molding, and many more. They described each DFM adapted process and the characteristics of the parts turned out, design and tolerance recommendations, and potential improvements to the bottom line. Yuguang et al., [8] presented a new approach to automated modular fixture planning. The approach identified all the location plan candidates of a work piece using linkage mechanism theory and excluded the unfeasible location plan candidates by evaluating their accessibility and fixturability. The algorithms for analyzing accessibility and fixturability and generating feasible clamp positions of a fixture plan were developed based on several new concepts including IRC triangle, locator visible cone, etc. The approach was capable of handling the work piece whose side clamping faces consisted of planar faces. Rong et al., [9] suggested that processes such as fixture and die design were often a necessary but time - consuming and expensive component of a production cycle. Coupling such attendant processes to product design via feature-based CAD could lead to more responsive and affordable product design and redesign. The context of on-going research in automating fixture configuration design presents a fundamental study of automated fixture planning with a focus on geometric analysis. The initial conditions for modular fixture assembly are established together, by analyzing geometric relationships between fixture components and the work piece.

Djordje et al., [10] proposed a system providing new fixture layout design on the basis of previously designed solutions. The case-based reasoning technique was used for this system development.

Additionally, the system provided optimization of fixture layout. Productivity, accuracy and production costs were used as criteria for optimization. It described basic steps of applied methodology, description of particular system segments and system implementation in the production industry. John et al., [11] developed a kinematic method to analyze the work holding condition by evaluating the "motion stops" corresponding to the reciprocal screw motions within a given fixture configuration. More significantly, the method could be used to compare the relative quality of two or more configurations, in terms of the overall kinematic constraint. Graphically based methods were then developed which could be used to synthesize a fixture layout configuration for a given 3-D work part geometric model. A CAD system was used to demonstrate the techniques for automated fixture layout planning, and the results of this work have been applied directly to a set of modular fixture elements for sheet metal work parts. Bryan et al., [12] indicated that the design and construction of fixtures were a major hindrance to the reconfigurability of flexible manufacturing systems. A promising method was to use a modular fixturing system. There remained, however, a considerable problem in the design of appropriate assemblies of such fixturing elements. Its input was geometrical description of the work piece, the machining envelope and the fixturing points. Its output was an automatically generated fixture design.

Isabelle et al., [13] presented a modular MATLAB tool, namely MOPHEO devoted to the study of particle morphology by Fourier analysis. A benchmark made of four sample images with different features was proposed to assess the abilities of the software. Attention was brought to the Weibull distribution introduced to enhance fine variations of particle morphology. Anders et al., [14] discussed that GPUs were in some cases crucial for enabling practical use of computationally demanding algorithms. The review condensed the past and present work on GPU accelerated medical image processing, and served as an overview and introduction to existing GPU implementations. The review covered GPU acceleration of basic image processing operations (filtering interpolation, histogram estimation and distance transforms), the most commonly used algorithms in

medical imaging and algorithms that were specific to individual modalities. Xiaoming et al.,[15] proposed a nose tip detection method that had the following three characteristics. First, no training and no reliance on any particular model were required. Second, it could deal with both frontal and non-frontal poses. Finally, it was quite fast, requiring only seconds to process an image of 100–200 pixels with a MATLAB implementation.

Santana et al., [16], proposed the design and implementation of an open loop DC motor speed control that was based on a micro-controller and on IGBTs. Trial and error designs were expensive and time consuming. This problem was solved by using simulation tools which could predict the dynamic behaviour of systems consisting of mechanic and electronic modules. The simulations provided in the paper showed a satisfactory agreement with laboratory measurements. Abdulrahman et al., [17], presented an overview of Proportional Integral control and Artificial Intelligent control algorithms. AI and PI controller were analyzed using MATLAB software. The DC motor is an attractive piece of equipment in many industrial applications requiring variable speed and load characteristics due to its ease of controllability. The main objective of the paper was to show that the speed of the DC motor could be controlled using different controllers. The simulation results demonstrated that the responses of DC motor with AI control which is Fuzzy Logic Control showed satisfactory well damped control performance.

Based on the above literature survey, an overall concept regarding the initial design and available fixtures in the market are obtained. Moreover, some artificial intelligence system or expert system is mentioned, leading to the invention of the new concept of M2F algorithm. The new co-ordinate detection techniques using image processing in MATLAB are revised for implementation in the design.

2. Proposed Methodology

The method to convert the concept into a working mechanism is described below. The concept is first converted into an algorithm, to become a program and this is implemented into a fabricated model. The whole process is mentioned below. The flow chart with

all stages is shown in Fig.1. After the literature survey an overall idea of the new concept of mobile modular fixture is obtained. The concept is derived from the automation of mechanisms and its application of robotics in mechanical field. Implementing an artificial intelligence system into a modular fixture with a new design is the overall objective of this work. From the beginning stage the total focus is on the CAD modeling of the proposed design, using design software.

The next step is the invention of a new algorithm with M2F for the development of a program to automate the system smoothly. To meet this requirement some pseudo codes are developed. To implement all these things one real time model is needed, for considering the manufacturing aspects and developing the necessary mechanism. The electronics with communication architecture is the main step for the automation of the mechanism. The last but not the least step is the image processing and interfacing of the microcontroller with MATLAB. After all these steps the system works with the input of the image, producing electrical signals as output to the motor.

The image processing is done with MATLAB; the theory behind it is the overlapping of images with same size. There are two images: one is the reference image and the other is the fixture image having the object. The reference image is the image of the fixture workspace with markings of all the 72 inclusive co-ordinate points. The second image is that of the fixture having the irregular object. Overlapping these two images will form a new image and from that co-ordinate can be easily found out. The images are captured using a wireless camera..After getting the image the user can actuate the programs according to the co-ordinate.

These actuations lead to the operation of the DC motors. The lead screws will mobilize and the clamp will reach the particular co-ordinate position which will lead to the fixing of the work piece. After machining operations on the work piece the whole system will move to the next station by the actuation of the wheel motors. Thus the user will get full control of the system.

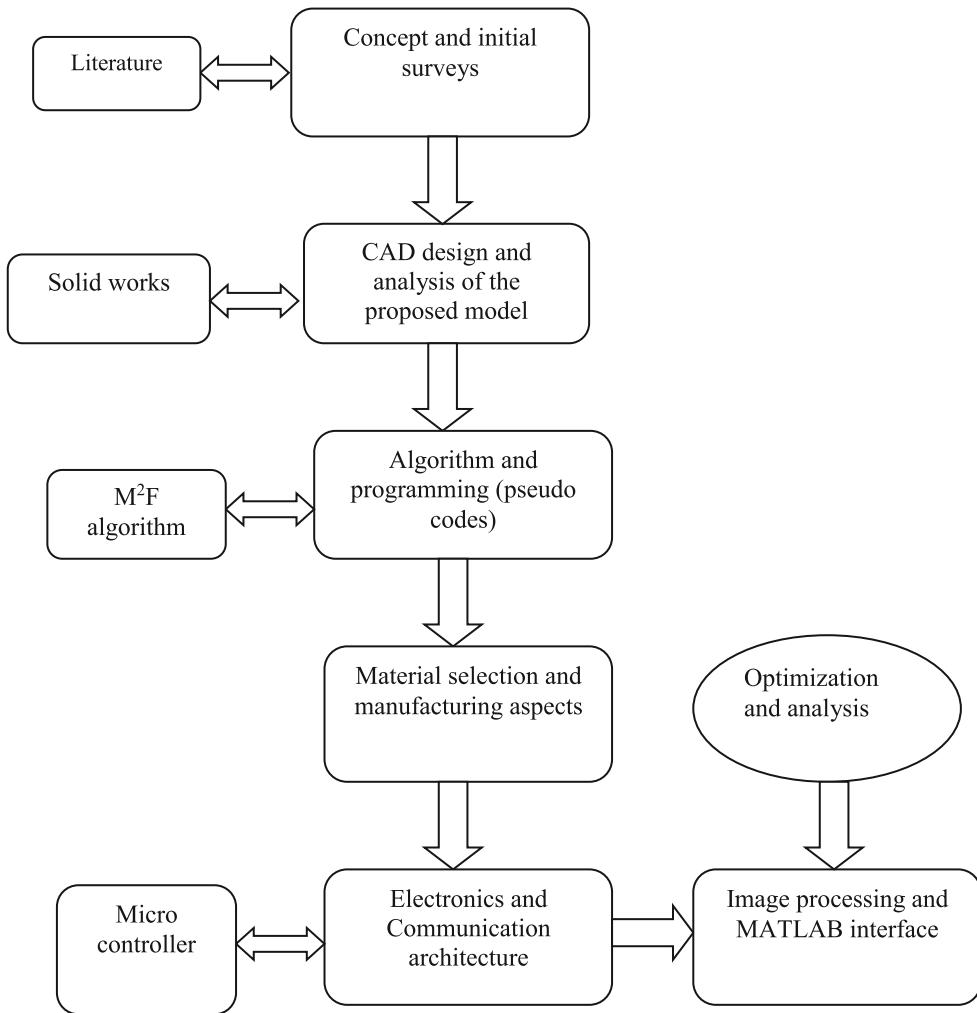


Fig.1. Flow chart for working principle of modular fixture

2.1. Modeling of Modular Fixture

Computer aided design modeling used to makeof the solid works software (SOLID WORKS 2013).

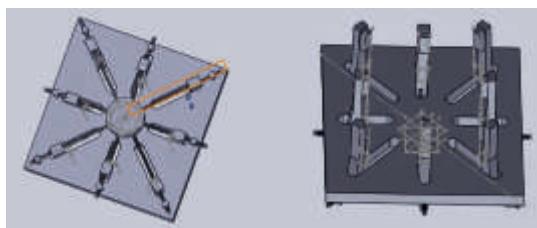


Fig.2 Plan views (left) and assembled view of Modular Fixture robot (right)

2.2 M2F Algorithm

This newly developed algorithm is used for the conversion of image into corresponding electrical pulses according to the object boundary co-ordinates to hold the work piece. In the modular fixture base one coordinate system is followed in the work volume, so any object placed in the center of the work volume will have boundary co-ordinate values. After that the steps detailed below are followed to grasp the object smoothly.

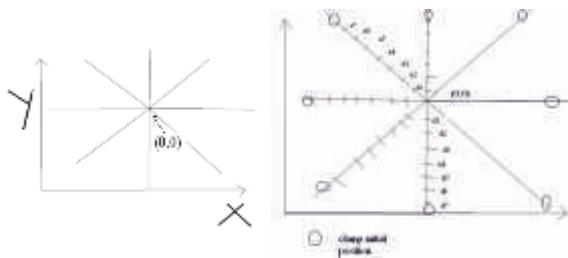


Fig.3 Work space and Coordinates of Fixture

Step 1:

From Fig.3, center point of the work space coordinate is marked as (0, 0) and the whole work space is divided into eight equal parts. The lines shown around the center is the center line of each clamp, where the coordinates are marked for different linear positions of the clamp. So in each and every position, one address or one co-ordinate value is there for each clamp.

Step 2:

Clamp 1; a1, a2, a3, a4, a5, a6, a7
 Clamp 2; b1, b2, b3, b4, b5, b6, b7

.....

Clamp 8; h1, h2, h3, h4, h5, h6, h7

Center axis of clamp is divided into 7 equal parts with equal spacing. For one clamp, seven possible positions are there, and are equally distributed. For example, for clamp 1: a1 to a7 are coordinate variations, so the system knows how much movement is needed to reach each address in the clamp. Similarly, 56 addresses are handled in the system, 7 for each clamp. These all are there within the work space.

Step 3:

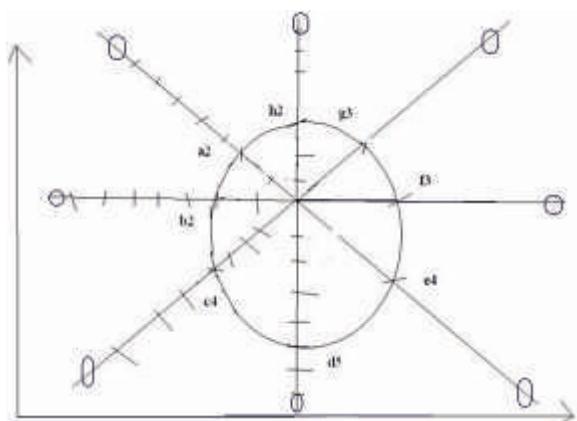


Fig.4 An object with fixture

Address of this object is: a2-b2-c4- d5-e4-f3-g3-h2

Consider the object with address a2-b2-c4- d5-e4-f3-g3-h2. After getting this address by image processing (edge co-ordinates), the signal will be received by the motors to reach the particular address of each and every clamp. (Ex. a2 to clamp 1, b2 to clamp 2 etc.). So, the system forms the shape of the object to hold it. Similarly, each and every object placed in the work volume has an address. These addresses are the input signal to the motor which simulates according to it. So any irregular shape with a defined size can be handled by using this algorithm.

Step 4:

Software is defined in fig.5.

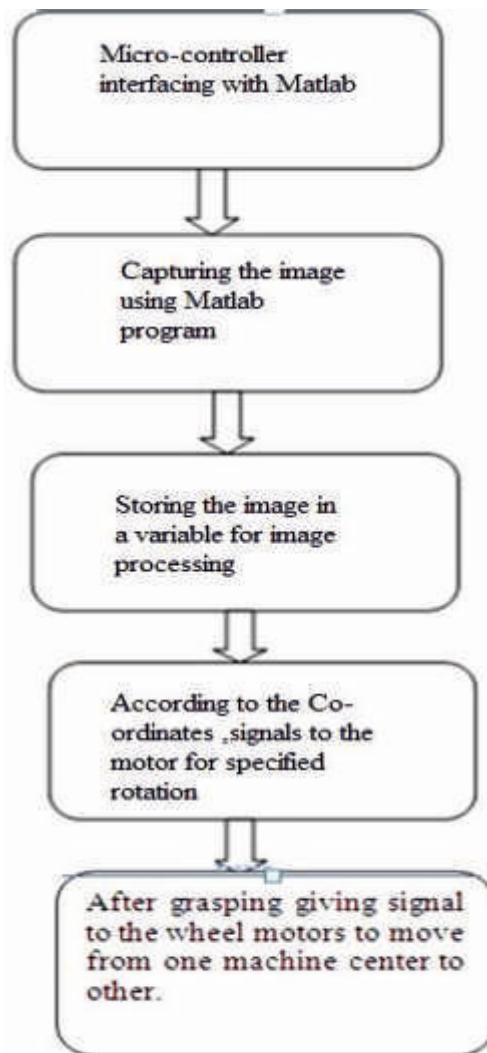


Fig.5 Programming steps of Image processing

Step 5:

After the execution of the program the clamps reach the particular coordinate position without much effort to work piece, and forms the shape of the particular object to simulate totally.

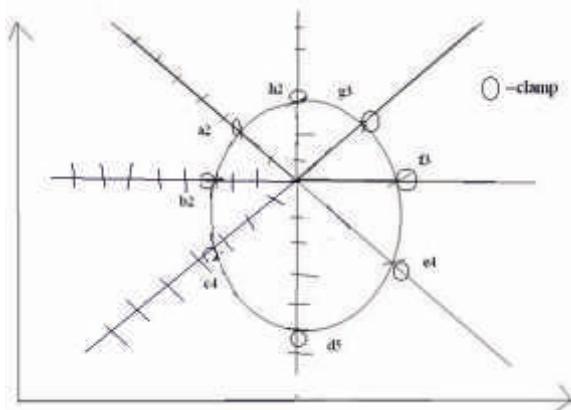


Fig.6 Grasping the circular object

Step 6:

After the machining process, the whole system moves from present machining center to the next machining center for the next process. For example, first process is drilling the work piece and then boring it, the process is continued till all the machining operations are completed. After completion of all machining the clamps loosen, alter and reach the initial position, and the process will start from the beginning. Locomotion is achieved by actuating the wheels by the motors.

2.3 Implementation of M²F Algorithm

It is actually a simple overlapping of images of the same size. To clarify, there are two images which are used, one is the reference image and the other is the fixture image, as shown in Fig.7 and Fig.8 respectively, with the object placed in the fixture. The reference image is the image of the fixture workspace with all markings, inclusive of 72 co-ordinate points. The second image is the image of the fixture having the work object. Overlapping these two images will form a new image and from that changes needed for the co-ordinate can be easily located by referring the deviation zoom in the new image, as shown in Fig 9.

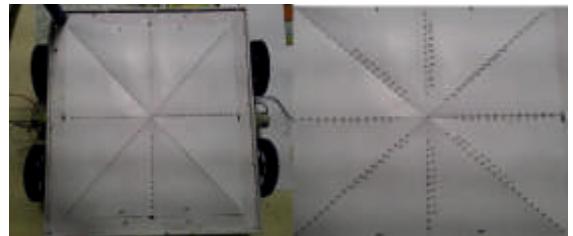


Fig.7 Real time Reference image (Left) and preprocessed real time image (Right)



Fig.8 Object placed in the fixture (Left) and preprocessed image (Right)

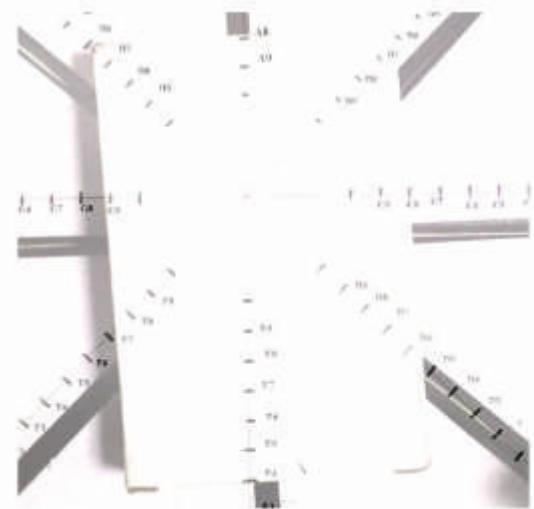


Fig.9 Matlab Output Overlapped image (zoom in object portion)

The result from the final image is A8-B7-C8-D5-E4-F7-G9-H6. It is the assumed address of the object and according to the object address the program can be executed.

2.4 Electronics and communication architecture:

The brain of the whole system is a micro controller which is controlled by programs. 4 DC motors

are used for the locomotion of the fixture and another 8 DC motors are used for the purpose of clamp movement. The electronics and communication has been explained in Fig.10.

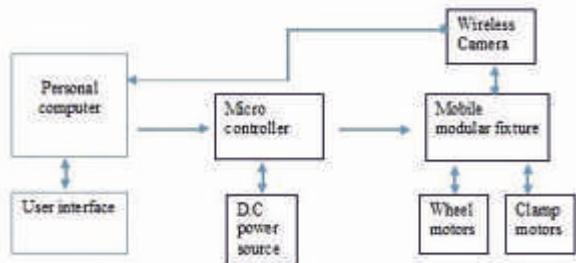


Fig.10 Electronics and communication architecture

3. Result and Discussions

The main force acts on the member of the assembled mobile modular fixture clamp; when it moves with the work piece load some force will be exerted. Here, taking the gripping force from calculation and the actual force exerted due to the lead screw movement as 2N based on the assumption analysis, d simulation is done in CAD software. Based on machinability data handbook the total clamping force is 350N. In this design eight clamps are used, so the clamping force for one clamp is 43.75N. The factor of safety is taken as one. Gripping force is taken as minimum of 30 and maximum as 100 N. Force produced due to the lead screw movement is assumed as 2N. Material selected is aluminium 1060 alloy. The address of the object is obtained as A6-B6-C6-D6-E6 F5-G5-H6.

3.1 Modeling of clamp fixture

The clamp is modeled using solid works software. As a part of analyzing the clamp arrest and the degrees of freedom the bottom portion of the clamp is fixed. Force is applied along the gripping position and lead screw attaching position. For better results different magnitudes of forces are applied as shown in Fig.11-12.



Fig.11 Modeling and meshing of Clamp

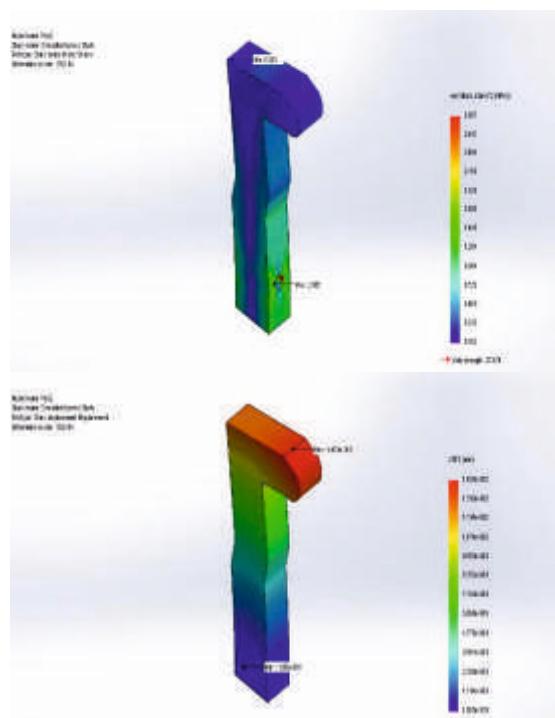


Fig.12 Stress and Displacement analysis of Clamp

From the analysis for applied 5N force, the minimum Von Mises stress acting at the node 9632 is get as 0.001694 N/mm² and corresponding maximum in the node 9632 is a magnitude of 2.88732N/mm². The minimum displacement occurred at the node 108 and maximum displacement occurred at a magnitude of 0.0143256 mm in node 380.

3.2 Deformation analysis of clamp

The analysis is carried out from 30- 100 N with 10 N intervals and the clamp bottom is fixed. The results are tabulated in Table.1.

Table.1 Displacement obtained for different forces

Sl.No.	Force (N)	Displacement (mm)
1	30	0.0107442
2	40	0.0143256
3	50	0.0179069
4	60	0.0214883
5	70	0.0250697
6	80	0.0286511
7	90	0.0322324
8	100	0.0358138

In diagram below, force should start with capital F.

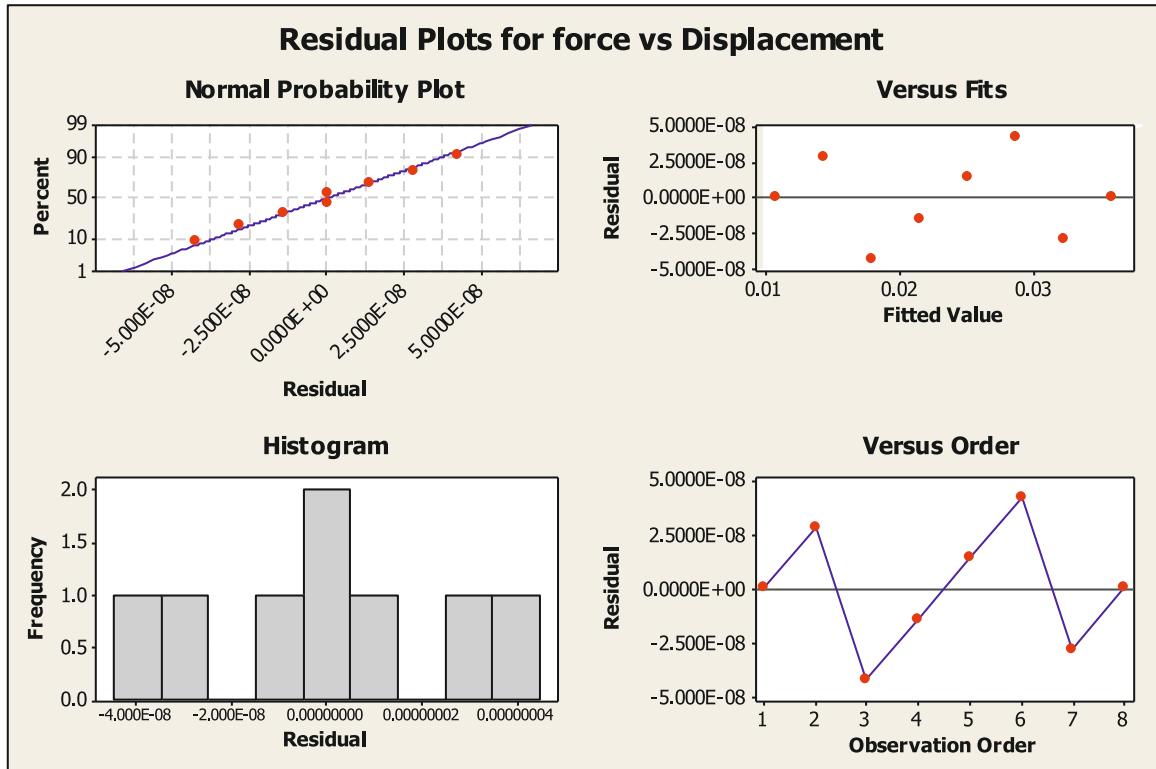


Fig.13 Residual plot of Fixture Clamping force

The clamp is studied, analyzed and simulated using CAD software. Due to the application of the force some deformation occurs. More stress acts along the leadscrew position of the clamp. Mesh analysis gives accurate results. Manual calculation shows that the gripping force for the particular operation is 43.75N. The minimum deformation occurred at 30N and the maximum deformation occurred at 100N. The least Von Mises stress acting to the clamp is 0.0016941 N/mm² (MPa) and the maximum at the lead screw position with a magnitude of 2.88732 N/mm² (MPa). Factor of safety is the main consideration of the design of a robot. The obtained graph is a straight line. Fig.13 depicts the residual plot of fixture clamping force. Here, the normal probability graph is also obtained as a straight line.

The first task in image processing is the edge detection of the work piece; one image is analyzed with a program to find out coordinate of the objects, as shown in Fig 9. After getting the co-ordinate values, it is possible to convert them into corresponding addresses. The image processing is done in MATLAB - the theory

behind it is the overlapping of images of the same size. To clarify, there are two images: one is the reference image and the other is the fixture image having the object placed. The reference image is the image of the fixture workspace with markings of all the co-ordinates, including 56 co-ordinate points. The second image is the image of the fixture having the irregular object. Overlapping these two images will form a new image and from that image co-ordinates can be easily quantified. The images are captured using a wireless camera. After getting the image the user can actuate the programs according to the co-ordinate. The image mentioned here is only for reference purpose, the programming is still in the developing stage.

3.3 Regression Analysis of Modular Fixture Robot

The adequacies of the modular fixture robot motion models are checked by using the Analysis of Variance (ANOVA) technique. ANOVA analyses for Robot motion results are presented in Table 2. The p-value of models is 0.000, indicates that the models are

significant. In the same manner the main effect of each delay in seconds is a relevant factor. A large FAo (1162114.95) value indicates that the particular parameter is significant, that it affects the process output of robot motion.

$$\text{Modular fixture Forward motion} = 0578 + 5.5 \text{ delay(s)} \quad (1)$$

$$\text{Modular fixture Reverse motion} = 101 - 5.64 \text{ delay(s)} \quad (2)$$

Table. 2 ANOVA for Mobile modular fixture forward motion analysis

Machining parameters	Degree of Freedom (f)	Sum (space?) of Squares (SSA)	Variance (VA)	FAo	P	Contribution (%)
Delay (Sec)	1	9979.7	9979.7	1162114.95	0.000	99.90
Error	8	0.1	0.0			0.10
Total	9	9979.8				100

Additionally, the developed regression models for fixture motion have been checked by using residual analysis. The residual plots for the response parameters of delay are shown in Fig. 14 (a-d). In normal probability plots, the data are spread approximately in a straight line, which indicates a good correlation between experimental and predicted values. The responses shown in Fig. 14(a). Fig. 14(b) indicates the residual versus predicted values, which shows only a minimal

variation between observed and fitted values. The statistics about the residuals are shown in histogram plots in Fig. 14(c). Fig. 14(d) shows the residuals calculated against the order of experimentation. It asserts a tendency to have runs of positive and negative residuals confirming the existence of certain correlation which is a whole analysis of residual plots for both responses of distance Vs delay but the models do not reveal inadequacy.

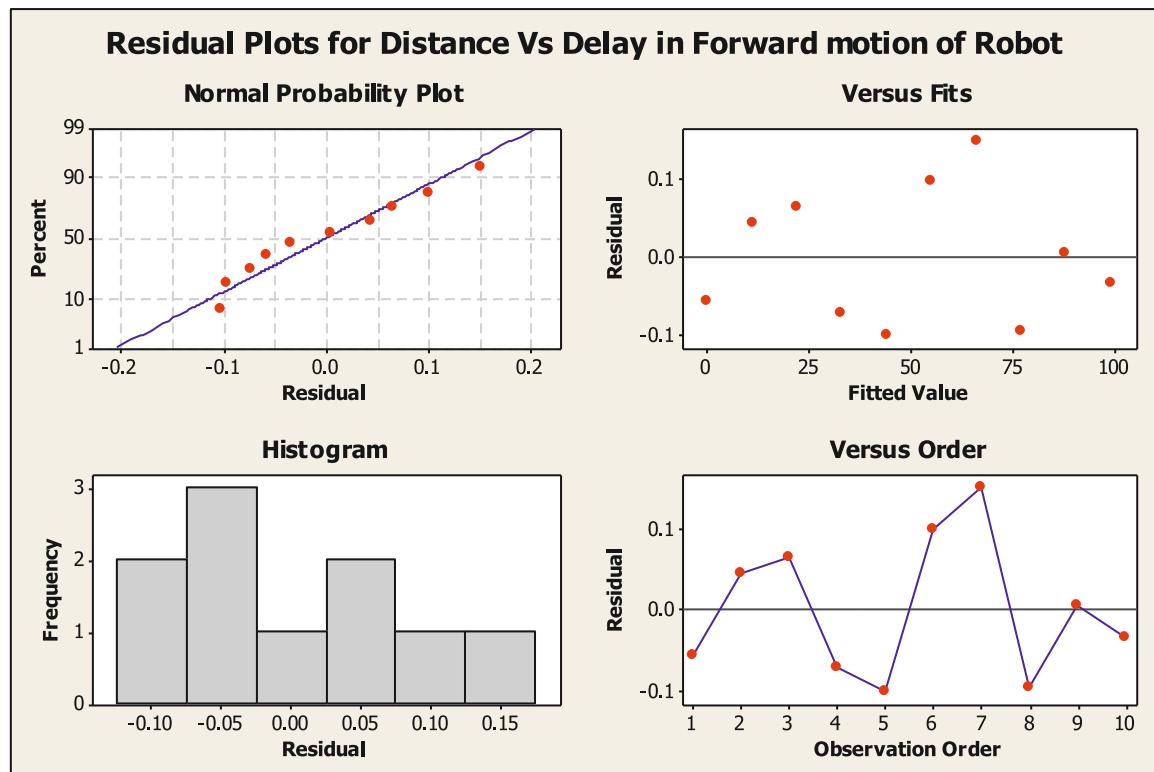


Fig.14 Plot of residuals for response of forward motion of fixture (a. Normal probability plot of the residuals, b. Residuals versus the fitted values, c. Histogram of the residuals, and d. Residuals versus the order of the data).

Table.3 Comparison of regression model with experimental measurements for Modular fixture robot motion

Exp. No.	Modular fixture Robot motion		
	Experimental Forward Motion	Predicted Model motion	Error (%)
1	11.10	11.06	0.38
2	22.12	22.05	0.28
3	32.98	33.07	0.24
4	43.95	44.06	0.25
5	55.15	55.08	0.17
6	66.20	66.05	0.21
7	76.95	77.07	0.14
8	88.05	88.05	0.01
9	99.01	99.05	0.05
		Mean	0.04

Table.3 shows that the maximum test error for forward motion using regression model is 0.38 %. From the results, it is seen that error of measurement that occurred in fixture motion is well controlled using optimum experimental values.

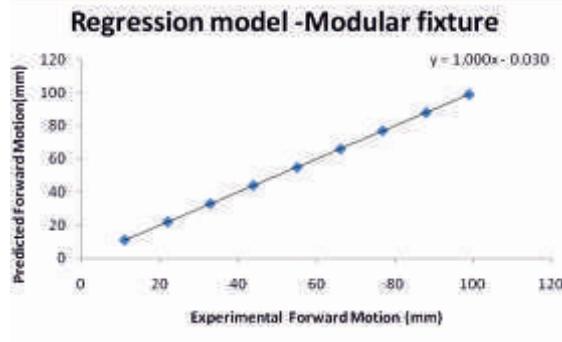


Fig.15 Error analysis of Regression model with experimental values

Fig.15 shows the error analysis of regression model mobile modular fixture with experimental values. The R2 value of robot motion is 1.00. The high R2 indicates that the better model fits the data very well, using delay signals to forward motion of fixture to clamp accurately.

3.3 Simulink model of Fixture clamp DC motor

In order to study the dynamic behavior of the

clamp motor, a virtual environment is needed. A block diagram, as shown in Fig.16 is the working principle of DC motor. So the best alternative for the same is Simulink in MATLAB. Simulink model of Modular Fixture Clamp motor is shown in Fig.17.

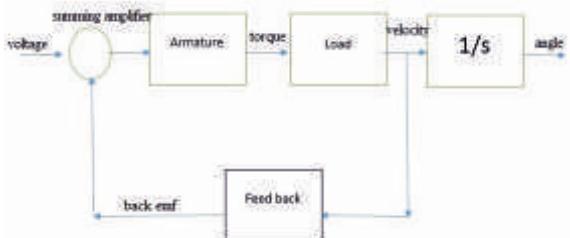


Fig. 16 A block diagram of the working of DC motor

The torque of the motor is calculated based on the following Equ. 3, 4.

$$K_t = \frac{\text{Torque}}{\text{load}} \text{ Nm/A} \quad (3)$$

$$K_b = \left(\frac{\text{Voltage}}{\text{velocity}} \right) \frac{\text{volt}}{\text{rad.s}} \quad (4)$$

Inductance (L) is 0.2 Henrys and Resistance is 1 ohm and the moment of inertia is 0.005 Kgm2. The calculated torque constant for DC motor is 0.6537 Nm/A and the voltage constant used is 0.445 V rad/sec. The gain of the Ro amplifier is taken as -1.

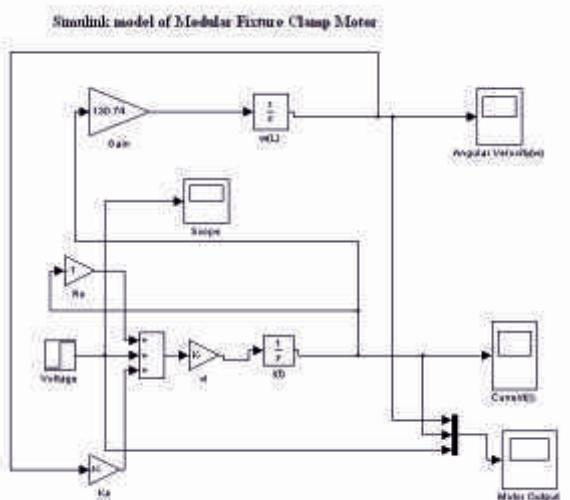


Fig.17 Simulink model of clamp motor

In this simulink model the main components are voltage supply, gain amplifiers, integrators and the

output scopes. A multiplier is used to increase the signal to different amplifiers. The gain of the first amplifier is calculated by taking the ratio of Equ. (3) to the M value and the figure obtained is 130.74. Similarly, from Fig.18 the gain of v1 amplifier is calculated by taking the ratio of Equ.(4) to L. The gain of the Ro amplifier is taken as -1.

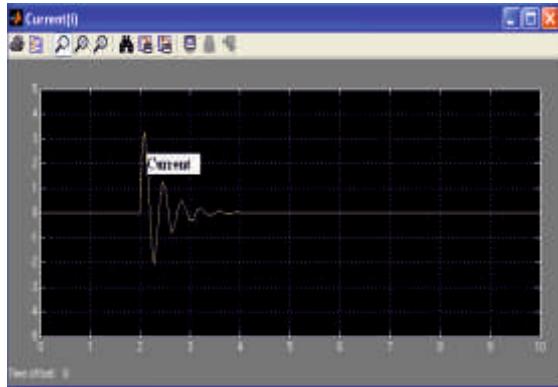


Fig.18 Simulink output obtained of current parameter

Fig.18 shows the relationship of current with time. At the starting time the amplitude is very high; when time increases the amplitude reduces and reaches a stable constant line. This implies that at the starting time the current will be very high.

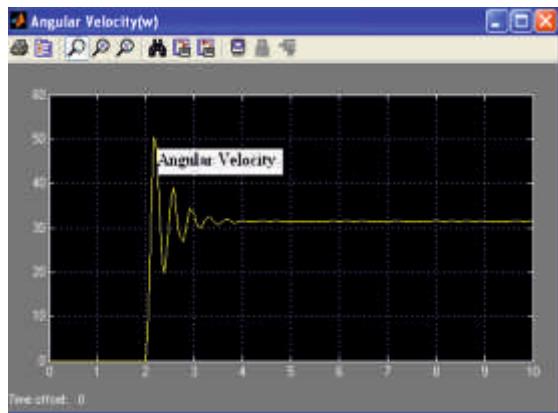


Fig.19 Simulink output obtained of angular velocity parameter

Fig.19 depicts the relationship of angular velocity with time. Here the velocity is increased from zero and it reaches the highest peak initially. After that it reduces to a particular limit and stays constant.

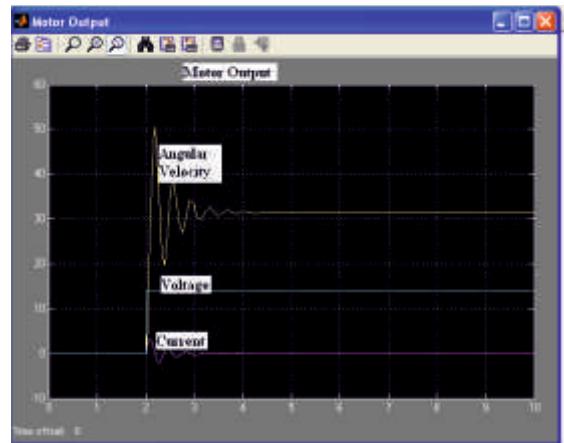


Fig.20 Simulink output of the motor

Fig.20 represents the motor output with all variables like angular velocity, voltage, current vs time. After some time the whole system stabilises . So it is clear that at the starting the amplitude is at peak and then reaches a constant value.

3.4 Real time model of M2F robot

To apply the algorithm a real time model is developed. Material selection is the primary stage of manufacturing of an object. In M2F robots the material is selected according to the function of each part. Description of each component is detailed in Fig.21 with image of the assembled view of the fixture and Fig.22 shows the image of the fixture with an object fixed.

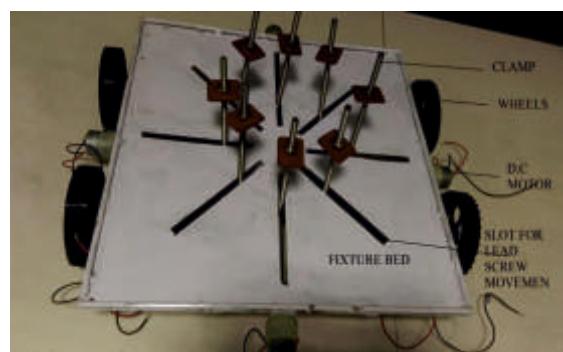
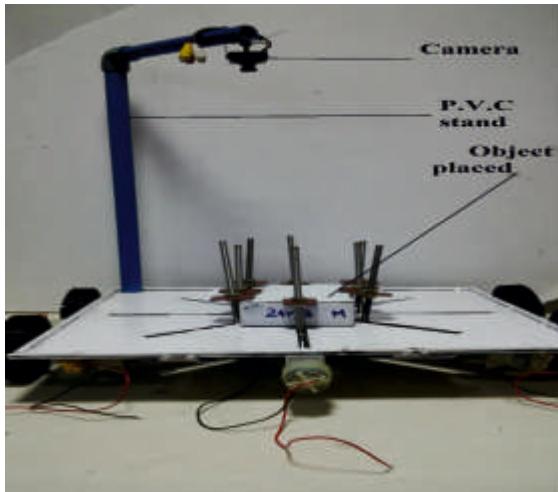


Fig.21 Assembled view of M2F robot

The materials used are Galvanized Iron and Stainless Steel. The M2F robot parts are Fixture bed, Clamp and Lead screw, Wheels and Camera stand.



The fixture bed is the base part of the fixture so it should have capacity for carrying the object which is going to be placed in it. G.I sheet with gauge 16 is used for the manufacturing of the bed. The clamp is made in such a way that it should move inside the slots in the fixture. At the time of rotation of the motor the clamp should move inside the slot both forward and backward according to the function. To achieve this task the clamp is made of a special design with lead screw and the material used for manufacturing the clamp is stainless steel. To achieve the fixture's mobility task wheels are necessary. Here, the fixture has four Omni directional wheels and four castor wheels. The castor wheels are powered by DC motors. The camera in the fixture is attached with a stand. The specialty of the stand is that its height is adjustable according to the camera focus and it is made in such a way that the camera should cover the top of the fixture bed.

4. Conclusions

The M2F (Mobile Modular Fixture) algorithm has been developed for the automation of the fixture with the help of image processing technique using MATLAB platform.

1. The final fixtured simulation is graphically represented as solid models on the screen of a Computer-Aided Design (CAD) system. By simulated CAD software results the clamps movement due to application of forces are visualized.
2. In calculation the obtained gripping force for the particular operation is 43.75N. The minimum deformation occurred at 30N and the maximum deformation occurred at 100N.

The least Von Mises Stress acting at the bottom of the clamp is 0.0016941 N/mm²(MPa) and the maximum at the top position is a magnitude of 2.88732 N/mm² (MPa).

3. The analysis of the final result plotted as a graph of deformation and force shows they are directly proportional, as a straight line. Locomotion capability reduces the cycle time and increases the machining capability. User friendly and smooth operation leads to a good multi-tasking expert system.
4. A real time model is developed for the purpose of implementing the algorithm. The address of the object is obtained as A6-B6-C6-D6-E6-F5-G5-H6 (one irregular object used for study).The gripping force of the clamp is equal to the torque of the motor.
5. The motion of mobile modular fixture for DC motor forward motion simulation is optimized using MATLAB Simulink analysis. A full plot of motor speed in rpm versus the armature voltage at a given load level is obtained.

REFERENCES

- [1] Saigopal Nelaturi, Arvind Rangarajan, Christian Fritz, Tolga Kurtoglu.: Automated fixture configuration for rapid manufacturing planning. J.Computer Aided Design.46, 160-169(2014).
- [2] Senthil Kumar.A, Nee.A.Y.C, Prombanpong,S: Expert fixture-design system for an automated manufacturing environment. J.Computer Aided Design.26, 316-326(1992).
- [3] Bartholomew, Nnaji, Saqm Alladin: E-CAFFS: An Expert computer-aided flexible fixturing system. J. Computers rod. Engrn.18, 297-311(1990).
- [4] Gandhi.M.V, Thompson.B.S: Automated Design of Modular Fixtures for Flexible Manufacturing Systems. J. Manufacturing Systems.5, 243-252(1998).
- [5] Peng Gaoliang, Wang Gongdong, Liu Wenjiana, Yu Haiquan: A desktop virtual reality-based interactive modular fixture configuration design system. J. Computer-Aided Design.42, 432-444, (2010).

- [6] Fleischer.J, Lanza.G, Otter.M, Elser.J: Spatial alignment of joining partners without fixtures, based on component-inherent markings. *J. Manufacturing Systems.*32, 489-497(2013).
- [7] James,Asada, H, B: Kinematic analysis of work part fixturing for flexible assembly with automatically reconfigurable fixtures. *IEEE Trans Robot Automat.*2, 86–94, (1996).
- [8] Yuguang Wu, Shuming Gaoa, Zichen Chenc: Automated modular fixture planning based on linkage mechanism theory. *J. Robotics and Computer-Integrated Manufacturing.*24, 38-49 (2008).
- [9] Wu,Y, Rong,Y, Ma,W, LeClair,S.R: Automated modular fixture planning Geometric analysis. *J. Robotics and Computer-Integrated Manufacturing.* 14, 1-15(1998).
- [10] Djordje Vukelić, Branko Tadić, Janko Hodolič, Peter Križan, Nenad Simeunović:
Development of an Intelligent System for Fixture Design Using Case-Based Reasoning (CBR) Technique.*J. Computing & Information Science in Engineering.*5, 8-11(2006).
- [11] John.J.Bausch, Kamal Youcef-Toumi: : Kinematic Methods for Automated Fixture Reconfiguration Planning. *IEEE.*1396-1401(1990).
- [12] Bryan Ngoi Kok Ann: Computer aided design of modular fixture assembly. *Mechanical Engineering* at the University of Canterbury. (1990).
- [13] Isabelle Mazon, Wallack. A.S, Canny. J.F: Planning for modular and hybrid fixture. *Algorithmica.*19, 40-60(1999).
- [14] Anders Eklund, Paul Dufort, Daniel Forsberg, Stephen.M, LaConte: Medical image processing on the GPU – Past, present and future. *J. Medical Image Analysis.* 17,1073-1094(2013).
- [15] Xiaoming, Peters. R.R: Automatic design of 3-D fixtures and assembly pallets. *IEEE.*1,45-50(2002).
- [16] Santana.J, Naredo.J.L, Sandoval.F, Grout. I, Argueta, O.J:Simulation and construction of a speed control for a DC series motor. *Mechatronics.* 1145-1156(2002).
17. Abdulrahman A.A Emhemed, Rosbi Bin Mamat : Modeling and Simulation for Industrial DC Motor using Intelligent Control. *Procedia Engineering.* 41, 420 – 425(2012).

FROM REACTIVE LEARNERS TO PROACTIVE LEARNERS: PROJECT BASED LIFE SKILL EDUCATION

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Abstract: Today's life and work environments have become complex. The 21st generation students need 21st century skills. The ability to think critically and solve problems is an important part of what students need to learn in order to be successful in life. For this the confidence to make a decision is needed. Vocabulary.com explains if you are proactive, you make things happen, instead of waiting for them to happen to you. Our experience at Amrita Vishwa Vidyapeetham is that majority of our students were reactive learners. They lacked the confidence in interviews and their resumes did not have substantial content in terms of experience.

The modern education system which limits creative and critical thinking and the sheltered living are some of the reasons for this. The other factor is that they are not inquisitive enough to search for answers themselves. This made us to switch over to Project Based Learning as Pedagogy while delivering Life Skills.

It made the students work on their own, seek answers rather than ask for answers. Thus become proactive learners. The success could be seen in the university placement statistics for eligible candidates, which has consistently been around 99% for the past six years. This paper looks into various Life Skills programmes based on Project Based Learning (PBL) developed by Amrita Vishwa Vidyapeetham over a decade. This is based on frequent need analysis and is customised to include every student at Amrita.

Keywords: Proactive, Curiosity, Employability, Pedagogy, Project Based Learning

INTRODUCTION

India churns out tens of thousands of graduates each year but less than half of them are "employable" or possess the basic skills necessary for any industry role, says a report. This makes us wonder what is it that the industry is looking for. 'Lack of Leadership Skills Leaving Indian Youth Jobless' says another report.

It is found that today's graduates severely lack skills like problem solving, decision making, and prioritizing tasks. This is because everything has been chalked out for them. Even the most important decisions on important aspects like their career or their life partner are taken by their parents. They are more or less like robots, carrying out instructions. A partner at a US consulting firm in India once told me that he had a problem with their Indian recruits. They were exceptionally bright but they had a missing dimension. "Beyond studies and work, they have no other interests to offer," he said

Focussed on training and placements, Corporate and Industry Relations (CIR) at Amrita University is a

department with the motive "to facilitate holistic career development of students through comprehensive and systematic training on Life Skills. It also tries to build competence in core areas through innovative practical applications". CIR draws inspiration from Mata Amritanandamayi Devi (Amma), the Chancellor of the university who says that there are two kinds of education: education for life and education for livelihood. The most important aspect is education for life. But at the same time Amma also stresses on education for living. It is Her wish to bring the two together, creating professionals in all fields with the skills, the mental strength and the heart to uplift the world.

Before 2009, every week during the semester three hours was dedicated to train the students in skills which included training in resume-building, group discussion, interviews, verbal aptitude and quantitative aptitude. They were also given some motivational talks.

It was noted that this model had more disadvantages than advantages. Some of the major concerns were:

- a. The university was not able to attract tier-1 companies or core companies which would be the dream job for majority of the students.
- b. The number of students who bagged an offer in the first chance itself was very low.
- c. Rate of rejection was high during interviews.
- d. Students were rated low in confidence level and communication skills by the companies.

All this made us to change the way we deliver our Life Skills classes. This paper narrates the journey of the Department of Corporate and Industry Relations (CIR) at Amrita University in our endeavour to fulfil the vision of Amma. The university has come up with a well-structured Life Skills programme based on PBL that helps in moulding a student into a successful engineer.

2.0 What is Project Based Learning?

It was John Dewey who coined the concept of Project-Based Learning. Most of the schools and colleges have implemented Project-Based Learning as an important medium of pedagogy. Students have to come out of their comfort zones and face real world problems. Through projects they see challenges that they have to face in the real and professional world. They learn by doing; capturing real-world problem which provokes critical thinking and development of real-life skills. It not just benefits students but also teachers; they get new roles as facilitators, frame meaningful tasks and questions and carefully assessed what students have learned through these experiences.

Today's students need to see and understand the relevance, reality, and authenticity of concepts both in the classroom and in the real world. One unique teaching method that is proving to be effective in the classroom is Project-Based Learning (PBL).

Well-designed projects encourage active inquiry and higher-level thinking (Thomas, 1998).

The focus of project based learning lesson plans becomes much more on 'student learning' as opposed to the 'teacher teaching'. In this manner, students are encouraged to become not just reactive learners, but rather critical thinkers, in other words proactive learners, who are highly capable of solving real-life problems that they are likely to encounter as they grow and mature into adults.

The students are encouraged to facilitate a constructive investigation of the situation in which they are fully engaged. The focus is on the student's taking the initiative, rather than simply being directed by their teacher. Students learn from their mistakes, they are encouraged to make the necessary corrections and effectively solve the problem at hand.

By bringing real-life context and technology to the curriculum through a PBL approach, students are encouraged to become independent workers, critical thinkers and lifelong learners. They can communicate with administrators, management, and exchange ideas with subject-area experts, while breaking down invisible barriers such as fear of embarking on an unfamiliar process, and lack of assurances of success.

PBL is a way of working together. The students learn to take responsibility for their own learning, they form the basis for the way they will work with others in their adult lives.

We at Amrita ensure that the students go through three major non-technical, Life Skill based projects during their B Tech programme.

Amrita Serve Rural Internship

'Become a Contributor' Programme

Student Social Responsibility Projects (SSR)

3.0 Amrita Serve Rural Internship

It was Mata Amritanandamayi Devi's (Amma's) humble suggestion that students should spend time in villages, as part of the university curricula. The students should be provided with the opportunity to observe the lives of the people who live there— their struggles and hardships. Students should interact with them and listen to their problems. This will provide them with insight into aspects of life that otherwise would remain concealed to them. In turn, when our students attain the success and positions of power they seek, the experiences they gained in these agricultural communities will remain with them and impact the decisions and policies they put into action.

Mata Amritanandamayi Devi's Amrita SeRVe 101 Village Adoption Project is a unique and one-of-a-kind rural internship organized in Amrita University. Students, accompanied by faculty members and mentors, spend a period of 2 weeks living among the villagers and closely interacting with them. Students interact with youth groups in most villages. They

experience the spirit of self-reliance already prevalent in the villages. They see villagers making many things they use including beds, hand fans and ropes.

They pitch in to help make a rain water harvesting pit in Uttarakhand and a smokeless chulha in Uttar Pradesh. They initiated a clean-up drive in Odisha. Students conducted classes for small children. In some of the tuition centres started by the ashram, they introduced tablet-based learning. When word got around, the number of children in the classes began to swell. In some places, student teams were invited to village schools and anganwadi centres to conduct interactive sessions. Wherever possible, students conducted essay writing and painting competitions. They organized camps for not only children, but also their parents. Adult literacy was initiated in some places. An effort was made to identify special talents in the children and encourage them. Last year eighty eight students and twenty faculty had participated in this.

This time three hundred students have registered for this internship out of which two hundred and two students are first timers.

For many of the students it was an eye opener. They had not known the other side of life. They were not aware that one could live happily without luxuries. At the same time they were appalled by the lack of basic amenities. Some of the students did not have a decent place to stay. Yet they all want to go back to help solve problems related to water, sanitation, health and malnutrition. They even want to combat evils such as the use of tobacco and gutka prevalent even among youngsters in these villages.

How does this affect employability? It is not easy to venture into an unknown village and try to solve their problems. It requires a lot of planning, meeting people, talking to officials who may be corrupt, and dealing with bureaucrats. If a student is able to do all these things, it is natural that the student will become confident. Moreover he or she gets to know how the world outside functions.

Naturally their whole attitude towards the interview process changes. They become better employable and better employees. India will not be plagued by corrupt employees.

4. Become a Contributor Programme

Become a Contributor programme designed by 'i-become' is delivered to second year undergraduate

students. This programme uses a blend of scholastic approach and Project Based Learning approach. The aim of the course is to create more number of contributors than performers in the student community, who could productively contribute towards self, organisation, family and to the society at large.

Dealing with such sessions is tricky as today's generation does not like being lectured to on values, morals and responsibilities in life. We also have a dearth of role models who live the talk to take such sessions.

Students are taken through career role models, real life scenarios, ideas for life and work place best practices through a lot of dialogues and debates in class. In addition they are to research on known and unknown role models in and around their society and make short videos, posters and write ups on them. These are then presented to the class. Students also go out and interview contributors in the society and learn from them the challenges and benefits of being a contributor.

The programme is very lively and here the students take up the whole learning process on themselves by examining the society around them, the choices one makes in his/her personal and professional life and also by examining in details the pros and cons of being a contributor. This session could have been tricky had it been a lecture session as nobody likes being lectured to on morals and responsibilities. Here morals and responsibilities are not pushed on to them but they make a choice to accept them and make it a part of their lives by choice. This is what makes the programme a success.

Through this programme students learned decision making and how to make the right choices in their professional as well as personal life. They learn from the contributors how to lead a purpose driven life by avoiding distractions, staying focussed and having delayed gratification.

5. Student Social Responsibility Projects (SSR)

Since 2009, CIR has been offering a unique program titled Student Social Responsibility (SSR) projects to third year students to bring about in them better awareness of social issues. Many premier educational institutions, globally, are adopting this model to connect student communities with their immediate society.

What is it that makes a 'student life' complete? Is it just the knowledge that they imbibe within the four

walls of the classroom? Or is it the living experience that they gain by taking up challenging projects?

'Student Social Responsibility Project' is a challenging course offered by the Corporate and Industry Relations Department. Through this course, students at Amrita University learn to plan, develop, coordinate and execute projects that inculcate in them a sense of social responsibility. The students get an opportunity to become sensitized to the living conditions of the less fortunate in our society, learn to create and participate in activities for the common good such as Tribal welfare, Waste to Wealth Composting, Energy Conservation, Awareness Campaigns, Organic Farming, Medical Camps, Water Management, Sustainability Projects, Women Empowerment, Workshop for School Children, all grooming them to become better human beings. The students get into the practice of doing service - for example - students, who are interacting with the underprivileged children, cancer patients and inmates of old age homes, start thinking of how to and help them.

Today, SSR projects have gained increasing acceptance among students and is an integral part of the Life Skills training program in our campus. This program is contributing immensely to confidence building, developing leadership and organizing skills, becoming better team players, among several other reported benefits by students. In fact, graduate students give regular feedback that SSR projects have helped them to secure better placements and admissions for higher studies in good management institutes.

Through this programme students learn team dynamics. They work in teams and learn from each other. The collaborative work empowers the students by enabling them to take better decisions, think creatively and also to make effective use of resources. Students learn professional skills by learning to write official letters, mastering email etiquettes and formalities by working with various institutions and officials during this course.

There were many scenarios where in a team some students were inactive in the beginning of the projects but when exposed to challenges, demonstrated their latent leadership qualities and guided their teams towards better performance. Unlike regular classroom training sessions, SSR is different because it gives hands on experience with real time trouble shooting.

The aim of the SSR project is multifarious; students not only research on the topic of their concern but also explore the hidden potential in them. Working in teams, materializing one's innovative ideas, making optimum use of resources and troubleshooting on-the-spot problems are some of the essential life skills that students are equipped with, when their project sees the light of day.

This is just a small window that showcases the zest and vigour of students to commit. Thus the student community has benefitted by making utmost use of the opportunity provided to them.

Some of the best projects revolved around themes like tribal empowerment, pollution control, career guidance in schools, disaster management, agricultural study in villages, awareness on organ donation, drug abuse, join the services campaign, importance of temples in south India, self-defence, self-employment for women- Kudumbasree unit, traffic and e-waste awareness in schools, teaching programming in schools, importance of elders at home , camp in autistic school, AIDS awareness and blood donation camp, Sadgamaya cultural camp in schools, right to vote awareness etc.

To recognize and acknowledge the work done by students who participated in this programme, an 'SSR Awards Day' is being organized every year in the month of March in our campus. On this occasion, students get a unique opportunity to deliver a presentation of their work and certificates are distributed to all those who have successfully completed the projects.

6. Benefits for Students

The benefits for students from Project Based Learning are multi-pronged. They get inspired to gain a deeper appreciation for the subject they are working on, and develop an interest in gaining an enhanced knowledge of the subject by studying about the topic in depth. As they have gone through the experience, they can apply their learning experiences to solve future problems in adult hood.

Students who are participating in the Project Based Learning often develop a greater ability to organize and research all areas that they are enrolled in. Most of the time the group size is small so they are able to develop their communication skills and effectively listen and pass information along to the group. This is a

skill that is essential as an adult in the real world.

The project based learning has inculcated on our students the following 21st century skills:

- a. Being sensitised towards societal development needs
- b. Cross cultural and inter personal communication
- c. Identifying problems and finding feasible solutions
- d. proactive learners
- e. responsible citizens
- f. inquisitiveness and risk takers
- g. Team leaders

7. Conclusion

Being conformist is considered to be a virtue, being different is vice. In India, obedience to accepted ideas and authority is rewarded. How can anyone possibly bring forth something new if young people are not encouraged to question anything? This has led to a shortage of risk takers. So the PBL method will revolutionize the way the students behave. This will bring a whole attitudinal shift in the thinking of the next generation, the future of our country.

India will have a relatively large working-age population (aged between 15 and 59 years) over the next few decades. This 'youth bulge' will reach its peak in the year 2035. Analysts consider this period of a 'youth bulge' to be a boom, during which the abundance of human capital can be used as an impetus to the growth of the country. We need to utilize this opportunity. It is our duty towards the nation that we produce capable citizens for future.

Government of India is doing its bit by introducing various schemes like Make in India, Skilling India etc. The success of these initiatives will be evaluated by the level of employment they generate.

The University has been successful in placing more than 99 % of eligible students consecutively for the past six year. The recruiters have mentioned about the confidence with which students answer behavioural interview questions. They were also happy about the quality of projects mentioned in the resume.

These are indicators that show that project based learning is the right pedagogy to shift reactive learners to proactive learners.

ACKNOWLEDGEMENT

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REFERENCES

1. http://archive.indianexpress.com/news/firs_t-ever-employability-audit-almost-half-of-indian-graduates-unemployable/1133141/
2. http://www.newindianexpress.com/states/andhra_pradesh/Lack-of-Leadership-Skills-Leaving-Indian-Youth-Jobless/2014/08/22/article2392477.ece
3. <http://edtechreview.in/trends-insights/insights/1645-teaching-real-life-skills-through-a-project-based-learning-pbl-model> <http://edtechreview.in/trends-insights/insights/1645-teaching-real-life-skills-through-a-project-based-learning-pbl-model> <https://www.researchgate.net/publication/>
4. [202303814_Impact_of_Project_Based_Learning_on_Recruitment_of_Engineering_Students](http://www.edutopia.org/project-based-learning-on_recruitment_of_engineering_students) [accessed May 30, 2016]. <http://www.edutopia.org/project-based-learning-guide-importance>
5. - learning-guide-importance

DESIGN AND OPTIMIZATION OF CHASSIS DYNAMOMETER

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Abstract: A dynamometer is a device used to measure force, torque and power that can be calculated by simultaneously measuring the RPM with respect to time. The most prevalent dynamometer was the engine dynamometer which requires the engine to be dismounted from the main body, hence affecting the convenience of accurate deduction. A more approachable variant of the device is called the chassis dynamometer that measures RPM from the drive rollers, to which the power is delivered from the drive wheels. The prevalence of these dynos is very limited in India which leads to hampered development in the field of automobiles. Various modifications in design are also required to increase ease of usage. Our design covers myriad vehicles, in the entire range of the Indian market. Considerations such as variable wheel base, detachable fly wheel, additional safety and adaptability for all types of drives including 2 wheelers, presents an optimized design of the dynamometer. Load Analysis and Rotational Analysis in Transient and Static Structural mode of Ansys, provides us with a structurally sound design with a Factor of Safety of 5.

A scale-reduced prototype presents the working principal in a practical way and also provides an unconventional alternative way of RPM pick-up. These prototypes can also prove to be useful for smaller vehicles such as RC Nitro Cars and Chassis Robots. The prototype integrates the concepts of magnetic sensors, Arduino, and SimpleDyno-a software that allows us to plot power and RPM graphs.

We intend to present our work for future refinement and manufacturing so that colleges and automotive research in India can benefit from the work and raise our country's share in the Automobile sector.

Keywords: Automobile, Chassis, Dynamometer, Engine, Power, Revolutions per minute.

INTRODUCTION

A dynamometer is a device for measuring force, torque and power. For example, the power produced by an engine, motor or other rotating prime mover can be calculated by simultaneously measuring torque and rotational speed (RPM). A dynamometer that is designed to be driven is called an absorption or passive dynamometer. A dynamometer that can either drive or absorb is called a universal or active dynamometer. A chassis dynamometer is a type of absorption dynamometer which is used to simulate driving on a road inside a workshop. It consists of rollers which are actually very heavy metal drums connected up to sophisticated electronic measuring instruments that figure out how much torque, horsepower, or speed the engine is capable of producing by measuring how fast the drums take to accelerate. It eliminates the need for road trials and allows the user to identify issues within

minutes in a safe, reliable and repeatable environment. Chassis dynamometer is a device which is used for estimating performance figures of the vehicles, based on that the map of the engine is changed in the ECU to improve that performance factor (power, torque, fuel economy etc.) [5]

A. Need

India has a lack of commercially available dynamometers in the aspects of versatility. This is in spite of India's dominance in the manufacturing and usage of automobiles. There is a growing need for testing of a vehicle for its various specifications such as performance, environmental impact and research purpose. Universities promote student racing organizations but for the testing of the vehicles, the added hassle of shipping of the automobile to the few chassis dynamometer vehicles needs to be undertaken.

This design and optimization techniques benefit organizations with the option of an economically feasible and technically versatile design. The design spans across the Indian automobile market comprehensively and overcomes the shortcomings of the present system.

II. DESIGN AND RESULT

The design started with a market review of vehicles available in India that are used widely. [1] Simultaneously, the testing needs for high power vehicles which are made for racing purpose were considered. Two brackets have been considered while designing based on the power segments: Vehicles with less than 200 bhp and vehicles with more than 200 bhp. The design has considered variable wheel base according to which the dynamometer should adapt. A Factor of Safety of 5 has been considered.

A detachable flywheel with a yoke joint has been incorporated into the design that can be manually attached or removed from the main design using a lever mechanism. For variable wheel base, a lead screw mechanism with guide ways was provided beneath the front wheel roller assembly. A servo motor of 76 mm shaft diameter and 585N maximum continuous force is decided upon based on the motor calculations. An encoder disk for the Inductive Magnetic Crank Sensor has been designed with 32 teeth based on the processor speed of a 16 bit Free scale Processor. The sensor is mounted externally on the frame near the encoder disk. The strapping points are provided accordingly on the frame of each roller assembly.

An optimization in the signal pick up is the usage of magnets in the form of a Halbach Array to increase efficiency, ease and economy of usage. The sensor in this case is as simple as a coil or an earphone. The earphone can be plugged into the input microphone jack of a computer and the magnetic signal disturbances can be processed on an RPM vs Time graph.

Designing has been done using Solid Works 15, Catia and Ansys 15. Load Analysis was done on frame and rollers considering Factor of Safety 5. A Rotational analysis on roller was also done to get centrifugal deformation of roller while accelerating. All the deformation result from Ansys were well within tolerances. [2]

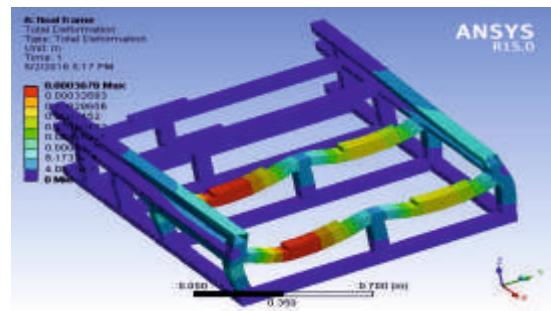


Figure 1 Structural Analysis

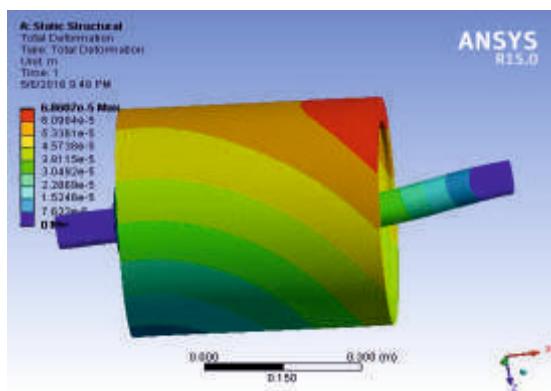
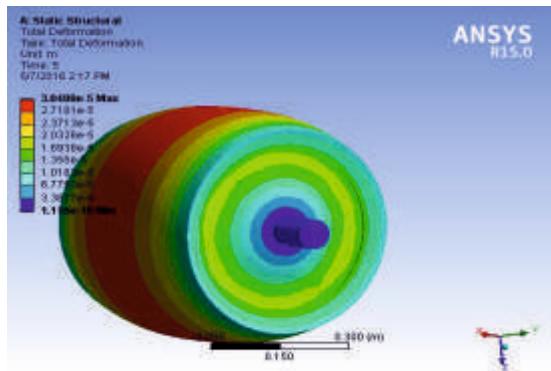


Figure 2 Roller Deformation



The length of the lever was calculated using the force needed to move the mass and the maximum force a human can apply (50 N). Frictional force in the Yoke Joint parts is calculated to be 726 N (Friction coefficient * Normal Load). Friction coefficient between two mild steel surfaces is 0.78 while the normal load calculated from the design is 931.95.

The lead screw assembly consists of a lead screw with ACME thread 2mm pitch, and a nut bolt plate at one end to couple it with motor. Bearing Block is designed to support the lead screw on either ends with holes to mount it on ground.

Assembly has been made at ground level with cladding support as a safety measure and for ease of use. This ensures that the vehicle can be easily mounted on the dynamometer and no moving parts will cause harm to the operator.



Figure 3 Front Roller



Figure 4 Rear Roller

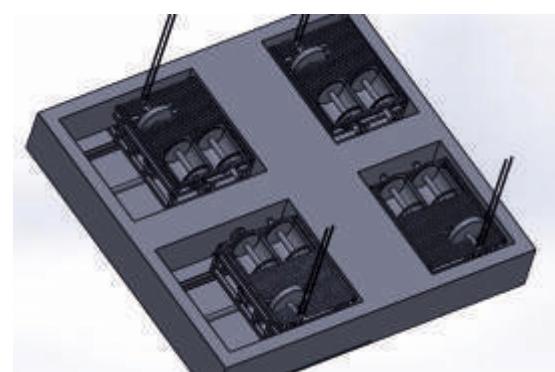


Figure 5 Final Assembly

A. Material List [2]

Sl. No	Description	Material Used	Quantity
1	Frame	Structural Steel	4
2	Roller Assembly with Flywheel	Structural Steel	4
3	Ideal Roller Assembly	Structural Steel	4
4	Plummer's Block	Structural Steel	24
5	Lever Assembly	Structural Steel	4
6	Lead Screw	Structural Steel	2
7	Lead Screw Bearing Block	Structural Steel	4
8	Lead Screw Nut	Structural Steel	4
9	Guideways	Cast Iron	4
10	Encoder Gear	Structural Steel	4
11	M10 Bolt, Nut and Washer	Structural Steel	16
12	M16 Bolt, Nut and Washer	Structural Steel	48

B. Explanation of Processor Code

A variable pulsesperturn varies for different types of toothed wheels depending on the number of holes on the disc. In this case, it is 32. This depends on the processing power of the control module. There are normally two types of triggering signals for sensors, in this case it is a falling signal and the sensor is triggered upon a high to low transition. The baud rate is set as 9600. Millis() is a function that returns the time that has elapsed since initial activation. The return value is in milliseconds. The attach interrupt command activates interrupt zero upon a falling signal and via the counter function increments the number of pulses. To avoid command overflow, the interrupt is detached when logical processing is going on. A timeold variable is updated after every calculation to store the presently elapsed time as it helps to get the elapsed time per processing.

III. MATH

$$1. \ Torque \ Req(Nm) = \frac{Force * Lead \ of \ screw}{2 * \pi * efficiency \ of \ screw} [3]$$

$$2. \ Approximate \ Inertia \ needed =$$

$$\frac{Engine \ Power * 1000 * desired \ time \ to \ accelerate * 2}{\left(\frac{Rpm \ of \ system \ at \ end \ of \ test}{9.549} \right)^2 - \left(\frac{Rpm \ of \ system \ at \ start \ of \ test}{9.549} \right)^2}$$

3. Approximate Power that can be measured=

$$\begin{aligned} & \text{Inertia of system} * 2 * \\ & \left(\frac{\text{Rpm of system at end of test}}{9.549} \right)^2 - \\ & = \frac{\left(\frac{\text{Rpm of system at start of test}}{9.549} \right)^2}{\text{Desired time to Accelerate}/1000} \end{aligned}$$

4. max Rpm of Roller =

$$\frac{\text{max vehicle speed in test}(kph) * 10^6}{\text{roller diameter} * \pi * 60}$$

Formula no 2,3,4 [4]

IV. PROTOTYPE FOR WORKING PRINCIPLE

To explain the working principle of the rpm detection, we used the most sublime method of pick up. We researched and stumbled upon an open source free software that allows you to input a pulse signal through the computer and helps represent it across the time axis. This software, called SimpleDyno, receives the signal through the microphone jack of the computer.

The first step is constructing a roller set-up. We used wood to construct a firm frame and after drilling holes through the ends, made space for the wooden axle which would be of approximately 5 mm. In the frame we have attached two rollers. The rollers are made of PVC pipe, hence providing us with hollow rollers. To increase the mass and strength, the roller ends are affixed with an additional mass of wooden periphery. This also helps stabilize the moment of inertia as is the case with the flywheel in real time applications.

A magnet is attached to the dyno rollers, and whenever the magnet passes the rested headphone, the software will 'listen' to these signals created and use the timing of the signals to calculate the RPM. The magnets used are neodymium magnets, taken off a virtual reality kit. The rollers are powered using a chassis with two motored wheels. The motors used are 12V, 200 RPM DC motors. A motor driver IC is used to power the wheels from an Arduino Uno and a 9V battery. The 2 Enable and Interrupt Pins of the Motor Driver IC are connected to Pins 4, 5, 6 and 8, 9, 10 of the Arduino.

One of the rollers are connected to the magnet for pick up while the other roller is the idle/support roller, as is the case with every chassis dynamometer. The code for Arduino allows the chassis to run for a few

seconds (5-10s) and then stop for a few seconds. This is done considering the general engine testing time of a dynamometer be similar. The software allows to enter the desired parameters of the testing prototype and divides them respectively into critical and non-critical parameters. The sensor alternatives for higher accuracy or in the case of a weak magnet are as follows:

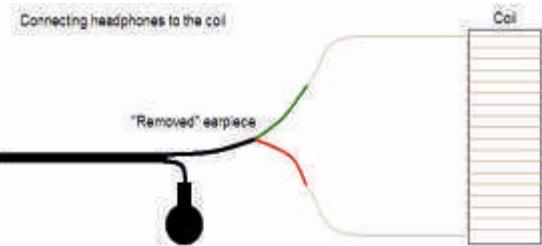


Figure 6 Sensor Alternative

The application of this method of signal detection can be used on a larger scale in real-time applications by making a unidirectional powerful magnet. This can be explained by using the Halbach Array application:

The application of this method of signal detection can be used on a larger scale in real-time applications by making a unidirectional powerful magnet. This can be explained by using the Halbach Array application:

A Halbach array is a special arrangement of permanent magnets that augments the magnetic field on one side of the array while cancelling the field to near zero on the other side. This is achieved by having a spatially rotating pattern of magnetization. The rotating pattern of permanent magnets (on the front face; on the left, up, right, down) can be continued indefinitely and have the same effect. The effect of this arrangement is roughly similar to many horseshoe magnets placed adjacent to each other, with similar poles touching.

A major application of this that is reduces the complexity of a control module handling intensive logical processing, the detection is cheaper and easily available, and the system can be directly plugged into the personal computer. External mounting of the sensor also prevents any damage to it. Further research on this method of detection could lead to its application on a large scale.



Figure 7 Prototype Frame



Figure 8 Prototype Arduino Circuit

V. CONCLUSION AND SCOPE FOR FUTURE WORK

The basic motive of the project apart from the design and elementary prototyping is to make the design optimized. The design will read different values from different rollers. Therefore, the assumption of there being no transmission loss from the differential to the wheels is relegated. The same design will be used for all types of drives and bikes as well. Bikes can be measured with a minimum power of 16 bhp. Cars can be measured with a minimum of 30 bhp for a 2 wheel drive with 10 seconds testing time. Cars with 4 wheel drive can be measured with a maximum value of 550 bhp with <5 seconds testing time. The design is safer with protective walls around the roller. The cladding on which the car is being mounted is at ground level. Because parts have been housed into a slot on the ground, safety is ensured as the risk of high RPM rotating parts being thrown away is negated. An after-market fan system will help in effective cooling while it is running, as it acts as an effective exhaust. A variable wheel base system helps include a myriad type of vehicles.

Indian market lacks such optimized types of dynos and nor does it have any institute taking an initiative to design one. With this design and further refinement and development, many will benefit. As one of the fastest developing countries in the world, India needs to increase its share in Research and Development which will in turn lead to manufacturing growth. The dynamometer developed will help Educational Institutes as well as Commercial Industries eventually leading to the development of the Automobile Sector of India.

The design is complete and can be taken forward for development and further manufacturing. As for further work, development of a software compatible with and dedicated to the plotting of performance graphs for this particular dynamometer is easy to undertake. The present software used for the prototype has specification restraints that make it suitable for only small scale vehicles. The Dynamometer environment can be designed for exhaust emission testing, noise testing and vibration testing of the vehicles. The method of signal pick up used in the prototype can be used on a large scale using the Halbach Array, where magnets are so aligned that the field on one face is doubled while the field on the other side is negated. This makes the method convenient and cheap.

VI. REFERENCES

- [1] "Carwale," [Online]. Available: www.carwale.com.
- [2] S. Bhavikatti, Structural Design, New Age International, 2007.
- [3] "Festo Lead Screw Mechanism," [Online]. Available: www.festo.com.
- [4] Dtec, "Dtec Mft," [Online]. Available: www.dtec.com.
- [5] J. a. M. Plint, Engine Testing, 2007.

DESIGN AND DEVELOPMENT OF ELECTROMECHANICAL SYSTEM FOR STIRRUP MAKING MACHINE

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Abstract: Stirrup is a reinforce element for columns & beams in civil construction world. These stirrups are presently made manually. This manual stirrup making process suffers from many drawbacks like low productivity & less accuracy. Due to the repetitive work by the operator, many operators undergo several diseases like muscles spasm or muscle strain. To over come this draw backs author have design & developed low cost electromechanical system for stirrup making, which provides choice of shape& size of stirrups.

Key Words: Stirrups, ARM-7, UART, Encoder, LPC2148

I. INTRODUCTION

Stirrup is a reinforce element for columns & beams in civil construction world. Stirrups or lateral tie is one of the necessary element of reinforced cement concrete which is used for strengthening columns & beam. Stirrups are to hold and support vertical and horizontal plain mild steel or torr-steel bar. The hooked ends also provide proper anchorage which in turn safe guard the structure against horizontal forces occurring due to wind, earthquakes etc. This manual stirrup making process have many drawbacks like low productivity & less accuracy. Due to the repetitive work by the operator, many operators undergo several diseases like muscles spasm or muscle strain. Considering drawbacks of manual stirrup making process, an automatic stirrup making system using microcontroller ARM-7 is developed. This system provides choice of shape & size of stirrups to the user. Due to automatic system productivity and accuracy increases.

II. RELATED WORK

There is verity of mechanical systems currently producing stirrups. In [1] S.B.Thakre, A.V.Vanalkar and P.M.Padole proposed Stirrup making machine with four workstations using chain drive and stirrup making machine using single workstation.

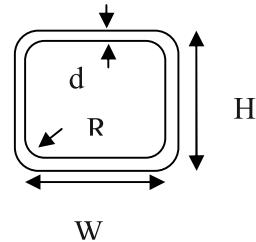


Fig. 1: Schematic of stirrup d is diameter of stirrup & R is radius of bending

In [2] A.V.Vanalkar and P.M.Padole proposed Optimal design of mechanism for stirrup making machine. This paper suggests that the path of follower or bending pin should be such that, after completion of bending, the contact between the automatically.

- A. Simulation using elliptical path
- B. Simulation using circular path of pin

A. Simulation using elliptical path

The stirrup wire (1) is carried out between two guide plates (3) as shown in fig.2. The elliptical path (2) traced by the bending pin in clockwise direction. The bending pin comes in contact with wire at point 'A' and starts bending het wire, the bending continues until pin reaches to point 'C' via 'B'. While travelling the path ABC, the wire is bent by 90 degree. The contact of pin with wire losses automatically at point C [2].

B. Simulation using circular path of pin

The bending pin travels in a circular path (2) in

clockwise direction. At position 'A', the bending pin comes in contact with stirrup wire (1). When the pin moves along the path ABCD stirrup wire bends continuously. Thus, rotating approximately 280° the pin completes the bending of stirrup wire by 90°. The contact of pin with wire starts loosening automatically from point 'D' onwards.[2]

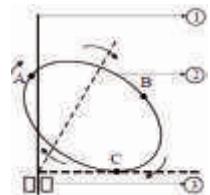


Fig. 2: Simulation using elliptical path

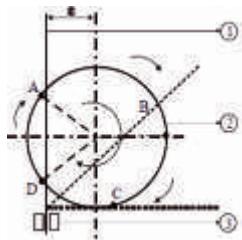


Fig. 3: Simulation using circular path of pin rotating in clockwise direction

To prepare stirrups by machine we need to bend bar with specific angle which is done by stepper motor. In [3] Shuqiu Gong, Bin He proposed LabVIEW-base automatic rising and falling Speed control of stepper motor. This paper provides a LabVIEW-base approach for automatic rising and falling speed avoiding losing step and over step of stepper motor. In [4] Gh. BALUTA and M. COTEATA proposed Precision Micro stepping System for Bipolar Stepper Motor Control. The paper presents a high performance system for stepper motor control in a micro stepping mode, which was designed and performed with high-performed dedicated integrated circuits IXMS 150 PSI. In [5] Hausila Singh and Sudhansu Mohan Sharma proposed Some novel up-based configurations for controlling remotely located stepper motors with single-step resolution control to work as actuators of control valves. In [6] Xinghai Han Sch. and Xiangxin Kong proposed the design method based on RS232, designed the hard circuit of serial communication, and realized the programming to PC Microcomputer and single chip microcomputer by using assembly language and C++ Builder separately.

III. MECHANICAL ASSEMBLY

In this system Roller used are made-up from milled steel steel. Roller1 and roller2 are used as balancing roller. Which are used for proper movement of steel bar. The shaft of motor1 is connected to roller3, this arrangement rotates roller 2 & 3 in forward direction and hence bar in between this roller pairs will move in forward direction.

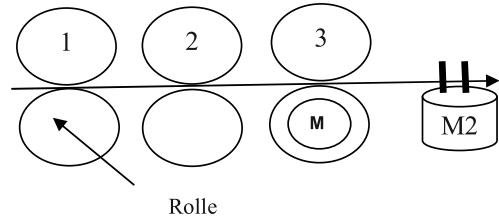


Fig. 4: Mechanical Arrangement

Fig. 4 shows bending mechanism. The shaft of motor2 is connected to bending mechanism. When motor2 rotates clockwise, then the steel bar between two poles will get bend 90 degree. After bending 90 degree motor will again rotates and keeps the poles in its original position.

IV. HARDWARE DEVELOPMENT

PC & GUI: A GUI is prepared in Visual Basic Language and is stored in the personal computer. The screen shot of GUI is shown in Fig. 05.

This GUI provides the choice of shape & size. This system constructs rectangular and square stirrups. This system inputs the size from user in the form of length & width. This system also provides the total no stirrups to be constructed.

From the GUI we are receiving the values serially inside ARM-7. There are two inbuilt UART in ARM 7. Out of this any one UART can be used. In this system RS232 protocols are used for serial communication.

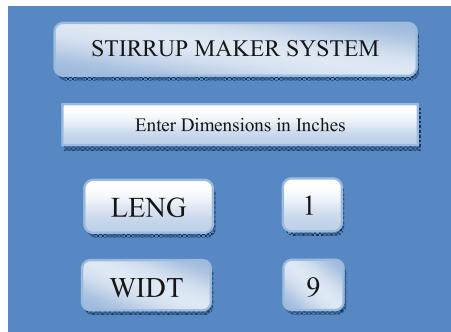


Fig. 5: Front screen of GUI

A. RS232 Protocols

RS-232 (Recommended standard-232) is a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices. RS-232 is the interface that your computer uses to communicate with your modem and other serial devices. DTE stands for Data Terminal Equipment. A computer is a DTE. DCE stands for Data Communication Equipment. A modem is a DCE.

B. LCD 16x2

The LCD provides an alternative arrangement for displaying messages. All messages appearing on serial port same is displayed on LCD.

C. Encoder

Here an optical encoder is used as sensor. Optical encoder is a Transducer which will convert a movement of shaft into electric pulses. In one complete rotation of a rotor, encoder generates fix amount of pulses. This is known as reference. In the controller the pulses required for length & width is calculated by considering reference. This calculated pulses decides start and stop operation of motor1 & motor2.

D. DC Motor 1 AND 2

In this system DC motor with gear box is used.
Two DC

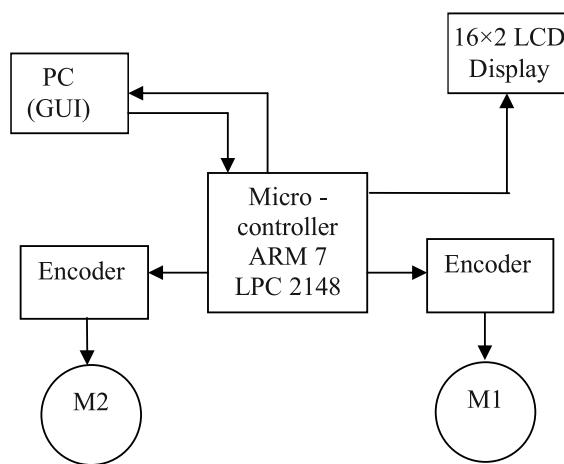


Fig. 6: Block Diagram of Stirrup making system

motors are dedicated for specific task. Motor1 is used for moving the steel bar in forward direction for specified length and width. Motor 2 is used for bending the bar 90 degree.

E. ARM-7 (LPC2148)

ARM-7 family have number of processors, out of this we are using LPC2148 processor. Following are the features of LPC2148

- 32 bit processor
- Two 32 bits GPIO
- Two inbuilt UART i.e. UART0 & UART1.
- 4Kb static RAM & 128Kb on chip flash memory.
- Inbuilt 32 bit event counter & Timer.
- 16 bit thumb mode.
- 10 bit DAC. etc.

In the designed system ARM-7 controller performs following function important functions

- Serial communication for asking and receiving length, width and total number of stirrups through inbuilt UART0.
- Controlling operation of LCD for display purpose.
- Controlling movement of Motor1 for forward movement of the steel bar.
- Controlling movement of Motor2 for 90 degree bending of steel bar.
- Counting number of stirrups prepared using internal timer/counter.

V. SOFTWARE DEVELOPMENT

The programming is done in Embedded C language. The ARM 7 processor can be programmed by using its registers. Some important registers are

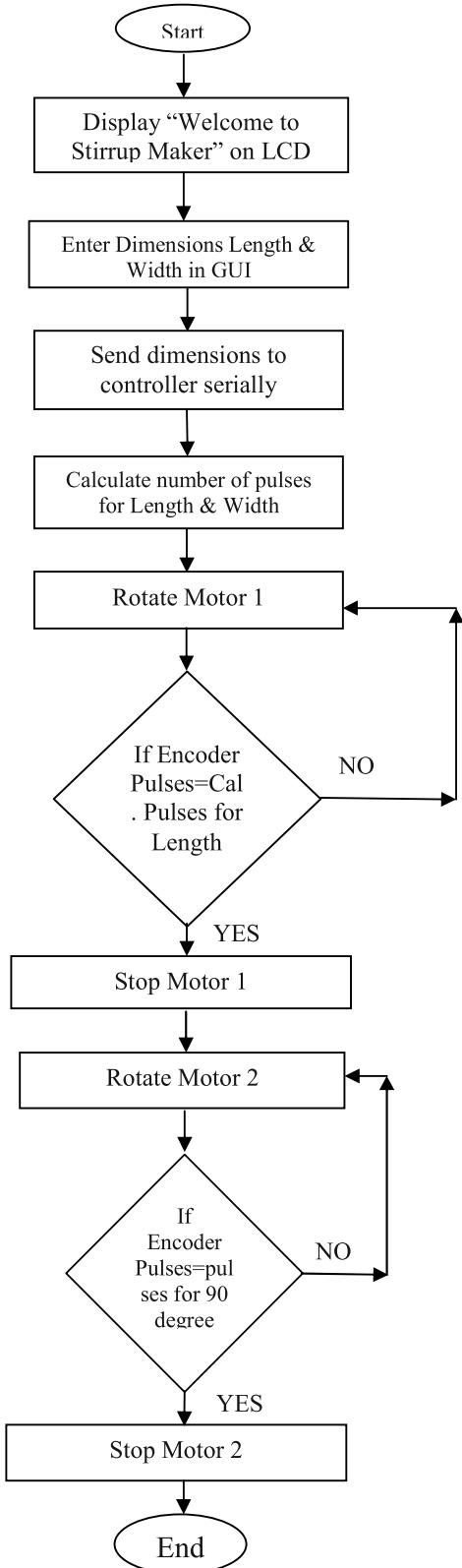


Fig. 7: Flow Chart of Stirrup Making System

- PINSEL0/1/2- All pins are multi functioned. It Sets the function of a pin by setting this register.
- IODIR0/1-Sets port pins input or output.etc.
- Set the input & output pins & GPIO for all pins.

As soon as we will open GUI it demands dimensions in the form of Length, width and total number of counts. Once operator enters these values, then same message is displayed on the LCD placed on machine. Now the same dimensions are sending to the ARM 7 processor through its UART0.

Now controller calculates total number of pulses for entered length and width. This is calculated by following formula

$$\text{Total Length} = \text{Entered Length} \times \text{Pulses for movement of steel bar}$$

$$\text{Total Width} = \text{Entered Width} \times \text{Pulses for 1 inch movement of steel bar}$$

Rotate DC motor 1 for entered Length dimension by comparing total length pulses with pulses of encoder. If both are equal then stop motor1 and start motor 2. Motor 2 is used for bending the steel bar. As 90 degree bend is required, so by taking reference of encoder pulses, total pulses required for 90 degree bending is calculated.

Now motor 2 will rotate for this much amount of encoder pulses clock wise for 90 degree bending and anti clock wise for returning back the mechanical bending assembly to its original position. Repeat same procedure for width. This cycle of length-bending-width-bending is performed two times. Once a stirrup is ready internal 32 bit timer/counter of ARM-7 processor counts the stirrup on interruption of sensor.

VI. RESULT

The performance of the ARM based system for development of stirrups is designed, developed and tested. The dimensions and quantity of stirrups are taken as an input from user and are supplied to ARM processor. The bar is bend by rotating stepper motors to 90°. Bending steel bars at four different places according to size will give a stirrup. By testing and observation it is proved that the old system produces 30-35 stirrups per hour whereas the proposed system produces 50-55 stirrups per hour.

VI. CONCLUSION

This paper proposes an automatic system for stirrup making using ARM processor. The old methods for stirrup designs have fixed size but the proposed system is efficient in producing stirrups of any size. The proposed system reduces human effort as it is automatic. Experimental result shows the proposed system is fast, efficient and accurate.

VI. REFERENCES

- [1] S.B.Thakre, A.V.Vanalkar and P.M.Padole by Design and Development of coupled to uncoupled system for stirrup making Machine, International J. of Multidispl. Research and Advcs. In Engg.(IJMRAE), ISSN 0975-7074, Vol. 3, No. 1 (January 2011), pp.213-227
- [2] A.V.Vanalkar and P.M.Padole by Optimal design of mechanism for stirrup making machine - A Computer Approach, Proc. 11th National Conference on machines and Mechanisms, NaCoMM-2003,IIT New Delhi, India pp-177 Dec.2000
- [3] A. Shuqiu Gong, B. Bin He, Lab VIEW-base automatic rising and falling Speed control of stepper motor, Proceeding of the ICEMS International Conference on Electrical Machine and System, 2009,pp. 1-4.
- [4] GH. Baluta and M. Coteata, Precision Microstepping System for Bipolar Stepper Motor Control, International Conference on Electrical Machines and Power Electronics, ACEMP 2007.
- [5] Hausila Singh, and Sudhansu Mohan Sharma, Some Novel μ P-Based Configurations for Controlling Remotely Located Stepper Motors as Actuators of Control Valves, IEEE Transaction on Industrial Electronics, Vol.38, No.4, August 1991, pp 283-287.
- [6] Xinghai Han Sch. and Xiangxin Kong, The Designing of Serial Communication Based on RS232, CDEE '10 Proceedings of the 2010 First ACIS International Symposium on Cryptography, and Network Security, Data Mining and Knowledge Discovery, E-Commerce and Its Applications, and Embedded Systems Pages 382-384.

PARTIAL VOLUME CORRECTION USING MAPS: AN APPROACH FOR ACCURATE MEASUREMENT OF LESION SIZE ON CT IMAGES

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Abstract: Digital image processing is one of the popular area dealing medical diagnosis for various diseases. Oncology is one such medical branch with the need of processing of images from various scanning devices during the treatment phase. Computed Tomography (CT) images are used to obtain the images of solid lesions and the estimation of size of tumor is the main task in the oncological chemotherapy based therapeutics to determine whether the treatment is in progress or not. That means the tumor either grows or shrinks as the time improves. So the size of the tumor should be determined accurately. Due to the irregular growth of tumor, diameter of tumor is not a good parameter for calculating the size. But volume is a best parameter to determine the size of lesion. The presence of partial volume artifacts, which arise due to low resolution of imaging device, reduces the accuracy of volume as well as leads to misclassification of tumor. So partial volume correction (PVC) which extracts the necessary information from the segmented output is the only solution to this unnecessary effect. This paper presents a different approach for accurate volumetric measurement by correcting partial volume effect which is at the borders of segmentation result. Before finding the volume, the classification also takes place.

Index Terms - Computed Tomography, Classification, Support Vector Machine, Partial volume effect, Partial volume correction, Boundary map, and Distance map.

1. INTRODUCTION

Oncology is one of the main branch which deals with the study of cancerous tissues. Chemotherapy based therapeutics is one among technique used in oncology. CT images of solid lesions like lung or liver are required for the chemotherapy based therapeutics. Lung or liver cancer screening is another application based on reproducible size measurements of tumor besides chemotherapy assessment with CT which has proven to be the most efficient modality. Here, estimating the tumor size will guide treatment in right path. Volume of tumor on medical images is a standard parameter to determine the accurate size of tumor. Measuring the change in tumor size is the best strategy for assessing the cancer severity. Change in tumor size can be found out by various methods. Diameter measurement is one such method. A diameter is not always an accurate measure to assess the size of a tumor, because most of the tumors grow and shrink irregularly in three dimensional description [1]. But volume of the tumor defines the size of the tumor

accurately and compensating the irregular tumor growth. If the tumors are shrinking and no new tumors arise, then radiologist can identify the therapy is successful. Otherwise, further treatment is required.

According to Frank Heckel [2], for measuring the size of the tumor, voxel-counting is not a standard approach. This is because of partial volume effect, which arises due to limited spatial resolution of CT imaging device, at the borders of segmentation result [2]. So these artifacts should be under consideration to avoid misclassification of tumors. Partial volume correction is the best solution to this problem. Segmentation based partial volume correction with spatial sub division is an approach to improve the accuracy and reproducibility of volumetric measurements of tumor [2]. Earlier solution is a segmentation based partial volume analysis (SPVA) algorithm for lung nodules [3] that is not able to handle appropriately inhomogeneous lesions or lesions surrounded with multiple structures. So Frank Heckel et al. [2] introduced a generic fast algorithm for measuring the volume of solid lesions as well as compact tumors in

CT that considers partial volume effects at the border of the segmented output and performs spatial sub division. The spatial sub-division can extract the necessary information for compensating the bad effects of partial volume artifacts.

The method spatial sub-division divides the segmented output into separate spatial sub segments. After that, volume calculation over each sub segments is performed separately [2]. This is time consuming when the size of the tumor or number of sub divided regions becomes larger. The accuracy is not always guaranteed for very small lesions. To improve the accuracy of volume measurement, the spatial subdivision over the segmented output is modified as each segment covers a homogeneous region inside and outside of the tumor. The accuracy of this system [2] depends on maximum distance d_{max} , a global parameter, for the whole lesion. This parameter can take on different values depending on the size of the lesion. The actual size of the inner tissue, outer tissue areas, inner partial volume and outer partial volume depends on this global parameter, which in turn decides the accuracy of the calculated tumor volume. This is not applicable for dynamic approaches.

In this paper, a dynamic volume estimation based on distance map and boundary map is being incorporated for identifying the basic areas. Considering the fact that partial volume effect occurs at the edges of the segmented tumor, the basic principle behind the proposed system is that the intensity resembles the same value, in the most of the inner part of the lesion. Before volume estimation, determine whether the tumor is healthy or benign or malignant. If it is malignant, it requires the further treatment. So volume of tumor estimates after categorized. No volume estimation of tumor takes place for healthy lung or liver because they are tumor free.

The remaining part of the paper is organized as follows. In Section II survey for this work will be described in detail. Section III will be detailed about the proposed method. This paper concludes with a brief summary.

II. BACKGROUND

Volume measurement requires segmentation and classification as pre-processes. Due to the effect of partial volume artifacts, from 3-D image segmentation, some voxels will be lost at the border of the

segmentation output. To overcome this problem, partial volume correction should be performed. There are many methods for segmentation and partial volume correction [4]. Segmentation methods include robust and automated algorithms which is working on CT. Methods for partial volume correction include histogram based analysis combined with Bayesian classifiers [5], methods using reverse and anisotropic diffusion [6], approach for measuring the volume of atherosclerotic plaque in CT based on Markov random fields (MRF) and a modified expectation maximization [7].

To segment lung nodules in three dimensional CT volume dataset in slice-per-slice basis by a robust and automated algorithm is present. Since any completely automated algorithm may fail in a complicated case, it requires user interaction for the correctness of segmentation results [9]. This algorithm can overcome this situation. The automatic segmentation developed for small ellipsoidal lung nodules in a given volume of interest is another method for extraction. This is done by dynamically initializing and adjusting a 3D template and analyzing its cross correlation with the structure of interest [10]. Another three-dimensional method for the segmentation, analysis, and characterization of small pulmonary nodules uses a semi-automatic classification of the target nodule into different nodule models. But formulating mathematical models of each class and developing separate segmentation schemes accordingly made this method a difficult one. A powerful statistical estimation and verification framework for characterizing the ellipsoidal geometrical structure of nodules in the multi-slice X-ray CT images is another approach for segmenting the lesion. But due to irregular nodule growth and the change in shape of lesion is a potential drawback of this ellipsoid approximation approach [11]. Another automated method for 3D image analysis for segmenting lung nodules in HRCT has been proposed. But it is harder to integrate, if there is any dependence on a preprocessing step, as a plug-in to existing workstations or CAD systems [12].

For correcting partial volume artifacts, most of the work focus on techniques like single-photon emission computed tomography (SPECT), MRI as well as PET. An algorithm for identifying the distribution of different material types in volumetric datasets uses a probabilistic Bayesian approach is introduced by D. H

Laidlaw [5]. One approach which is based on iterative deconvolution with a 3D maximum likelihood expectation-maximization (MLEM) algorithm for correcting the partial volume artifacts on PET images which arises due to its limited resolution [13]. This method is used for the estimation in unsupervised manner that simultaneously estimates partial volume effects, by means of the locations of tissue boundaries within the image, as well as the different tissue classes [14].

Another method to restore the ideal boundary is by splitting a voxel into sub-voxels and distributing the signal into the sub-voxels is introduced. Each voxel is divided into four or more sub-voxels by nearest neighbor interpolation. The gray level of each sub voxel is treated as materials which is able to move between sub voxels but it is not same as in the case of movement between voxels [15]. There is an anisotropic method to create interpolated 3D images corrected for partial volume without enhancement of noise.

III. PARTIAL VOLUME CORRECTION USING

MAPS

The method proposed by Frank Heckel et al. [2] is a general form of the SPVA algorithm for lung nodules, which is not able to handle lesions of inhomogeneous nature or lesions with multiple structures around them appropriately. This is because of the partial volume effect and the tissue regions like nodule core and lung parenchyma are estimated once for the whole lesion and a priori knowledge about lesions in CT is also included in the analysis [2]. Besides, the algorithm uses intermediate results from the dedicated nodule segmentation algorithm. So this method is not applicable to results from different segmentation algorithms or after manual corrections to the segmentation result. The spatial subdivision of the segmentation result can overcome these limitations. From this subdivision, extract all information that is necessary for compensating the partial volume artifacts. But the accuracy of that system depends on a global parameter, d_{max} for the whole lesion. This parameter can take on different values depending on the size of the lesion. The actual size of the inner tissue area, outer tissue area, inner partial volume area and outer partial volume area depends on this global parameter, which in turn decides the accuracy of the calculated tumor volume.

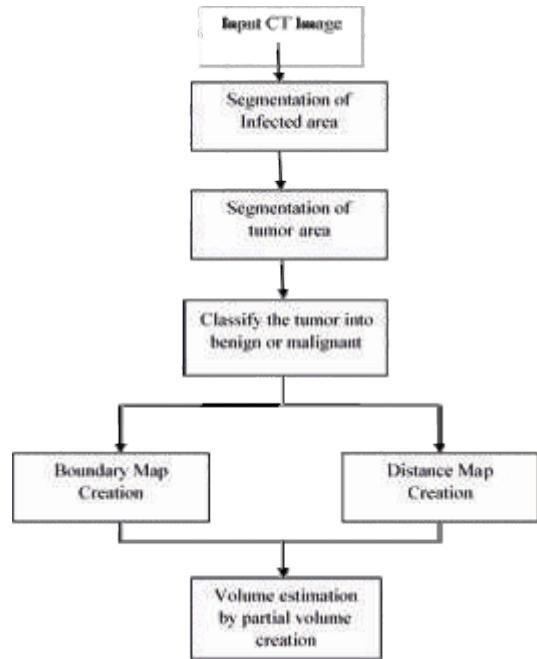


Fig. 3.1 Overall architecture of the system

In the proposed approach, a dynamic method based on distance map and boundary map is being incorporated for identifying the basic areas. The basic areas are lesion core, inner tissue area, inner partial volume area, outer partial volume area and outer tissue area. This kind of division of whole lesion is done by maps instead of spatial sub-division. The segmentation of region of interest (ROI) is done by level set based contour segmentation [17]. This is not necessary if the CT image contains only the ROI. For this, the foreground and background regions are described in terms of local regions. In-order to optimize these local energies, each point is considered separately and then moved to minimize the energy to be computed on its own region. The local neighborhoods are split into local interior and local exterior regions by evolving the curve to compute local energies. After that, the energy optimization takes place by fitting a model to each local region. The segmentation by spatial Fuzzy C-Means clustering (SFCM) is done for extracting tumor [18]. The neighboring voxels have similar feature values is one of the important characteristics of every image, and the probability that they belong to the same cluster is high. The spatial information is important in clustering of voxels, and this information is utilized in the SFCM algorithm. The spatial function is the obtained by the weighted summation of the

membership function in the neighborhood of each pixel under consideration.

On the segmented output, calculate the Gray level co-occurrence matrix (GLCM) features for classifying the tumor as benign or malignant. After classification, estimate the volume by finding basic areas based on boundary maps and distance map. Weight of voxels on each region is calculated then clamp the calculated weight to range [0,1] then find the final volume.

The basic principle behind the proposed system is that the intensity of the intermediate output resembles the same value in the most of the inner part of the lesion by considering the fact that partial volume effect occurs at the edges of the segmented tumor. The distance map contains distance of a voxel to the closest boundary. Voxels inside the object have a positive boundary and outside pixels have a negative value. With the help of distance map, basic areas such as inner core, inner tissue region, inner partial volume region, outer partial volume region and out tissue area can be labelled based on their proximity to region boundaries. This is based on inner boundary and outer boundary map. Boundary map is also a matrix which contains 1 for boundary pixels and 0 elsewhere. This can be generated by identifying the edge of the segmentation output. Fig.1 shows the architecture of the proposed method.

The distance map is computed by iteratively applying a morphological erosion operator, starting with an initial binary image. This is the image which has value 1 for each voxel corresponding to the tumor region, and 0 elsewhere. The region shrinks in each iteration while preserving the shape by using an increasing width kernel. The distance map is completed by assigning to each voxel the last iteration number in which the voxel still belonged to the actual (shrunk) region. Clearly, the iteration number determines how far the voxel lies from the nearest region boundary. It is only necessary to iterate until the region is empty. In the distance map, the larger the value for a voxel means that it is farther from the boundary and thus it is less affected by PVE. One simple idea is then, to set every boundary voxel to the innermost average tumor intensity. To exclude extreme values while preserving local features, the mean value of the surrounding innermost or highest labelled voxels is taken. The surrounding innermost or highest labelled voxels is taken. The inner tissue and outer tissue areas are the identified based on the average intensity values.

The proposed system is accurate in terms of volume measurement. There is a great scope for this method in the medical image processing for oncology therapeutics. Volume is a standard parameter for identifying the size of tumor. At every consultation, the volume of the tumor is calculated from CT image of solid lesion. Based on the value of volume the doctor can determine whether the treatment is in right path or not. If the volume is reducing, the dosage of medicine for chemotherapy should be reduced as per the previous prescription.

IV. RESULT AND DISCUSSION

The proposed method is with real time medical CT images of solid lesions. Two segmentation is done for extracting the tumor from the input image. Then find whether the tumor is benign or malignant before finding the volume. The volume estimated by finding the basic areas and weights of voxels on each region. The estimated volume of the proposed method is more accurate as compared to the existing methods. The method proposed is evaluated using ground truth value of volume of lesion. This means, the difference of a volumetric measurement V to the known ground truth V_g can be measured in terms of the relative difference using the formula:

$$Rel(V, V_g) = \frac{V - V_g}{V_g}$$

The value of relative difference is less than the existing methods. This is experimentally proved by CT images of solid lesions with ground truth values. One example with ground truth value 1.462ml is shown in table 4.1.

Sl. No	Method	Volume Measured	Relative Difference
1	Voxel Counting	1.326	0.09302
2	Partial Volume Correction by Spatial Division	1.533	0.04856
3	Partial Volume Correction using Maps	1.432	0.02051

V. CONCLUSION

This work has been performed for the map based partial volume correction which is useful for accurate volumetric measurement of lesions. As tumors

grow and shrink irregularly, diameter measurement of tumors and voxel- counting are not accurate parameters for assessing its size. Partial volume artifacts must be taken care of, for the accurate volume measurements. This paper suggests a method which is a best alternative to spatial subdivision for partial volume correction, based on boundary map and distance map. By this method, accuracy and reproducibility of volumetric measurement are guaranteed. This method will be efficient and effective in terms of time.

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REFERENCES

- [1] J. E. Husband, L. H. Schwartz, J. Spencer, L. Ollivier, D. M. King, R. Johnson, and R. Reznek, Evaluation of the response to treatment of solid tumours—A consensus statement of the international cancer imaging society, Br. J. Cancer, vol. 90, no. 12, pp. 2256–2260, 2004
- [2] Frank Heckel*, Hans Meine, Jan H. Moltz, Jan-Martin Kuhnigk, Johannes T. Heverhagen, Andreas Kießling, Boris Buerke, and Horst K. Hahn, Segmentation-Based Partial Volume Correction for Volume Estimation of Solid Lesions in CT, IEEE Trans. On Med. Imag., vol. 33, no.2,pp 462-480 February 2014.
- [3] J.-M. Kuhnigk, V. Dicken, L. Bornemann, A. Bakai, D. Wormanns, S. Krass, and H.-O. Peitgen, Morphological segmentation and partial volume analysis for volumetry of solid pulmonary lesions in thoracic CT scans, IEEE Trans. Med. Imag., vol. 25, no. 4, pp. 417–434, Apr. 2006.
- [4] Bitty S Varghese and Lakshmi S, A Survey on Segmentation –Based Correction of Partial Volume Artifacts for the Accurate Volumetric Measurement of Solid Lung Lesions on CT Images, IJSEAS, vol. 2, pp. 459–465, Jan. 2016
- [5] D. H. Laidlaw, K. W. Fleischer, and A. H. Barr, Partial-volume Bayesian classification of material mixtures in MR volume data using voxel histograms, IEEE Trans. Med. Imag., vol. 17, no. 1, pp. 74–86, Feb. 1998.
- [6] O. Salvado and D. L. Wilson, A new anisotropic diffusion method, application to partial volume effect reduction, in SPIE Med. Imag.: Image Process., vol. 6144, pp. 614 464-1–8, 2006.
- [7] J. Dehmeshki, X. Ye, H. Amin,M. Abaei, X. Y. Lin, and S. D. Qanadli, Volumetric quantification of atherosclerotic plaque in CT considering partial volume effect, IEEE Trans. Med. Imag., vol. 26, no. 3, pp. 273–282, Mar. 2007.
- [8] Yang Xiang, Albert C.S. Chung and Jian Ye, An active contour model for image segmentation based on elastic interaction, Journal of Computational Physics 219 ,pp. 455–476, 2006.
- [9] N. Xu, N. Ahuja, and R. Bansal, Automated lung nodule segmentation using dynamic programming and EM based classification, Proc. SPIE Med. Imag., vol. 4684, pp. 666–676, May 2002.
- [10] J.-M. Kuhnigk, V. Dicken, L. Bornemann, A. Bakai, D. Wormanns, S. Krass, and H.-O. Peitgen, Morphological segmentation and partial volume analysis for volumetry of solid pulmonary lesions in thoracic CT scans, IEEE Trans. Med. Imag., vol. 25, no. 4, pp. 417–434, Apr. 2006.
- [11] K. Okada, D. Comaniciu, and A. Krishnan, Robust anisotropic gaussian fitting for volumetric characterization of pulmonary nodules in multisliceCT, IEEE Trans. Med. Imag., vol. 24, no. 3, pp. 409–423, Mar. 2005.
- [12] C. I. Fetita, F. J. Prêteux, C. Beigelman-Aubry, and P. Grenier, 3-D automated lung nodule segmentation in HRCT, in Proc. MICCAI, pp. 626–634, 2003.

- [13] A. S. Kirov, J. Z. Piao, and C. R. Schmidlein, Partial volume effect correction in PET using regularized iterative deconvolution with variance control based on local topology, in *Phys. Med. Biol.*, vol. 53, pp. 2577–2591, 2008.
- [14] D. L. Pham and P.-L. Bazin, Simultaneous boundary and partial volume estimation in medical images, in *Proc. Int. Conf. Med. Image Comput. Comput. Assist. Intervent.*, vol. 3216, pp. 119–126, 2004.
- [15] O. Salvado, C. Hillenbrand, and D. L. Wilson, Partial volume correction using reverse diffusion, in *SPIE Med. Imag.: Image Process.*, vol. 5747, pp. 625–633, 2005.
- [16] Kaihua Zhang , Lei Zhang, Huihui Song, Wengang Zhou, Active contours with selective local or global segmentation: A new formulation and level set method, *Image and Vision Computing* , vol.28 pp. 668–676, 2010
- [17] Shawn Lankton and Allen Tannenbaum, Localizing Region-Based Active Contours, *IEEE Trans. On Img. Proc.*, vol. 17, No. 11, Nov 2008
- 18. Hamed Shamsi and Hadi Seyedarabi , A Modified Fuzzy C-Means Clustering with Spatial Information for Image Segmentation, *International Journal of Computer Theory and Engineering*, Vol. 4, No. 5, October 2012.

EFFECT OF PARAMETERS ON PENETRATION OF SUBMERGED ARC WELDS OF STAINLESS STEEL

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Abstract: Submerged arc welding (SAW) is characterized by higher metal depositing rate, higher welding speed and higher process efficiency. It is one of the most widely used processes for fabrication of pressure vessels, thick plates, pipes, ships, heat exchangers etc. The geometry of the weld bead is influenced by direct process parameters such as welding wire feed rate, arc voltage, welding speed and nozzle to plate distance. It is necessary to establish the relationships between the welding parameters and weld bead geometry to get better control over the weld quality. Also, the need to improve productivity, reduce the labour cost and stringent safety requirements have increased the demand for automatic welding processes. Box-Behnken design of Response surface methodology was employed for conducting the experiments and analyzing the effect of process parameters (open circuit voltage, welding current, welding speed and flux basicity index) on the penetration of the weld using developed flux in submerged arc welding process.

Index Terms – Submerged Arc Welding, Developed flux, RSM, Penetration.

1. INTRODUCTION

Submerged arc welding process is one of the most widely used processes for fabrication of pressure vessels, thick plates, pipes, ships, heat exchangers etc. It contributes to 10% (approximately) of the total welding. Apart from joining, this process can also be used for overlaying applications to increase corrosion and wear resistance on the surface.

Submerged arc welding process is characterized by higher metal depositing rate, higher welding speed, higher process efficiency [2, 10, 11, 12, 13] and suitable for welding of low carbon steel, high strength low alloy steel and stainless steel [1].

The maximum linear distance from the surface of base plate and to the depth upto which fusion takes place is known as weld bead penetration. The penetration is affected by various welding process parameters i.e. current, arc voltage, travel speed, basicity index of the fluxes, nozzle to tip distance, etc. If the penetration is more, the number of welding passes required to fill the weld joint becomes less and less time is required to fill the joint. The penetration is significantly affected by welding current and welding wire feed rate, as welding current increases the penetration also increases [7]. Electrode polarity also affects the penetration, when electrode is changed from DCEN to

DCEP deepest penetration is achieved. With the increase in welding travel speed, the time during which the arc force is allowed to penetrate into the surface of material decreases which results in decrease in penetration. Decrease in current density is observed with the increase in electrode diameter due to which penetration decreases.

Flux basicity index also influences the penetration [5]. In general higher penetration is obtained with using low basicity index fluxes due to high viscosity which enhances the tendency of heat concentration in the narrow zone. The penetration increases with the increase in slag viscosity and interfacial tension [9]. An increase in viscosity, arc stability, surface tension resulted in deeper penetration.

In this research work it is tried to investigate the effect of welding process parameter of (open circuit voltage, welding current, welding speed and flux basicity index) on the penetration of the weld. The cost effective and high performance agglomerated fluxes with different basicity index were developed systematically and scientifically for the submerged arc welding of stainless steel.

It is essential to generate the data by conducting the experiments according to the corresponding actual conditions of welding to predict

the effects of welding parameters on the bead geometry. Therefore, the experimental plan must be designed in order to perform the required experiments efficiently. The design of experiment is the procedure of selecting the number of trials and conditions for running them, essential and sufficient for solving the problem that has been set with the required precision.

In general, the statistical method of design of experiment is based on a more sound logic than any other approach and helps in minimizing the time and the cost of experimentation and at the same time increases the authenticity of the results. Many latest techniques are available for experimental design which can be effectively used in scientific investigations of welding processes. One such important technique is Response surface methodology for evaluating the effect of the parameters on the response.

Hence in the present work, this approach was selected for conducting the experiments and generating the data for predicting the effect of welding parameters on the penetration of the welds.

II. METHODS AND PROCEDURES

A. Experimental Design

The experimental design was according to design matrix based on the Box-Behnken method of Response surface methodology. Analysis of variance (ANOVA) was used to investigate and model the relationship between a response variable and independent variables. The analysis of variance (ANOVA) technique has been adopted to determine the level and degree of the direct or interactive effect of welding current, voltage, travel speed and flux basicity index on penetration. Models were developed using response surface methodology to analyze and predict the effects of open circuit voltage, welding current, travel speed and basicity index on weld penetration. These models were used for estimating the individual and interaction effect of these parameters on the weld penetration within the designed range of the parameters. Analysis of variance technique (ANOVA) was used to test the adequacy of the developed models. The analysis of variance test was performed to evaluate the statistical significance of the fitted models and factors involved therein for response factor.

B. Experimentation

The Ador TORNADO SAW M-800 submerged arc welding equipment, with current capacity of 600 A

and open circuit voltage ranging 12-48 volts fully mechanized system was used to conduct the experiments. DCEP polarity was used throughout the experimentation. The welds were laid by using 2.5 mm diameter SS 308L wire. The compositions of the base plate and wire are given in Table-1. The plate size used for bead on plate welds was 100 × 50 × 6 mm. Developed agglomerated fluxes with different basicity index were used. The welds were laid on the base plate using bead on plate technique. The experiments were carried out as per the design matrix shown in Table 3. The process parameters for the study of bead geometry were varied as per design matrix and by keeping all other parameters constant at intermediate level. The experiments were performed in a random manner to avoid any systematic error. The process parameters and the range used for welding are given in Table 2.

C. Analysis and Discussions

The experiments were planned by using the Box-Behnken method of Response surface methodology. The response characteristic data is provided in Table 3. In the Table 4, the model F-value of 8.28 implies that the model is significant. There is only a 0.02% chance that model F-Value could occur large due to noise. The values of "Prob > F" less than 0.0500 indicates that the model terms are significant. In this case B, C, D, B2, D2, AC, BC, BD are found to be significant model terms. If there are many insignificant model terms model reduction may improve the model. The "Lack of Fit F-value" of 1.56 implies that the Lack of Fit is not significant relative to the pure error. There is a 35.50% chance that a "Lack of Fit F-value" could occur large due to noise.

Table 1: Chemical composition

Material	Element (%)						
	C	Mn	Si	S	P	Ni	Cr
Electrode wire (ER 308L)	0.03	1.6	0.44	0.02	0.02	9.2	20.2
Base plate (SS 304)	0.07	1.7	0.65	0.02	0.03	9.17	18.5

Table -2: Welding parameters and their range

Parameter	Unit	Symbol	Lower value	Higher value
Open circuit voltage	Volts	V	32	38
Current	Ampere	A	275	325
Travel speed	m/hr	S	26	32
Basicity Index	BI	B	0.6	1.4

From the Table 5, the "Pred R-Squared" of 0.4717 is observed not to be as close to the "Adj R-Squared" of 0.7845 which is normally expected. This indicates that model reduction i.e. dropping out the insignificant model terms may improve the model. "Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 13.469 indicates that the model is observed to be adequate and can be used to navigate the design space.

D. Regression Equation for Penetration

$$\text{Penetration} = +2.12 -0.097 * \text{A} +0.39 * \text{B} -0.20 * \text{C} -0.40 * \text{D}-0.18 * \text{A}^2 +0.23 * \text{B}^2 +0.049 * \text{C}^2 +0.23 * \text{D}^2 -0.045 * \text{A} * \text{B}-0.34 * \text{A} * \text{C} +0.23 * \text{A} * \text{D} +0.31 * \text{B} * \text{C} -0.39 * \text{B} * \text{D}+0.17 * \text{C} * \text{D}$$

Table 3: Box Behnken design matrix with Experimental Results of Response Characteristic

R U N	Factor 1 Voltage (V)	Factor 2 Current (A)	Factor 3 Travel Speed (m/hr)	Factor 4 Basicity Index of flux (BI)	Response Penetration (mm)
1	38.00	300.00	26.00	1.00	3.48
2	38.00	300.00	32.00	1.00	2.76
3	38.00	325.00	29.00	1.00	2.96
4	35.00	300.00	32.00	0.60	2.88
5	35.00	300.00	32.00	1.40	2.9
6	38.00	300.00	29.00	0.60	2.82
7	32.00	275.00	29.00	1.00	3.46
8	35.00	300.00	29.00	1.00	3.36
9	35.00	325.00	32.00	1.00	2.86
10	35.00	275.00	29.00	0.60	2.78
11	35.00	275.00	29.00	1.40	2.46
12	32.00	300.00	32.00	1.00	3.24
13	35.00	275.00	32.00	1.00	2.66
14	35.00	300.00	26.00	0.60	3.54
15	35.00	300.00	29.00	1.00	3.16
16	32.00	300.00	29.00	0.60	3.44
17	35.00	300.00	29.00	1.00	3
18	35.00	300.00	29.00	1.00	3.12
19	35.00	325.00	26.00	1.00	4.42
20	32.00	325.00	29.00	1.00	3.4
21	35.00	300.00	29.00	1.00	3.1
22	35.00	325.00	29.00	1.40	3.32
23	35.00	325.00	29.00	0.60	3.2
24	32.00	300.00	29.00	1.40	3.24
25	32.00	300.00	26.00	1.00	4.1
26	35.00	275.00	26.00	1.00	2.64
27	35.00	300.00	26.00	1.40	3.8
28	38.00	300.00	29.00	1.40	2.72
29	38.00	275.00	29.00	1.00	2.48

From the Table 6, the model F-value of 10.12 implies the model is significant. There is only a 0.01% chance that model F-Value" could occur large due to noise. The values of "Prob > F" less than 0.0500 indicates that model terms are significant. In this case all the insignificant model terms from the Table 6.5 has been dropped out and B, C, D, B2, D2, AC, BC, BD are found to be significant model terms. The "Lack of Fit F-value" of 2.00 implies that the Lack of Fit is not significant relative to the pure error. There is a 26.39% chance that a "Lack of Fit F-value" could occur large due to noise.

From the Table 7, the "Pred R-Squared" of 0.5817 is observed to be in reasonable agreement with the "Adj R-Squared" of 0.7227 as compared to the values in the Table 6.6. The value "Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 14.829 indicates that the model is adequate and can be used to navigate the design space.

Table 4: ANOVA for Quadratic Model for penetration

Source	Sum of Squares	DF	Mean Square	F Value	Prob > F	Remarks
Model	7.14	14	0.51	8.28	0.0002	significant
A	0.11	1	0.11	1.82	0.1985	not significant
B	1.87	1	1.87	30.42	< 0.0001	significant
C	0.46	1	0.46	7.41	0.0165	significant
D	1.89	1	1.89	30.67	< 0.0001	significant
A^2	0.22	1	0.22	3.54	0.0808	not significant
B^2	0.34	1	0.34	5.53	0.0338	significant
C^2	0.016	1	0.016	0.25	0.6216	not significant
D^2	0.35	1	0.35	5.66	0.0322	significant
AB	8.100E-003	1	8.100E-003	0.13	0.7222	not significant
AC	0.46	1	0.46	7.51	0.0159	significant
AD	0.22	1	0.22	3.59	0.0790	not significant
BC	0.37	1	0.37	6.05	0.0276	significant
BD	0.59	1	0.59	9.63	0.0078	significant
CD	0.12	1	0.12	1.88	0.1921	not significant
Residual	0.86	14	0.062			
Lack of Fit	0.69	10	0.069	1.56	0.3550	not significant
Pure Error	0.18	4	0.044			
Cor Total	8.00	28				

Final Regression Equation for Penetration

After dropping out the insignificant factors from the developed models, final regression equation for penetration is as follows:

$$\text{Penetration} = +2.05 + 0.40 * B - 0.20 * C - 0.40 * D + 0.25 * B^2 + 0.25 * D^2 - 0.34 * A * C + 0.31 * B * C - 0.38 * B * D$$

Table 5: Model summary statistics for penetration

Std. Dev.	0.25	R-Squared	0.8922
Mean	2.26	Adj R-Squared	0.7845
C.V.	11.00	Pred R-Squared	0.4717
PRESS	4.23	Adeq Precision	13.469
Std. Dev.	0.25	R-Squared	0.8922

Table 7: Model summary statistics for penetration

Std. Dev.	0.28	R-Squared	0.8020
Mean	2.26	Adj R-Squared	0.7227
C.V.	12.48	Pred R-Squared	0.5817
PRESS	3.34	Adeq Precision	14.829
Std. Dev.	0.28	R-Squared	0.8020

Table 6: Pooled ANOVA for Quadratic Model for penetration

Source	Sum of Squares	DF	Mean Square	F Value	Prob > F	Remarks
Model	6.41	8	0.80	10.12	< 0.0001	significant
B	1.87	1	1.87	23.64	< 0.0001	significant
C	0.46	1	0.46	5.76	0.0262	significant
D	1.89	1	1.89	23.84	< 0.0001	significant
B ²	0.43	1	0.43	5.47	0.0298	significant
D ²	0.44	1	0.44	5.58	0.0284	significant
AC	0.46	1	0.46	5.84	0.0254	significant
BC	0.37	1	0.37	4.70	0.0424	significant
BD	0.59	1	0.59	7.49	0.0127	significant
Residual	1.58	20	0.079			
Lack of Fit	1.41	16	0.088	2.00	0.2639	not significant
Pure Error	0.18	4	0.044			
Cor Total	8.00	28				

E. Effect on Weld Penetration

The effect of open circuit voltage on penetration is shown in Figure 1. It can be seen from the Figure 1 that with the change in voltage from 32V to 38V, penetration changes from 2.03 to 1.84 mm. It has been found that with the increase in voltage has the insignificant effect on the penetration of weld metal.

The effect of current on penetration is shown in Figure 2. It can be seen from the Figure 2 that with the change in current from 275A to 325A, penetration changes from 1.95 to 2.74 mm. It has been found that with the increase in current, penetration also increases. Welding current has significant effect on penetration as compared to other parameters.

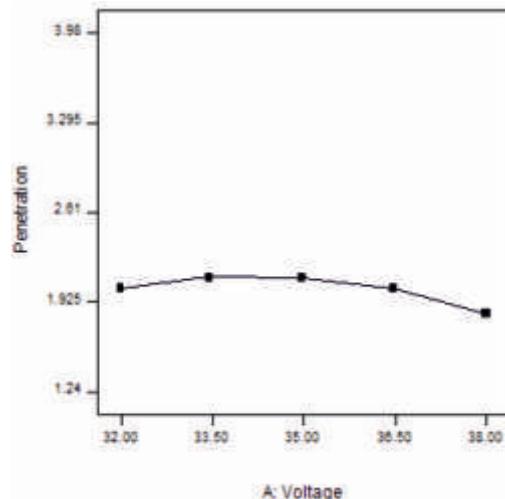


Fig.1 Effect of voltage on penetration

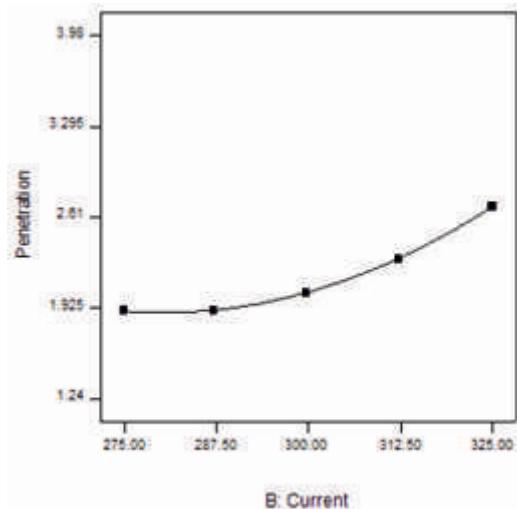


Fig.2 Effect of current on penetration

The effect of travel speed on penetration is shown in Figure 3. It can be seen from the Figure 3 that with the change in travel speed from 26 m/hr to 32 m/hr, penetration changes from 2.36 to 1.97 mm. It has been found that with the increase in travel speed, penetration decreases.

The effect of basicity index of flux on penetration is shown in Figure 4. It can be seen from the Figure 4 that with the increase of basicity index of flux from 0.6 to 1.4, penetration decreases from 2.74 to 1.93 mm. It has been found that the increase in basicity index of flux has significant effect on penetration.

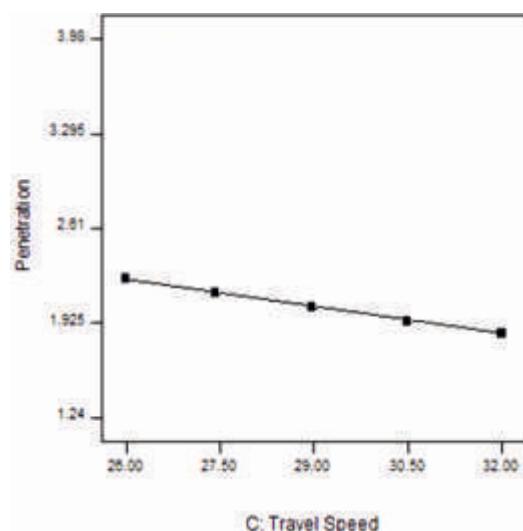


Fig.3 Effect of travel speed on penetration

It is evident that the arc length increases with the increase in open circuit voltage, which in turn results in spreading of the arc cone at its base which further results in more melting of work piece instead of penetrating the plate. As the rate of decrease in penetration with the increase in open circuit voltage is less than rate of increase in bead width with an increase in open circuit voltage, the weld pool size increases [4]. The increased voltage resulted in increased bead width. This increase in bead width causes corresponding reduction in penetration and reinforcement. It was observed that, the increase in voltage has insignificant effect on penetration of weld metal.

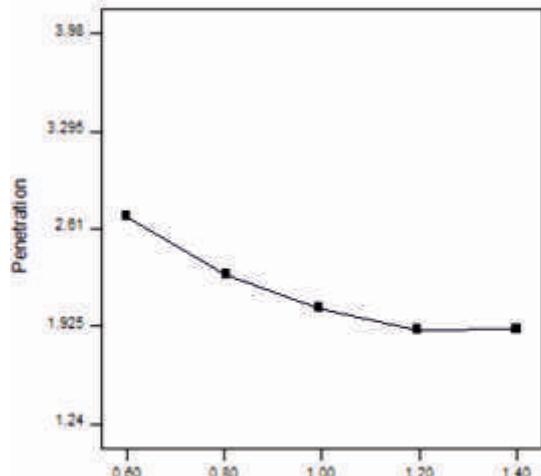


Fig.4 Effect of basicity index on penetration

The deposition area of the weldment for a given electrode material, electrode diameter and voltage increases with the increase in welding current. The welding plasma have a high temperature columnar shape and some of its heat is transferred to the parent metal. The higher the heat generated in the arc column, the greater the plate melts. Plate melting is related to the penetration, while the weld bead shape is related to electrode melting [3]. The molten metal droplets from the electrode are superheated as they pass through the arc column. This superheat gets added to the parent metal, when the droplets come in contact with it [2]. As welding current increases the temperature which in turn increases the heat content of the droplets, because of which more heat is transferred to the base material. Increase in current also increases momentum of the droplets, which on striking the weld pool causes a deeper penetration. It was observed that, the penetration is significantly affected by welding current and welding wire feed rate, as welding current increases the penetration also increases.

Travel speed has negative effect on penetration, which is due to the fact that penetration depends on heat input. Therefore, penetration decreases with the increase in travel speed because of decreased heat input. For a given welding current, the low heat input was obtained by increasing travel speed. The low heat input in SAW process means that a small molten pool remained liquid for a short time [6]. Therefore, the thermal gradient between the weld interface and fusion

zone became steeper at high travel speed. Moreover, when travel speed increases, the thermal energy transmitted to the base plate from the arc per unit length of the weld bead decreases. Therefore, less filler metal is deposited per unit length of weld bead, resulting in thinner and narrower weld bead. Hence, at higher travel speeds, the penetration of weld metal also decreases.

Flux basicity index influences the penetration significantly. Flux basicity index had the negative effect on the penetration of the weldment. In general, higher penetration is obtained with using low basicity index fluxes, due to high viscosity which enhances the tendency of heat concentration in the narrow zone [5]. The penetration increases with the increase in slag viscosity and interfacial tension [9]. There are three interfacial tensions to be considered in a submerged arc weld: the flux-solid metal interfacial tension, the flux-liquid metal interfacial tension, and the liquid-solid metal interfacial tension. The interfacial tension depends upon the flux and weld metal composition. With the increase in viscosity, arc stability and surface tension, deeper penetration can be obtained. Weld bead surface quality and heat transfer during welding are influenced by interfacial tension of a flux. Interfacial tension of flux plays important role during the protection of weld pool from the atmospheric gases and thus influences the weld bead surface quality. Interfacial tension influences the spreading tendency of weld pool and also the penetration (Patchett, 1980). As interfacial tension between flux and molten weld increases, the weld metal penetration also increases.

III. CONCLUSIONS

1. The penetration of the weld metal is significantly affected by welding current. Penetration increases with increase in welding current.
2. The travel speed had the negative effect on the penetration, as the travel speed increases, penetration decreases.
3. Negative effect of basicity index of flux was also observed on penetration, with the increase in basicity index of flux, penetration decreases.
4. The open circuit voltage had the insignificant effect on the penetration of weld metal.

REFERENCES

- [1] R.L. Brien, Welding Handbook., 8th ed. vol.2, Miami, U.S.A, American Welding Society, 1969, pp.191–231.
- [2] R.S. Chandel, Seow and H. P. Cheng, "Effect of increasing deposition rate on the bead geometry of submerged arc welds". Journal of Materials Processing and Technology 72nd ed., 1997, pp.124 -128.
- [3] V. Gunaraj and N. Murgun, "Application of response surface methodology for predicting weld bead quality in submerged arc welding of pipes", Journal of Materials Processing Technology, vol. 88, 1999, pp. 266-275.
- [4] V. Gunaraj, and N. Murugan, "Prediction and Optimization of Weld Bead Volume for the Submerged Arc Process- Part-1", Welding Research Suppl., 79th ed. vol. 10, 2000, pp 286s-294s.
- [5] S.R. Gupta and P.C. Gupta, "Investigation into flux consumption in submerged arc welding", Indian Welding Journal, 21st ed. vol. 3, 1988, pp 365-369.
- [6] C. S. Lee, R. S. Chandel and H. P. Seow, "Effect of Welding Parameters on the Size of Heat Affected Zone of Submerged Arc Welding", Materials and Manufacturing Processes, 15th ed. vol. 5, 2000, pp. 649-666.
- [7] J.C. McGlone, "Weld bead geometry prediction-A review", Metal construction, 14th ed. vol. 7, 1982, pp. 378-384.
- [8] B.M. Patchett, "Some effects of physical properties on weld bead formation, in SAW process", Materials for energy system, 5th ed. vol. 3, 1983, pp. 165- 174.
- [9] D.D. Schwemmer and D.L. Olson, "Relationship of Weld Penetration to Welding Fluxes", Welding Journal, 58th ed. vol. 5, 1979, pp. 153s-160s.
- [10] B.L. Shultz and C.E. Jacson, "Influence of weld bead area on weld metal mechanical properties". Welding Journal. 52nd ed. vol.1, 1973, pp.26s- 37s.
- [11] Y.S. Tarn and S.C. Chang, "The use of grey- based Taguchi methods to determine submerged arc welding process parameters in hard facing". Journal of Materials Processing Technology 128th ed., 2002, pp.128-131.
- [12] P.S. Visvanath, (1969), "Submerged arc welding fluxes," Indian Welding Journal 2nd ed. vol.1, 1969, pp. 27-33. P.S. Visvanath, "Submerged arc welding fluxes". Indian Welding Journal 15th ed. vol.1, 1982, pp.1-11.

DESIGN AND FABRICATION OF A BIO-INSPIRED FISH-SHAPED AUTONOMOUS UNDERWATER VEHICLE

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Abstract: Autonomous Underwater Vehicles (AUVs) are very important for search and rescue, health monitoring, data collection and naval surveillance. Their design and implementation is gaining huge significance with advances of research in materials, robotics, control systems and image-signal processing. This field of research is progressing impedingly. Present work brings in a design and fabrication method for the engineering of an indigenous robotic fish named NEMO. Computational fluid dynamics (CFD) studies have been carried out at the outset for understanding the fish locomotion and quantifying the forces and moments during propulsion and maneuvering respectively. The design consisted of modeling and optimizing in CREO. The robotic fish has three parts viz. body, abdomen and tail and has been provided with two hinges for the independent motions of the abdomen and tail. Prototyping has been carried out using the in-house 3D printer with acrylic (verowhite) as the material. Controls have been implemented using an Adruino-nano board and obstacle detecting sensors have been integrated through programming. On the whole NEMO mark 1 has been successful in analysis, design and operation. The second version of the fish, NEMO mark 2 is proposed to be used for water quality measurements and surveillance.

Index Terms - Biomimetics, AUV, CFD

1. INTRODUCTION

Autonomous underwater vehicles (AUVs) are gaining importance of late. They are intelligent robots that travel without any manual input. Torpedoes are the most popular among AUVs and these employ conventional rotary propellers for thrust generation and executing maneuvers. The astonishing locomotion of fish and its ability to swim swiftly in narrow spaces inspires engineers to improvise on the design of existing AUVs. The propulsion of fish is due to the undulatory motion of its tail. This kind of a motion is observed to be less noisy with better maneuverability and enhanced efficiency than the conventional propeller based design.

In our vision we can imagine a school of fish, deep in the ocean, performing vital tasks with utmost accuracy and efficiency, taking decisions reacting to exigencies and obstacles and communicating to each other. These multi intelligent robotic fishes could be used for a variety of tasks including missions such as detecting nuclear wastes, underwater search and rescue in emergency situations, tsunami detection and warning, leak detection in under water pipe lines, water quality assessment and lot more. Biomimetic swimming robots have wide applications, ranging from ocean sampling and defense at the meter scale, to pipe inspection at the centimeter scale, to micro-surgery at

the millimeter to micrometer scale. Oscillating foil for propulsion is used due to its higher energy conversion efficiency and quieter operation compared to traditional motors. Although almost all marine vehicles use propellers for their propulsion, propellers and especially those designed for small underwater vehicles are not very efficient, their efficiency being no more than 40 percent [2]. The main cause is the production of vortices perpendicular to the direction of motion. Due to their orientation, these vortices do not produce thrust, though they increase power consumption. An alternative apparatus for thrust development is the oscillating foil. The production of thrust is based in the formation of a reverse Karman vortex street in the flow wake. Thrust generation and its sensitivity to the Strouhal number are similar to the efficient propulsion of fish. The implementation of a fish-like propulsion mechanism is not possible in ships and submarines due to practical constraints. However its use in small underwater vehicles is promising and motivated many previous studies. The most famous one is MIT's Robotuna, which was used to study fish propulsion mechanisms. Berkeley's Calibot, various projects at Japan's NMRI and Draper's VCUUV are examples of autonomous fish robots.

SSET's robotic fish is named NEMO and is autonomous, which means it has everything it needs to

run, like power, actuators and control systems on board. It has been modeled sophisticated enough that it has changed ones idea of a robot as a hinged machine with rigid segments.

As a launch of the mission, hydrodynamic modeling and simulations of a self-propelling robotic fish whose thrust is produced by its oscillating tail, has been carried out using ANSYS ICEM CFD and FLUENT respectively. The fish has been modeled, to resemble a real one, and has imitated one of the most efficient swimming modes of the real fish.

The most efficient blending of all discussed, has given birth to an autonomous biomimetic robotic fish, which gives motion responses very similar to a real one. In this work, an underwater vehicle is developed, characterized by

- (a) an efficient oscillating foil propulsion mechanism
- (b) power autonomy for at least half an hour
- (c) the ability to traverse in rectilinear and curvilinear paths
- (d) low cost of production so that the possibility of losing does not make its use prohibitive
- (e) ultrasonic/infra-red sensors to enable autonomous navigation

This paper discusses design and implementation issues related to the development of this vehicle. Starting from scratch, our team successfully built a working prototype.

II. PAST WORKS

One of the pioneering contributions in fish biomimetic was from [1] and [2] wherein studies presented the hydrodynamics of fish-like swimming. Studies entailed the use of both Computational and Experimental fluid dynamics.

The early design method and sizing of components and control systems for a robotic fish was presented in [3].

A 3D simulator for the kinematics and hydrodynamics of a robotic fish was proposed in [4]. Comparison with experiments proved that the simulator provides reliable prediction of the navigation of the robotic fish.

An autonomous robotic fish for mobile sensing was developed by [5] which was propelled by an ionic

polymer-metal composite (IPMC) actuator and equipped with a GPS receiver, a ZigBee wireless communication module, a microcontroller, and a temperature sensor for autonomous navigation, control and sensing. The body here was fabricated using a mould.

Sixteen characteristics of the kinematics and dynamics of fish locomotion were presented lucidly in [6]. The work also has contribution from interesting PIV results from experiments

A robotic fish in the ADCS Laboratory of Tehran was designed and fabricated in [7]. CFD studies had been used in the outset for understanding the fish locomotion. The robotic fish was made of fiber and plexi glass and had four segments operated by three servo motors. The connection points here are articulated joints. [8] presented a four hinged fish structured robotic fish with different controls and motion.

Present work uses a different design from the above works. It uses a gear train for motion transmission. The prototype is fabricated using a 3D printer enabling the incorporation of every minute details of the design. Moreover the two hinges at the abdomen and tail greatly helped the easy propulsion of the robotic fish.

III. CFD STUDIES FOR UNDERSTANDING FISH LOCOMOTION

The idea of NEMO is inspired from the fresh water fish tilapia (20 cm in length, 7.5 cm in width 3 cm in thickness and 600gm in weight). The fish has a caudal fin carangiform swimming technique. Fish in this group are stiffer and faster-moving than its counterparts. Major movement is concentrated in the very rear of the body and tail. Carangiform swimmers generally have rapidly oscillating tails. The model has three parts head, middle and the tail.

In order to understand the locomotion better, a 2D NEMO model has been developed and meshed in ANSYS ICEM CFD. Initially the tail motions have been studied. An oscillatory motion about z-axis has been imposed on the tail using User Defined Functions (UDF) module of FLUENT by compiling an externally written C++ code within the solver. Pressure distribution around the tail in extreme motion is shown in Fig.1. Tail motions were accompanied by vortex shedding in simulations and hence the propulsion. Lift and drag force on the 2D (length-thickness plane) integrated over unit width of fish body have been shown in Fig. 2 and 3.

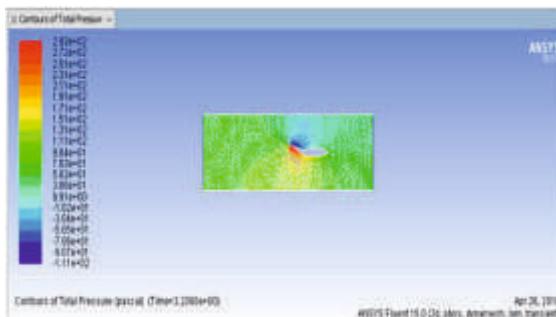


Fig. 1. Pressure distribution around tail in extreme motion

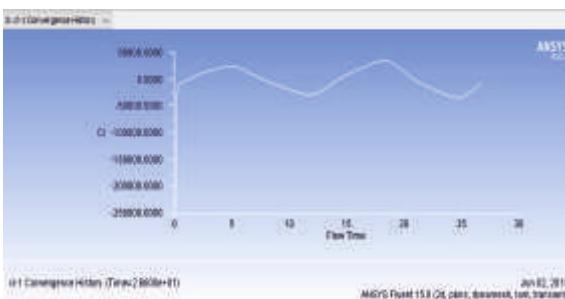


Fig. 2. Variation of lift force over two cycles of tail oscillation

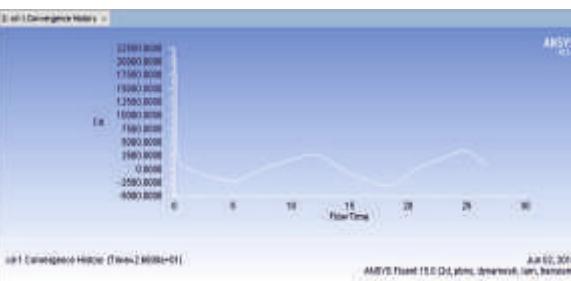


Fig. 3. Variation of drag force over two cycles of tail oscillation

Since fish change course by twisting its abdominal muscles, the simulations were carried by rotating the abdominal muscles of the model. Fig. 4 shows a clockwise moment produced in the direction of rotation indicating a turn from the straight course and hence the maneuvering. Fig. 5 shows the variation of moment on the fish body about z axis (along width).

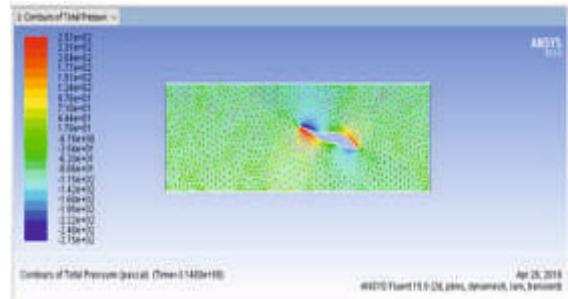


Fig. 4. Moment generation during turning of abdominal part

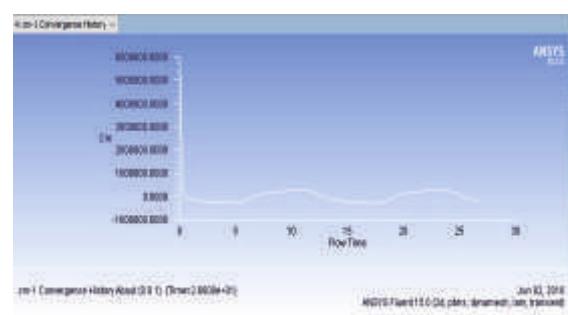


Fig. 5. Variation of moment over two cycles of abdominal oscillations

IV. DESIGN AND FABRICATION OF 3D MODEL

The NEMO mark 1 has the basic purpose to understand the basic feasibility of water proofing, controlling and thrust generation through indigenously designed body and built-in mechanism. The flapping mechanism is made from servo motors with gear drive to suite the purpose. The motion is given by two separate motors, one for the tail and the other for the abdominal part.

The fish has a control system that helps to detect upcoming obstacle and to move away from the obstacle. For this purpose the NEMO mark 1 has a proximity sensor which gives a digital signal to the controller. The controller interprets the input and gives controlling signals to control the motion of motors.

The controller used is ATmega328. The micro controller is embedded in to an Arduino-nano board and is programmed using Arduino software. Power supplied is from two 3.7 V Lipo (Lithium polymer) batteries. The batteries each have a 550mAh resulting in smooth operation for about half an hour.

A. Cad Model and Prototype

The NEMO mark 1 is inspired from the fresh water fish tilapia. The fish adopts a caudal fin (tail) carangiform swimming technique. Fish in this group are stiffer and faster-moving than their counterparts. The vast majority of movement is concentrated in the very rear of the body and tail. Carangiform swimmers generally have rapidly oscillating tails.

The model has three parts head, abdomen and the tail. These parts are made such that each is detachable from the rest. The head houses the sensors, the motor to drive the middle part, the controller and the power source, i.e. the batteries. For these to be held, the design has a provision of separate slots to place the devices in the correct places. The part also provides a hinge for the middle part to rotate. Screws of diameter 3 mm each are placed at three strategic points. The middle part houses only a gear and a servomotor to control the motion of the flapping of the tail. The part is attached with a 20 mm gear also. The tail part is connected to a 16 mm diameter pinion which imparts motion to it. All these parts have been fabricated using the state of the art 3D printer of SSET, Karukutty. Material used here is acrylic (verowhite). Fig. 6 shows the CAD models. 3D printed prototype is illustrated in Fig. 7. Final form of NEMO is presented in Fig. 8.

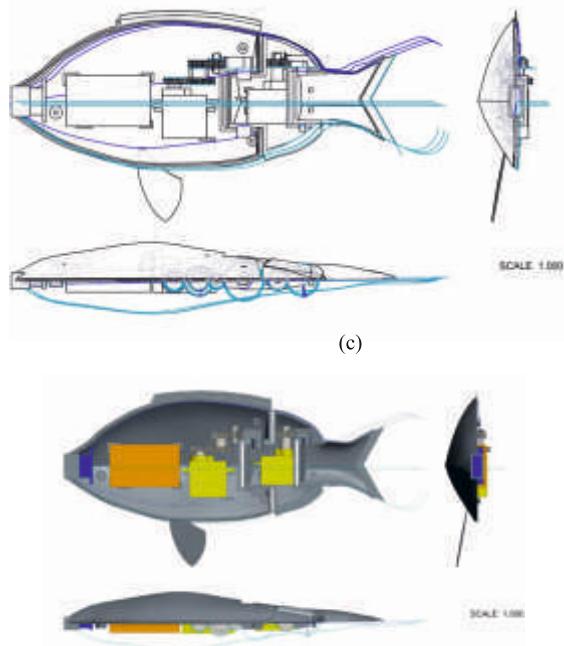
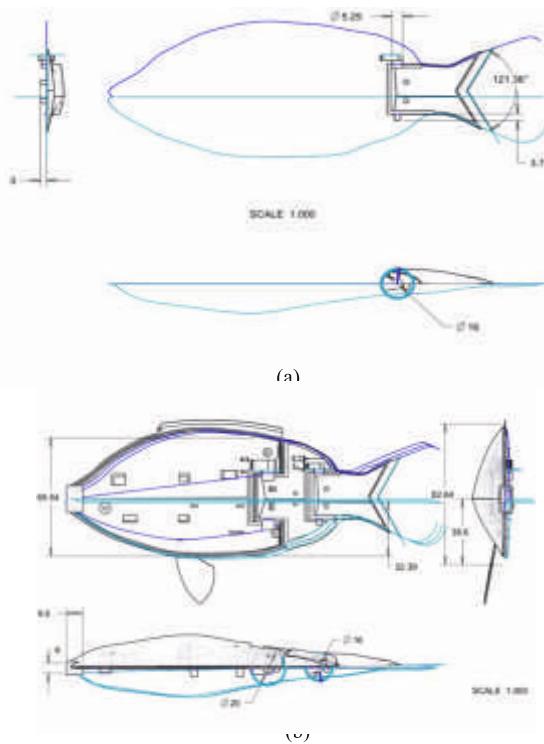


Fig. 6. CAD Model of NEMO in 3D developed in CREO

(All dimensions are in mm.)

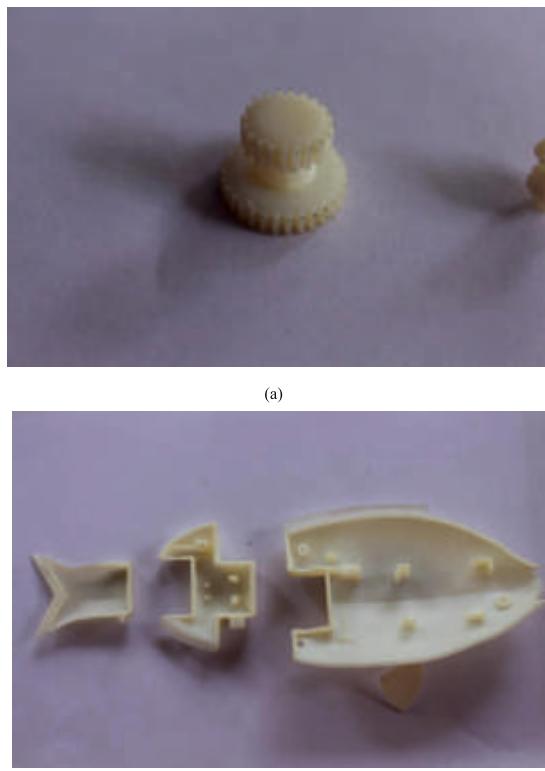


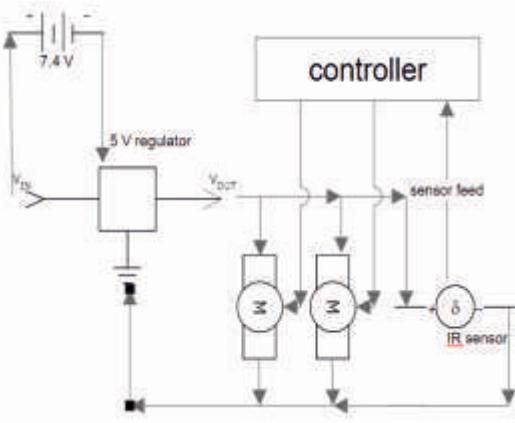
Fig. 7. Components of NEMO fabricated using 3D printer



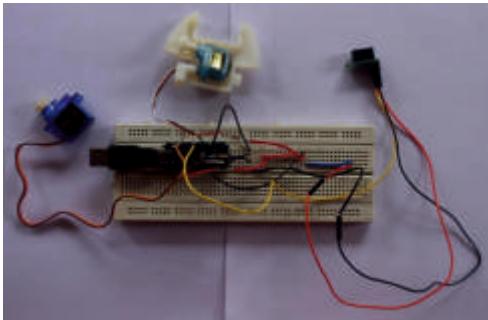
Fig. 8. Operating form of NEMO

B. Control System

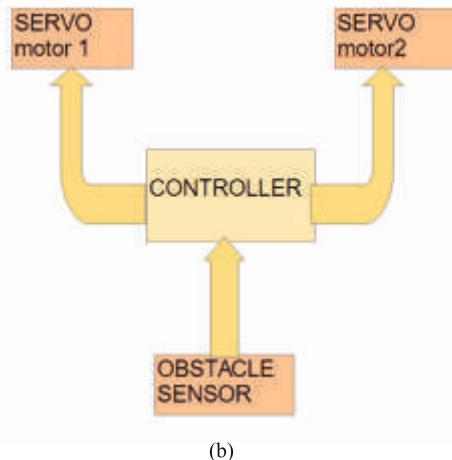
Basic control of the NEMO mark 1 has been accomplished through an Arduino-nano board. The board has a micro controller, ATmega328. The controller is programmed and burned to provide motion control to the robotic fish. The entire board of the controller works on 5V and hence a higher voltage supply is regulated to 5V using a built in regulator. NEMO also houses an IR obstacle sensor. On sensing the obstacle NEMO is programmed to change its direction. The feed from the sensor is interpreted by the controller and the controller sends signals to the servomotors to move the fish as desired. Fig. 9 shows the controller layout in NEMO.



(a)



(b)



(b)

Fig.9. Controller and servo motor arrangement in NEMO

V. RESULTS AND DISCUSSIONS

NEMO generates a torque of 1.92 kg cm and a maximum angular displacement of 44 deg. It can successfully propel on 0.792 A current since it is driven by a single servo motor at a time. This proves the efficiency in design for converting the robotic fish into an AUV. CFD studies indicate a propulsive force of approximately 2N which can be verified through experiments. 3D CFD studies are in progress and are expected to yield more reliable results.

VI. CONCLUSIONS

The propulsion of fish is produced by the to and fro flapping of the tail. The turning couple is generated by tilting the abdomen. The abdominal part acts like a rudder in ships and the tail, propeller. The control system is durable in the given circuit, but with a higher current utilization external power has to be supplied. On the whole the present work finds its success in designing and fabricating a robotic fish with an indigenously developed technology. The current fish is indeed a useful prototype to learn the motions of fish, robotics and stereolithography.

VII. SCOPE FOR FUTURE WORK

NEMO mark 2 is proposed to be used for surveillance and water quality assessment by incorporating appropriate sensors. Further improvisations of NEMO design would be carried out to keep the AUV technology updated with the demands of the world.

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REFERENCE

- [1] Triantafyllou M.S., Triantafyllou G. S. (1995), " An Efficient Swimming Machine ", Scientific American, pp.40-48.
- [2] Triantafyllou M.S., Triantafyllou G. S., and YueD.K.P. (2000), "Hydrodynamics of Fishlike Swimming", Annu. Rev. Fluid Mechanics, Vol. 32, pp. 33-52.
- [3] Tzeranis D., Papadopoulos E. and Triantafyllou G. (2001), "On the Design of an Autonomous Robot Fish", www.nereus.mech.ntua.gr/med03.
- [4] Liu J. and Hu H., (2004), "A 3D Simulator for Autonomous Robotic Fish", International Journal of Automation and ComputingVol.1 pp.42-50.
- [5] Tan X., Kim D., Usher N., Laboy D., Jackson J., Kapetanovic A., Rapai J., Sabadus B and Zhou X., (2006), "An Autonomous Robotic Fish for Mobile Sensing ", Proceedings of the IEEE/RSJ, International Conference on Intelligent Robots and Systems, Beijing, China, pp. 5424-5429.
- [6] Lauder G. V. and Madden P. G. A. (2006), "Learning from Fish: Kinematics and Experimental Hydrodynamics for Roboticists", International Journal of Automation and Computing , Vol. 4 pp. 325-335
- [7] Mohammadshahi D., Yousefi-Koma A., Bahmanyar S., Ghassemi H., Maleki H., (2008), "Design, Fabrication and Hydrodynamic Analysis of a Biomimetic Robot Fish", International Journal of Mechanics, Vol. 2 (4), pp. 59-66.
- [8] Korkmaz D., Budak U., Bal C., Koca O. G. and Akpolat Z., H. (2012) "Modeling and Implementation of a Biomimetic Robotic Fish", International Symposium on Power Electronics, Electrical Drives, Automation and Motion.

A COMBINED REVERSIBLE AND LOSSLESS DATA HIDING SCHEME FOR DATA SECURITY SYSTEMS

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Abstract: The security of the data being transmitted is coming to a serious issue in today's fast moving world. Hence for providing data security, we can use any type of lossless or reversible data hiding techniques. Due to the compatibility between the lossless and reversible schemes, the data embedding operations in the two manners can be simultaneously performed in an encrypted image. So here we use a combined lossless and reversible data hiding technique so that one part of data can be extracted before image encryption and another confidential part can be extracted after encryption. In the combined scheme we use visual cryptography for image encryption to improve the efficiency of the system by reducing the time consumption. Then we use hash encryption method for lossless hiding of one part of secret data and difference expansion method for reversible hiding of next part of secret data. Thus we can embed two parts of data in a single encrypted image which provides more security to our data.

Keywords: Data Hiding, Reversible Data Hiding, Lossless Data Hiding, Visual Cryptography Image encryption, Image decryption.

1. INTRODUCTION

Nowadays the data that is to be secured is transmitted by embedding it in encrypted images. This way improves the security of the data. This type of data hiding where we can achieve reversibility is called as Reversible Data Hiding. Hence the security of the cover image can be ensured. We can use this technique in situations where the security of both the transmitted data and the cover image are confidential.

The Reversible Data Hiding is a technique which is established based on both steganography & security. That is the data to be secured is embedded in an encrypted image. In the first step, the image is encrypted using any encryption technique. Then the data to be secured is embedded in that encrypted image by the sender. With an encrypted image containing the additional data, the receiver can extract the additional data if he knows the data-hiding key even though he does not know the image content. He can also decrypt the received encrypted image to recover an image similar to the original image if he knows the encryption key. If the receiver has both the data hiding and encryption keys he can extract the additional data and also he can recover the original content which is an errorless process.

We can do the data hiding schemes in a lossless or reversible manner. The terms lossless and reversible

can be distinguished differently. The data hiding method is said to be lossless if the display of cover image containing embedded data is same as that of original cover image even though the cover image have been modified for the data embedding process. On the other hand, the data hiding method is reversible if the original image content can be perfectly recovered from the encrypted image containing the embedded data even though a small distortion has been brought in the data embedding procedure.

In this paper, we combined both lossless and reversible data hiding schemes together to get a more secure and error free data hiding scheme. The process of data embedding can be done in an encrypted image using both of the schemes. But the data extraction processes in the two schemes are different. Hence by combining these two schemes we can embed two parts of data into a single cover image. That means the different types of data for various purposes may be embedded into an encrypted image, and a part of the data can be extracted before decrypting the cover image and another part can be extracted after decrypting the cover image.

II. RELATED WORKS

Reversible data hiding technique focuses on the data embedding or extraction. The main aim of this technique is the error free and separable data extraction

and image recovery. Lossless data hiding focuses on the display of cover image containing embedded data which will be same as that of original cover even though the cover image have been modified for data embedding. A combination of both lossless and reversible schemes will provide security to highly confidential data so that one part of data can be extracted before encrypting the cover image and other highly confidential part can be extracted after encrypting the cover image.

A. Reversible data hiding schemes

There are a number of techniques for reversible data hiding. In all reversible data hiding techniques data embedding is performed in an encrypted domain. The reversible data hiding can be done in Encrypted JPEG Bitstream [1]. The secret message is embedded into the encrypted bitstream by slightly modifying the JPEG stream. The system identifies the usable bits for data hiding so that the encrypted bitstream carrying secret data can be correctly decoded. The encryption and embedding are based on the encryption and embedding keys respectively. Hence if a receiver has both the keys, the secret data can be extracted by analysing the blocking artifacts of the neighbouring blocks and the original bitstream can be perfectly recovered. In the case if the receiver has only the encryption key he/she can still decode the bitstream to obtain the good quality image without extracting the hidden data.

The technique of image interpolation and the detection of smooth and complex regions in the cover images provides an improved reversible data hiding scheme [2]. A binary image that represents the locations of reference pixels is constructed based on the local image activity. In complex regions, more reference pixels are chosen and thus some pixels are used for embedding the data which reduces the image degradation. In the smooth regions, less reference pixels are chosen, which increases embedding capacity. Pixels are interpolated according to the constructed binary image, and the interpolation errors obtained are then used to embed data through histogram shifting. The pixel values in the cover image are modified one gray scale unit at most to ensure that a high quality stego image can be produced.

Histogram Shifting is another technique which can be used for reversible data hiding [3]. Here the input image is divided into some number of blocks and then

histogram shifting is performed on each block which enhances the data hiding capacity and visual quality. This technique mainly consists of three stages: 1) Dividing image into two blocks 2) Processing Stage and 3) Data Embedding Stage. The first stage includes dividing the image into two main blocks. Processing stage includes histogram generation of each block and the difference of histogram are taken after histogram modification. The proposed approach shows a binary tree structure which overcomes the drawback of communicating the multiple peak points to the receiver. Also the data embedding is done after dividing the image into blocks.

B. Lossless Data Hiding Schemes

Lossless data hiding techniques provides the cover image containing embedded data to be same as that of the original cover. There are some lossless data hiding techniques. There is a method of lossless data hiding in which a lossless compression technique for encrypted gray scale image using a method called progressive decomposition and rate-compatible punctured turbo codes [4] are used. In this method they developed resolution progressive compression, which has been shown to have much better coding capacity and less computational complexity than that of the existing approaches. This lossless compression of encrypted sources can be obtained through Slepian-Wolf coding. For the encrypted real-world sources such as images, they are trying to improve the compression efficiency. There is a resolution progressive compression scheme which compresses an encrypted image progressively in resolution, so that the decoder can be able to observe a low-resolution version of the image, study local statistics based on it, and use the statistics obtained to decode the next resolution level.

There is another lossless generalized LSB data embedding method [5], which enables the exact recovery of the original host signal upon extraction of the embedded information. A generalization of the LSB modification is proposed as the data embedding method, which introduces additional operating points on the capacity distortion curve. Lossless recovery of the original image is achieved by compressing portions of the signal that are susceptible to embedding distortion and transmitting these compressed descriptions as a part of the embedded payload. A prediction based conditional entropy coder which utilizes unaltered portions of the host signal as side

information improves the compression efficiency and thus the lossless data embedding capacity.

A high capacity lossless data embedding techniques for palette images can be done based on histogram analysis [6]. The histograms are analysed to identify the embedding capacity of different image types. Histogram maxima and minima are used in embedding capacity estimation. The data embedding and extraction is performed using simple processing operations that can save power consumptions for wireless devices. The proposed algorithm uses the indices corresponding to zero values in the histogram to repeat the most used colours. After repeating colours, the indices of the repeated colours are used to map data bits according to a predefined mapping scheme.

C. Combined Lossless and Reversible Data Hiding Scheme

The above two separate data hiding schemes can be incorporated to form a single scheme which can be used for embedding two parts of data in a single encrypted image. A combined lossless and reversible data hiding schemes for public key encrypted images [7] is the advanced existing scheme. In both of the two data hiding techniques in the combined scheme, the data embedding operations are performed in encrypted domain. On the other hand, the data extraction procedures of the two schemes are very different. With the lossless scheme, data embedding does not affect the plaintext content and data extraction is also performed in encrypted domain. With the reversible scheme, there is slight distortion in directly decrypted image caused by data embedding, and data extraction and image recovery must be performed in plaintext domain. That implies, on receiver side, the additional data embedded by the lossless scheme cannot be extracted after decryption, while the additional data embedded by the reversible scheme cannot be extracted before decryption. The combined lossless and reversible schemes can be used to construct a new scheme, in which data extraction in either of the two domains is feasible. That means the additional data for various purposes may be embedded into an encrypted image, and a part of the additional data can be extracted before decryption and another part can be extracted after decryption

In the combined scheme, the image provider initially performs histogram shrink and image encryption on the original image. When having the

encrypted image, the data-hider may embed the first part of additional data using the method reversible data hiding. Then he can embed the second part of additional data using a lossless data hiding scheme. On receiver side, the receiver firstly extracts the second part of additional data from the LSB-planes of encrypted domain. Then, after decryption with his private key, he extracts the first part of additional data and recovers the original plaintext image from the directly decrypted image.

III. A COMBINED LOSSLESS AND REVERSIBLE DATA HIDING IN ENCRYPTED IMAGES USING VISUAL CRYPTOGRAPHY

To overcome the problems of data missing and degradation of image quality and to reduce the computational complexity of public key cryptosystems and also to ensure complete security, we proposes a new combined lossless and reversible data hiding in encrypted images with visual cryptography. Visual cryptography overcomes both the complexity as well as security problems associated with public-key cryptosystems. Also the data extraction and image recovery are much easier as there is no need of any key exchange and also it is less time consuming. The main stages of the new scheme are Histogram Shifting, Image Encryption, Data Embedding, Data Extraction and Image Recovery. The framework of the proposed scheme is shown in figure 1.

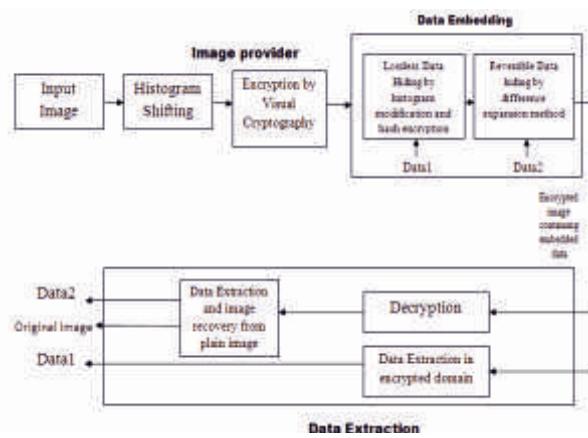


Fig 1. Combined Reversible and Lossless Data Hiding Scheme

In this phase the histogram of the input image is obtained and performs histogram shifting on it. In histogram shifting, it shifts slightly the part of the histogram between the maximum point and the minimum point to the right side by one pixel value to

create an empty bin besides the maximum point for hiding an input message. Advantages of this method include yielding superior hiding capacities and providing higher qualities in stego images.

In this Histogram Shifting process [7] a small integer shared by the sender and the receiver is used. Then the sender side collect the pixels with gray values in $[0, \lambda + 1]$, and represent their values as a binary stream BS1 and also collects the pixels with gray values in $[255 - \lambda, 255]$ and represent their values as binary stream BS2. Then the gray values are enforced into $[\lambda + 1, 255 - \lambda]$,

$$m_s(i, j) = \begin{cases} 255 - \lambda, & \text{if } m(i, j) \geq 255 - \lambda \\ m(i, j), & \text{if } \lambda + 1 < m(i, j) < 255 - \lambda \\ \lambda + 1, & \text{if } m(i, j) \leq \lambda + 1 \end{cases}$$

Then denoting the new histogram as $h'v$ where $h'v$ denotes the number of pixels in the original plaintext image with gray value v , there must be

1. If $v \leq \lambda$, then $h'v = 0$.
2. If $v = \lambda + 1$, then $h'v = hv$.
3. If $\lambda + 1 < v < 255 - \lambda$, then $h'v = hv$.

If $v > 255 - \lambda$, then $h'v = 0$.

Then the image provider finds the peak of the new histogram,

$$V = \arg \max h'v$$

Then a histogram shift operation is made on the received pixels. The figure 2 shows the histogram shrinked image and the original image.

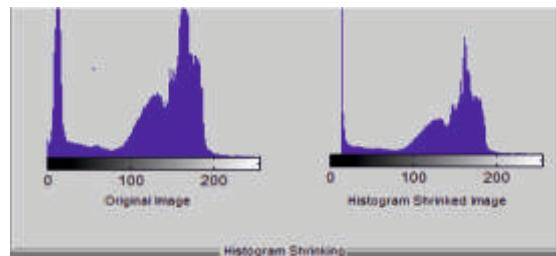


Fig.2. Histogram Shrinking

B. Image Encryption using Visual Cryptography

The input image is taken and it is divided into seven bit planes using bit plane slicing and of that the

last bit plane is selected. Then we performs visual encryption on that seventh bit plane. In the visual encryption process, the image is split into two shares. Each share has a pair of pixels for every pixel in the original image. These pixels are shaded black or white according to the following rule:

If the original image pixel was black, the pixel pairs in the shares must be complementary; randomly shade one pixel black and white and the other white and black. When these complementary pairs are overlapped, they will appear dark gray.

If the original image pixel was white, the pixel pairs in the shares must match both white and black or both black and white. When these matching pairs are overlapped, they will appear light gray. Then the six bit planes and the two shares are send to the receiver so that he can get the message as well as the original image back. The figure 3 shows the share.

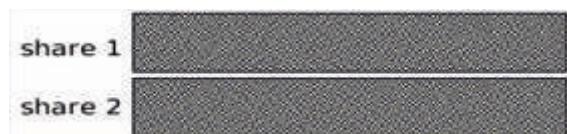


Fig. 3. Shares generated using visual cryptography

6. Inverse integer transform.

In a digital image, one can select some expandable difference values of pixels, and embed one bit into each of them. To extract the embedded data and restore the original values, the decoder needs to know which difference values have been selected for the DE. To facilitate it, we need to embed such location information, such that the decoder could access and employ it for decoding. For this purpose, we will create and embed a location map, which contains the location information of all selected expandable difference values.

The difference values are denoted as h and order them into a one dimensional list $h_1, h_2, h_3, \dots, h_n$. Next we create four disjoint sets of difference values,

EZ, EN, CN, and NC:

1. EZ: contains all expandable $h=0$ and expandable $h=-1$
2. EN: contains all expandable $h \neq EZ$.
3. CN: contains all changeable $h \neq (EZ \cup EN)$.
4. NC: contains all non-changeable h .

Each difference value will fall into one and only one of the above four sets. Next we create a location map of selected expandable difference values. For every difference value h in EZ, it will be selected for the DE. For EN, depending on the payload size, some difference values will be selected for the DE. Then the original LSBs of difference values are collected and after that the location map, original LSB and payload p (includes hash of original image) is embedded into the share. Finally all bits are embedded and apply, inverse integer transform to obtain embedded image.

E. Lossless Data De-embedding

In the lossless data decoding technique the size of the new message embedded image is obtained. The message embedded share, its size and the minimum pixel location are the input taken here. Then the embedded share is reshaped into a single row and after that the data is taken from it in the form of bits. The original message embedded is extracted by converting the bits extracted into character message.

F. Reversible Data De-embedding

We can retrieve the embedded bit stream by collecting LSBs of all changeable difference values. From the bit stream, we can decode location map and original LSB. After all changeable difference values have restored their original values, we can restore the original image exactly. The reversible data de-embedding includes 5 steps:-

1. Calculate the difference values (apply transform).
2. Create two sets (CH-changeable h) and (NC-Non changeable h).
3. Collect LSBs of all difference values in CH and form bit stream.
4. We decode the location map.
5. Restore the original values of differences.
6. Inverse transform to reconstruct a restored image.

G. Image Decryption and Image Recovery

At the receiver side, the two shares of the seventh bit plane and the other six bit planes are XORed together to obtain the original image. This step is performed after data extraction and so the share received here doesn't have any data. At first the two shares are XORed to get the seventh bit plane. After that the seven bit planes joined together to get the original input image.

IV. EXPERIMENTAL RESULTS

The proposed scheme is evaluated by obtaining the PSNR values and embedding capacity of the stego image. For embedding efficiency also called embedding quality or visual quality of the stego image, in order to avoid a subjective evaluation by human naked eyes, a well-known measurement called peak-signal-to-noise ratio (PSNR) is used to obtain the similarity between original image and stego image.

PSNR is defined as

$$\text{PSNR} = \frac{10 \log_{10} 255^2}{\text{MSE}}$$

Where MSE is the mean square error represents the difference between stego image and original image sized $H \times W$ pixels. The MSE is defined as

$$\text{MSE} = \frac{1}{H \times W} \sum_{i=1}^{H \times W} \sum_{j=1}^3 (I_{ij} - I'_{ij})^2$$

According to the visual quality evaluation, a high value of PSNR means that a stego image is much similar to its original image and the embedding efficiency is high.

Different image are taken and different data are embedded into it each times so as to evaluate its PSNR and embedding capacity in each cases. In each of the cases it is obtained that the PSNR and Embedding capacity are higher than the existing combined scheme.

V. CONCLUSION

This work proposes a combined reversible and lossless data hiding scheme for providing security to highly confidential data. The combined scheme performs data embedding in an encrypted image using both of the data hiding schemes. Here the image is encrypted using visual cryptography as it requires no key exchange. The highest time consumption and complexity which are the problems of existing combined data hiding schemes overcomes here. Also the efficiency and security of the system is improved. Thus we can use this system for the transmission of highly confidential data as we can embed two parts of data into a single cover image so that one part can be extracted after the decryption of the cover image and other part before the decryption of the image.

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REFERENCES

- [1] Z Qian, X Zhang and S Wang, "Reversible Data Hiding in Encrypted JPEG Bitstream", IEEE Transactions on Multimedia (2014).
- [2] Weing Hong and Tung-Shou Chen, "Reversible Data Embedding for High Quality Images using Interpolation and Reference Pixel Distribution Mechanism", J. Vis Commun. Image R22, Elsevier (2011).
- [3] W.Hong and T.S.Chen, "Histogram Shifting based Reversible Data hiding", International Journal of Engineering Trends and Technology (2014).
- [4] Wei Liu, Wenjun Zeng, Lina Dong, and Qiuming Yao "Efficient Compression of Encrypted Grayscale Images", Image Processing, IEEE Transactions Vol: 19, April 2010, pp. 1097 – 1102.
- [5] Mehmet Utku Celik, Gaurav Sharma, Ahmet Murat Tekalp, Eli Saber, "Lossless Generalized-LSB Data Embedding", IEEE Transactions on Image Processing.
- [6] Noura A Saleh and Hoda N boghdady, "High Capacity Lossless Data Embedding Techniques for Palette Images based on Histogram Analysis", Digital Signal Processing (Elsevier 2010).
- [7] Xinpeng Zhang, Jing Long, Zichi Wang, and Hang Cheng, "Lossless and reversible Data Hiding in Encrypted Images with Public key Cryptography", IEEE Transactions on Circuits and Systems for Video Technology , 2015.
- [8] Yongjian Hu, Member, IEEE, Heung-Kyu Lee, Kaiying Chen, and Jianwei Li, "Difference Expansion based Reversible Data Hiding using Two Embedding directions", IEEE Transactions on Multimedia, 2008.
- [9] X. Zhang, "Reversible data hiding in encrypted images," IEEE Signal Process. Lett., vol. 18, no. 4, pp. 255258, Apr. 2011.
- [10] Z. Ni, Y. Shi, N. Ansari, and S. Wei, "Reversible data hiding," IEEE Trans.Circuits Syst. Video Technol., vol. 16, no. 3, pp. 354– 362, Mar.2006.
- [11] J. Tian, "Reversible data embedding using a difference expansion" Trans. Circuits Syst. Video Technol., vol. 13, no. 8, pp. 890 2003.
- [12] D.M. Thodi and J. J. Rodriguez, "Expansion embedding techniques for reversible watermarking," IEEE Trans.Image Process., vol. 16,no. 3, pp. 721–730, Mar. 2007.
- [13] W. Zhang, B. Chen, and N. Yu, "Improving various reversible data hiding schemes via optimal codes for binary covers" vol. 21, no. 6, pp. 2991–3003, June. 2012.
- [14] W. Hong, T. Chen, and H.Wu, "An improved reversible data hiding in encrypted images using side match," IEEE Signal process. Lett., vol. 19, no. 4, pp. 199–202, Apr. 2012.
- [15] Wei Liu, Wenjun Zeng, Lina Dong, and Qiuming Yao "Efficient Compression of Encrypted Grayscale Images", Image Processing, IEEE Transactions Vol: 19, April 2010, pp. 1097 – 1102
- [16] Vinit K Agham and Tareek M Patterwar, "Seperable Reversible Data Hiding Technique Based on RGB-LSB Method", International Journal of Research in Advent Technology (2013).
- [17] Anuradha and Lavanya, "Secure and Authenticated Reversible Data Hiding in Encrypted Image", International Journal of Advanced Research in Computer Science and Software Engineering 2013).
- [18] Kede Ma, Wei. Zhang, Xianfeng Zhao, "Reversible data Hiding in Encrypted Images by reserving Room before encryption", IEEE trans. On information forensics and security, vol.8 No.3 , march 2013.
- [19] J Jagadersan Balika and Nikhila Nyapathy , "Reversible Data Hiding in Encrypted Images using AES Data Encryption Technique", International Journal of Emerging Research in Management and Technology(2014).

- [20] M. Johnson, P. Ishwar, V.M. Prabhakaran, D. Schonberg and K. Ramchandran, "On compressing encrypted data," IEEE Trans. Signal Process., vol. 52, no. 10, pp. 2992-3006, Oct. 2004.
- [21] Sukhdeep Kaur and Manshi Shukla, "Reversible Data Hiding in Images using Circular Hough Transform", International Journal of Computer Science and Information Technologies (2014).
- [22] Jiantao Zhou, Weiwei Sun, Li Dong, Xianming Liu, Oscar C. Au, and Yuan Yan Tang, "Secure Reversible Image Data Hiding over Encrypted Domain via Key Modulation", IEEE transactions on circuits and systems for video technology, 2015.
- [23] Kede Ma, Wei. Zhang, Xianfeng Zhao, "Reversible data Hiding in Encrypted Images by reserving Room before encryption", IEEE trans. On information forensics and security, vol. 8 No.3, march 2013.
- [24] Bhanodia, Mrudula Mukadam and Prashant Kale, "Seperable reversible Data Hiding using Matrix Addition Compression Approach for Color Images", International Journal of Emerging Technology and Advanced Engineering(2013).
- [25] Pramod R Sonawane and K.B Chaudari, "Reversible Image Watermarking Using Adaptive Prediction Error Expansion And Pixel Selection", International Journal of Engineering Science and Innovative Technology (2013).

E- POLL (A PRIVACY PRESERVING DATA SHARING)

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Abstract: Customary e-voting frameworks supplant the paper based process with an electronic one at authority voting areas. Remote electronic polling (e-Poll), where the voter can vote from any area, increments both support rates in the decisions and the client's fulfillment as it facilitates the voting process and recoveries time. Be that as it may, having a e-Poll framework expands the security vulnerabilities. Those vulnerabilities incorporate harder client validation, probability of pernicious programming on the client's gadgets, system vindictive hubs, pressure, and vote selling. In the advanced age, vote based frameworks progressively resort to innovation to bolster, compliment and even change political procedures. The developing utilization of different electronic means in decisions mirrors the general propensity of expanded digitalization, more noteworthy effort, and improved versatility in our social orders. On the other hand, the difficulties are significant. If not precisely arranged and composed, e-Poll can undermine the trust in the entire constituent procedure. The primary undertaking of this paper is to present the thought of electronic voting frameworks. The main concepts used in this e-Poll system are anonymous communication and electronic voting framework. There exists an opportunity and inspiration to execute such an application with the reason for offering voters a plausibility of voting at private or government race particularly for NRIs. The system also generates the graphical representation of the complete NRI votes casted. The results and analysis of the particular election are provided after the conventional election procedure and vote statistics are completed. On the completion of the above process the e-Poll system provides the final election results and the list of NRI voters who participated in the election.

Index Terms: Anonymous communication, AIDA, multiparty computation, electronic voting framework.

1. INTRODUCTION

INTRODUCTION

The use of web as a correspondence medium for business or individual necessities depends to some degree on its sponsorship for mysterious correspondence. Mysterious correspondence stays far from the result of identity revealing issues. The diverse application territories of baffling correspondence are: understanding remedial records (tolerant restorative report), long range interpersonal correspondence (person to person communication), electronic voting, and email. The exponential progress in the field of information development and electronic correspondence offered ascensions to new applications in the scope of voting. There is an in number inclination towards moving to Internet Voting – at any rate among the administrators – remembering the final objective to redesign voter solace, extend voter conviction and voter turnout [15]. Regardless, there are totally genuine

mechanical and social points of view that make Internet Voting infeasible in the unmistakable future. In this manner, different technologists have endorsed that remote outline site electronic voting, where the voter can vote at any survey site (not just his home territory study site), is all around the best meander forward as it gives better voter settlement, however in the interim, does not bargain security. A study on the best in class in Electronic Voting, including the particular works done in Internet Voting (and the disagreements against its use), besides in electronic outline webpage voting were done to look at the slants and harms of the framework [15].

Electronic voting insinuates the use of PCs or modernized voting apparatus to cast tickets in a choice. Once in a while, this term is used more especially to suggest voting that happens over the Internet. PC structures can be used to enroll voters, number tickets, and record votes [1, 15]. We can execute the e voting structure utilizing the electronic voting framework together with the thought of unknown

correspondence. To autonomous baffling ID assignment from obscure correspondence, consider a circumstance where parties wish to show their information all around, however subtly, in openings on an untouchable site. The IDs can be utilized to assign the spaces to clients, while puzzling correspondence can permit the get-togethers to cover their characters from the outsider. In another application, it is conceivable to utilize secure aggregate to permit one to stop of revenge to this point on the reason of specific statutes in quantifiable exposure snag or amidst a get ready and even to do as being what is shown in a perplexing way. Obviously, nearby no is known as to calendars permitting associations to withdraw of a protected planning in light of the aftereffects of the examination, if they feel that those outcomes are an excessive amount of enlightening about their information [2, 15].

II LITERATURE SURVEY

A. Anonymous Communication

The unknown correspondence investigates the relationship between presenting anonymous in a peculiar way, streamed secure multiparty estimation and anonymous ID undertaking. The use of the expression "unknown" here complexities from its importance in examination administering symmetry softening and pioneer decision up strange structures. Our framework is not obscure and the individuals are identifiable in that they are known not can be had a tendency to by the others. The structures grew in these works for the most part oblige a trusted head, as shaped, and their finished things. Taking all things into account separation from our own specific in structure and/or in quantifiable properties. The estimations AIDA appropriates a planning among the inside focuses rolling out an improvement of picked with a uniform likelihood of from the strategy of all movements of where will know just [2, 13]. Stage can be made the most of by the normal for metal porker. Metal porker include are moreover baffling nature and it utilize cryptographic strategy. Here, the individuals are semi-genuine, generally called standoffish or bona fide yet curious and execute their obliged traditions faithfully. Unknown correspondence is conceivable by offering information on top of secure aggregate. The offering processing will be utilized at every emphasis of the estimation for dark ID task [1, 13]. The AIDA calculation and secure whole can oblige a variable and unbounded number of emphases. Growing a parameter in the tally will decrease the measure of expected rounds.

Notwithstanding, the crucial calculation of anonymous correspondence obliges elucidating a polynomial with coefficients taken from a compelled field of numbers modulo a prime. That try keep the level to which can be essentially raised. Secure total figuring is used to enroll and grant only the ordinary of data things in the data base, for instance, number of mending focus picked up tainting, without revealing the estimation of this data thing for any person from the social event who partaking in the multiparty figuring. If there is a protected correspondence channel is available, it should be fundamental and resource raised then secure entire can be executed [1].

Consider a condition where a social occasion of center points wishes to bestow honest to goodness estimations of data things from their database instead of relying upon simply quantifiable unobtrusive components then power all out computation together with secure aggregate is more suitable. Power sum is a symmetric limit. Obscure data offering to power totals is completed in way that the power wholes can be assembled and granted using a single round of secure sum. Here the data is transmitted as a display. It uses vectors for transmitting and tolerating data [13].

B. E-Voting framework

The Caltech/MIT Voting Innovation Venture started to exist recollecting the completed goal to make another voting advancement to keep a repeat of the issues that happened in the 2000 U. S. Presidential Elections [6]. The crucial motivation behind that work was to find the tremendousness of the issues, their essential drivers and how progression can diminish them. They address an expansive blended sack of "What is" issues including voting strategies, voting apparatus, voter selection, looking over spots, non-master and early voting, overview security, cost and open record of decisions, and so forth. [1, 13, 15].

The NSF Web Voting Report addresses the plausibility of specific signs of Web voting from both the particular and human science viewpoints and depicts an examination plan to search for after if Web voting is to be achievable later on. It collects Web voting frameworks into three general requests as Poll-site page Web voting, Stand voting, Remote Web voting.

The try demonstrates two or three disclosures on the sound judgment of each of these classes and gives research suggestions to the entire arrangement future. It then sees criteria for decision structures. At

long last, it addresses the innovative issues (numbering voting framework vulnerabilities, dedicated quality, testing, accreditation and benchmarks, particulars of source code, stage likeness, and question, and so forth.) and human science issues, (for occasion, voter theory, voter get to, the race process, voter data, deliberative and authorities lion's offer rule government, assembling and character of decisions, diffusing of parts, voter choice, and so on.) [15].

The California Web Voting Report proposes an arrangement of transformative as opposed to element change towards accomplishing the objective of permitting voters to cast their tickets at whatever point from wherever through the Web. It depicts four exceptional Web voting models – Web voting at voter's exploring spot, Web voting at any mulling over spot, Remote Web voting from Area PCs or stands, Remote Web voting from any Web association [13, 15].

A sweeping survey of e-voting headway has been given in "e-Voting Security Study" [10]. It gives a layout for the most part scholarly and business extends in the degree, regardless of the region's undeniable scholastics' close and dear perspectives and affirmations as for the issues. It perceives hazards, potential wellsprings of trap and conceivable calendars for assault in such voting frameworks. It besides perceives security destinations and necessities of an electronic voting framework [13, 15].

Fujioka, Okamoto and Ohta (FOO) gives a sensible structure for a secured race that fuses an authority and a counter and the voter related by a dark channel. The method used by Census [12, 15] ensures that only enlisted voters can vote and that each chose voter votes precisely once, while mean while keeping up voter's security. It permits voters to confirm independently that their votes were checked feasibly and stealthily challenge the outcomes, in cases the votes are failed.

The Electronic Surveying Framework for Remote Voting Operations makes it conceivable to utilize E-Survey-stands wherever, inside a private, time tested and secured structure. The voter-acknowledgment structure is considering an imaginative sharp card with an implanted biometric finger impression peruse, which performs voter acknowledgment with total security. It shows a structure for secure electronic voting which does not depend on upon imaginative system relationship between looking over spots and the vote-

counting server. They produce the structure on a confined (or, all the more doubtlessly, an eccentrically joined) environment, which acts well without system network [6, 10, 12, 15].

"Security Criteria for Electronic Voting" considers some as key criteria for assurance, uprightness, accessibility, dependability, and assertion for PC frameworks included in electronic voting. Rubin perceives the new dangers recognized by demonstrating the best in class progression into the race process, which may not be worth taking. [9].

Voting on the Web utilizing consistently PC's offers basically feeble security, yet its rule wounds are in the areas of secret and assurance against intimidation and/or vote promoting. It's such a really horrendous thought, to the point that there is with everything taken into account no genuine instructive push to send it by any stretch of the imagination. The Presidential decisions of 2000 conveyed national thought concerning issues with current American plans for hurling and including votes open races. The bigger part recognizes that the present structure ought to be changed; there is much irregularity on how such changes ought to be made.

Neumann [10] gives a fast review of recommendations for "dull voting criteria" that proposes a voting system which is secure enough so no business structure is at threat to ever meet the necessities. Rebecca Mercuri's [8, 13] structure for electronic voting states that a voting machine must make conceivable printed copy paper results, which can be acknowledged by the voter before the vote is flung, and physically related later if fundamental.III. REVIEW ON SECURE SUM

Assume that a gathering of clinics with individual databases wish to figure and share just the normal of an information thing, for example, the quantity of doctor's facility Acquired diseases, without uncovering the estimation of this information thing for any individual from the gathering. In this manner N hubs n₁, n₂, n₃, n₄... ... n_N have information things d₁, d₂... d_N, and wish to register and share just the aggregate quality. A protected aggregate calculation permits the total to be gathered with a few assurances of obscurity. Furthermore, consider accept model of protection saving information mining is semi-fair in nature [1]. Under this model, every hub will take after the tenets of the convention, however may utilize any data it sees

amid the execution of the convention to bargain security. Should all sets of hubs have a safe correspondence channel accessible; a straightforward, however asset concentrated, secure sum calculation can be constructed.

Calculation (Secure Sum)[1]: Given hubs n_1, \dots, n_N every holding an information thing d_i from a limitedly representable abelian gathering, share the quality $T = \sum d_i$ among the hubs without uncovering the qualities d_i .

- 1) Each hub $n_i, i=1 \dots N$, picks arbitrary qualities r_1, \dots, r_{N} such that $r_1 + \dots + r_N = d_i$
- 2) Each "irregular" worth is transmitted from hub n_i to Node n_j . The entirety of all these irregular numbers $r_{i,j}$ is, obviously, the craved aggregate T .
- 3) Each hub adds up to all the irregular qualities got as: $S_j = r_1 + \dots + r_j, N$
- 4) Now every hub essentially telecasts to every other hub so that every hub can process: $T = s_1 + \dots + S_N [1]$

IV. PROPOSED SYSTEM

Security is crucial to trusted joint effort and collaborations to ensure against pernicious clients and deceitful exercises. Security is expected to ensure wellspring of data, the destination of data, the course of data transmission of spread and the data placate itself. The notoriety of web as a correspondence medium whether for individual or business utilization depends to some extent on its backing for unknown correspondence. Organizations additionally have real motivations to participate in mysterious correspondence and keep away from the results of personality disclosure. Cloud-based site administration apparatuses give capacities to a server to secretly catch the guest's web activities. The issue of sharing secretly held information so that the people who are the subjects of the information can't be distinguished has been scrutinized broadly.

This work manages effective calculations for anonymous identifiers (IDs) to the hubs of a system in a manner that the IDs are anonymous utilizing a distributed computation. The IDs are required in sensor systems for security or for managerial undertakings

obliging dependability, for example, setup and observing of individual hubs, and download of paired code or information accumulation portrayals to these hubs. An application where IDs should be unknown is matrix processing where one may look for administrations without uncovering the character of the administration requestor. To separate unknown ID task from mysterious correspondence, consider a circumstance where gatherings wish to show their information on the whole, yet secretly, in openings on an outsider site. The IDs can be utilized to allot the spaces to

- The system is exclusively for NRI voters.
- The entire list of NRI electorates is available with the administrator of the system.
- Once an electorate is added in the NRI voters list he/she is prohibited from casting a vote in the conventional election procedure.

A. Anonymous communication system.

Calculation for mysterious sharing of private information among gatherings is created. This method is utilized iteratively to dole out these hubs ID numbers extending from 1 to N. This task is mysterious in that the characters got are obscure to alternate individuals from the gathering. Imperviousness to plot among different individuals is checked in a data theoretic sense when private correspondence channels are utilized. This task of serial numbers permits more perplexing information to be shared and has applications to different issues in security safeguarding information mining, impact shirking in interchanges and circulated database access. The fundamental point of interest is the secrecy of DB is not influenced by embeddings the records.

The different modules of anonymous communication system are the following.

Homomorphic encryption module: This module to utilize the first convention is gone for concealment based unknown databases and it permits the proprietor of DB to legitimately anonymize the tuple t , without increasing any valuable learning on its substance and without needing to send to its proprietor recently created information. To accomplish such objective, the gatherings secure their messages by scrambling them. So as to perform the security safeguarding check of the database secrecy upon the insertion, the gatherings utilize a commutative and homomorphic encryption plan.

Generalization Module: In this module, the second convention is gone for speculation based mysterious databases, and it depends on a protected set crossing point convention, for example, the one found in, to bolster security saving reports on a speculation based k-unknown DB.

Cryptography Module: In this module, the procedure of changing over standard data called plaintext into incoherent nonsense called figure content. Decoding is the opposite, as it were, moving from the incoherent figure content back to plaintext. A figure (or) figure is a couple of calculations that make the encryption and the turning around decoding. The point by point operation of a figure is controlled both by the calculation and in every example by a key. This is a mystery parameter (in a perfect world known just to the communicants) for a particular message trade setting.

User and Administrator Module: In this module, to mastermind the database taking into account the voters subtle elements and records. The administrator to encode the voters reports utilizing encryption procedures utilizing concealment and speculation protocols

B. e-Poll frame work

The main modules in this real time e-poll system are: Registration process, Ballot design module, Database Administrator module, Voting module, Real-Time Live Results module.

Registration module: This module is for the voter, where he/she should first enlist his/her points of interest first into the enrollment structure, satisfying all the obliged particulars. The obliged fields are; Candidate name, Gender, Date of birth, current and permanent address, election ID card number, nationality, name of state, district, parliamentary assembly, legislative assembly, name of panchayath/municipality/corporation, name of the ward, email address, contact number, recent picture and VISA number. On the off chance that the approvals are legitimate then just the data get enlisted. Once the voter gets enlisted he/she is given voters character number (VIN) on the voter's card which would be printed out and be utilized as a part of instance of secret word misfortune [13].

Ballot Design Module: This element is handled by the administrator; where poll can be setup i.e. Admin can create and manage elections, assign the candidates of

the election [1, 13].

Database Administrator Module: Administrator has the privilege of viewing registered voters. He can view the details of all NRI electorates who have registered. The administrator is also entrusted with the feature of managing the election process [17].

Voting Module: This module is for the voters. The electorates can login in to the system by using the user name and password provided during the registration time. During the login, details of that particular electorate will be crosschecked with the database and his/her identity will be replaced by an anonymous identity. The registered users can login to the system only on the date of election.

Result Module: This module is developed for the voter, where he/she can view the results of the respective categories live immediately a vote is cast [17].

V. ANALYSIS AND DISCUSSION

As the quantity of bits per information and the quantity of hubs gets to be bigger, the strategy for the past segment gets to be infeasible. Rather, to fulfill this sharing, we will use an indexing of the hubs. Strategies for discovering such an indexing are produced in resulting segments. Expect that every hub n_i has a special distinguishing proof (ID) or serial number s_i component in $\{1, 2, 3...N\}$. Further, assume that no hub has learning of the ID number s_i of some other hub, and that $s_1...s_N$ are an irregular stage of $1...N$. This, once more, is termed an Anonymous ID Assignment (AIDA)[1].

Such an AIDA may be utilized to allocate openings as for time or space for interchanges or capacity. It might be conceivable to just have a database with focal stockpiling areas such that every hub basically stores its information there setting $C_{s_i} = d_i$. This could happen if there was a trusted focal power, or if the capacity operation was untraceable.

Given that there is no central authority (the situation for which secure sum was designed), secure sum can be used to accomplish the desired data sharing. Let zero be a vector of b - bits. Each node creates a data item D_i of $N.b$ bits. Numbering each of the N , b -bit components we have:

	1	2	s_i	N
$D_i =$	$\vec{0}$	$\vec{0}$	\dots	$d_i \dots \vec{0}$

The secure sum algorithm, given earlier in this paper, may now be used to collect the data items D1.....DN. The algorithm is applied using GF(2)^{Nb} as the abelian group. The group operation is bitwise exclusive-or, and each node n_i will choose N-1 random entries $r_{i,j}$, each composed N.b randomly chosen bits while calculating one entry.

How to find AIDA: A simple algorithm for finding an AIDA which has several variants depending on the choice of the data sharing method at step (3) below. At one step, random integers or slots|| between 1 and S are chosen by each node[1]. A node's position will be determined by its position among the chosen slots, but provisions must be made for collisions.

Algorithm (Find AIDA) [1]:

Given nodes n_1, \dots, n_N , use distributed computation (without central authority) to find an anonymous indexing permutation $s : \{1, \dots, N\} \rightarrow \{1, \dots, N\}$

- 1) Set the number of assigned nodes $A=0$.
- 2) Each unassigned node chooses a random number in the range 1 to S. A node assigned in a previous round chooses $r_i = 0$.
- 3) The random numbers are shared anonymously. Denote the shared values by $q_1 \dots q_N$
- 4) Let $q_1 \dots q_k$ denote a revised list of shared values with duplicated and zero values entirely removed where the number of unique random values is. The nodes n_i which drew unique random numbers then determine their index s_i from the position of their random number in the revised list as it would appear after being sorted: $s_i = A + \text{Card}\{q_j : q_j <= r_i\}$
- 5) Update the number of nodes assigned: $A = A + k$.
- 6) If $A < N$ then return to step (2). [1]

A Comparison of AIDA Variants

In the past segment the calculation to discover an AIDA obliged that the irregular numbers be shared namelessly at step 3. We now take a gander at two systems which are variations of that methodology. The parameter must be picked for every situation. The normal number of rounds depends just on the determination of and not on the variation picked.

Slot Selection AIDA [1, 3]: The opening determination technique was produced in where a more nifty gritty clarification may be found. In this variation of the AIDA calculation, every hub n_i presents the euclidean premise vector er_i $\in GF(N+1)^S$, zero with the exception of a solitary one in segment , to a protected total calculation[1, 4]. A hub which has gotten a task in a past round, notwithstanding, presents the zero vector The total T of these vectors is registered over the abelian bunch $GF(N+1)^S$ utilizing a safe total calculation. The irregular numbers picked and their multiplicities are easy to focus as $T_k = \text{Card}\{i : r_i = k\}$

Illustration (A Slot Selection AIDA): With the decision $S=10$ the AIDA sample from the past area would have executions of secure whole at every round with results as demonstrated in Table IV. Utilizing our illustration secure entirety calculation $N=4$ vectors of $S=10$ irregular numbers (not indicated) would should be picked by each of the $N=4$ taking an interest hubs at every round. This variation of the calculation has as its primary downside the long message lengths that are experienced when utilizing huge to keep the quantity of expected adjusts little [1].

2. Prime modulus AIDA [1, 3]: A prime $P>S$ is chosen from Slot Selection AIDA. The slot selection method was developed in where more detailed explanation may be found. In this variant of the AIDA algorithm[1], each node n_i submits the euclidean basis vector er_i $\in GF(N+1)^S$, zero except for a single one in component , to a secure sum algorithm. A node which has received an assignment in a previous round, however, submits the zero vectors. The sum T of these vectors is computed over the abelian group $GF(N+1)^S$ using a secure sum algorithm. The random numbers chosen and their multiplicities are simple to determine as $T_k = \text{Card}\{i : r_i = k\}$

VI. RESULT AND CONCLUSION.

e-Poll structure is more secured than the manual voting, and is exclusively for NRI electorates. e-Poll can promise a significant and solid decision. This tries to increase the voting rate. e-Poll is a solid example of anonymous communication and multiparty computations. One of the main requirement is that data base should be highly protected for avoiding fake

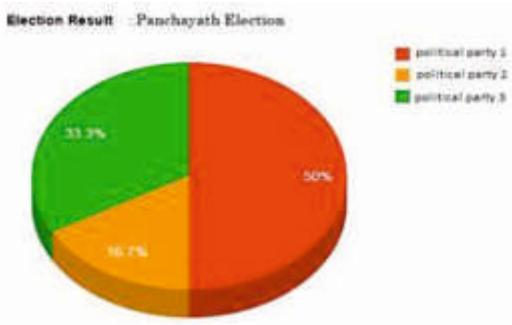


Fig 1: Graphical representation of election results.

REFERENCES

1. "Privacy Preserving Data Sharing With Anonymous ID Assignment||, Larry A. Dunning, and Ray Kresman, IEEE Transactions On Forensics And Security ,vol:8, no:2,pp 402-413 year 2013
2. "Voting – What is, What Could be||", Caltech/MIT Voting Technology Project (VTP) Repo, July 2001
3. A perfect collision-free pseudonym system||, J.W. Yoon and H. Kim, IEEE Commun. Lett., vol. 15, no. 6, pp. 686–688, Jun. 2011.
4. , Providing k-anonymity in data mining||, A. Friedman, R. Wolff, and A. Schuster, VLDB Journal, vol. 17, no. 4, pp. 789–804, Jul. 2008.
5. Tools for privacy preserving distributed data mining||, C. Clifton, M. Kantarcioglu, J. Vaidya, X. Lin, and M. Y. Zhu, ACM SIGKDD Explorations Newsletter, vol. 4, no. 2, pp. 28–34, Dec. 2002.
6. "A Preliminary Assessment of the Reliability of Existing Voting Equipment", The Caltech-MIT Voting Technology Project March 30, 2001 (revised). Available at <http://www.vote.caltech.edu/Reports/index.html>
7. Security and composition of multi-party cryptographic protocols||, R. Canetti, J. Cryptol., vol. 13, no. 1, pp. 143–202, 2000.
8. "A Better Ballot Box?" Rebecca Mercuri, IEEE Spectrum, Volume 39, Number 10, October 2002.
9. Security Criteria for Electronic Voting,. Peter Neumann, presented at the 16th National Computer Security Conference Baltimore, Maryland, September 20-23, 1993. Available at <http://www.csl.sri.com/ users/neumann/ncs93.html>
10. Secret-Ballot Receipts and Transparent Integrity,. David Chaum, draft. Available at <http://www.vreceipt.com/article.pdf>
11. Electronic Voting - Evaluating the Threat, Michael Ian Shamos, CFP '93. Available at <http://www.cpsr.org/conferences/cfp93/shamos.html>
12. Electronic Voting,. Rebecca Mercuri. <http://www.notablesoftware.com/evote.html>
13. e-Voting System: Technologies and Implementations, Madona Raichel and Anitha Sandeep, IJCA May 2015.
14. A survey of internet voting- US election assistance commission, Testing and certification technical paper #2 , 14 September 2005.
15. Undergraduate advising manual- Department of Computer science and Engineering, Johns Hopkins Whiting School of Engineering.
16. The Design and Development of Real – Time E-Voting System in Nigeria with Emphasis on Security and Result Veracity, Shafí'í Muhammad Abdulh Amid, I J computer networks and internet security,2013,5,9-18
17. Lorrie Cranor's Voting Papers. Lorrie Faith Cranor. <http://lorrie.cranor.org/pubs/voting.html>.

DEVELOPMENT OF A SOLAR MILK PASTEURIZATION SYSTEM FOR A DAIRY INDUSTRY

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Abstract: A solar parabolic trough collector was designed and fabricated for the purpose of pasteurization of milk in a dairy industry. Experimentations were conducted on the solar milk pasteurization system and were able to pasteurize the milk by holding it at 63 °C for 30 min. The pasteurized milk was found to be of excellent quality using methylene blue reduction test. A maximum water temperature of 84°C and 93°C were recorded with aluminum and stainless steel reflectors, respectively at relatively smaller radiation intensity. The total initial investment for fabricating solar PTC for Milma plant was found to be Rs 11,52,540. With the use of solar PTC in Milma dairy over 6 months in a year working for 6 hours in a day, daily and annual savings in fuel cost is found to be Rs. 2,124 and Rs. 3,86,568.

Keywords—pasteurization; solar PTC; evacuated tube; methylene blue reduction test

1. INTRODUCTION

Energy is the most important parameter for the economic development of a country and industries play a key role in the development of countries. Industrialization of any country is responsible for consumption of large amount of conventional energy and becomes a cause for depletion. Realizing this fact, the main focus is on using non-conventional energy which are non-toxic, renewable and are widely available free of cost.

Industries are consuming one third of the overall energy produced in the world and industrial heat demand alone constitutes around 50 to 60%. Most of the industrial processes require heat at a temperature range 60 to 260°C. Industries are depending on conventional boilers powered by coal, diesel, natural gas etc. and electric heaters to meet the heat requirements. Use of these conventional fuels causes its fast depletion and environmental issues like greenhouse gas emissions. Studies on industrial heat demand conclude that several industries are having favorable conditions of applying solar energy for process heating. Properly designed solar collectors could be used to meet the heat requirement for industrial processes like solar refrigeration, solar drying, desalination of water, etc. [1][2].

Industrial process heat refers to the thermal energy requirement for the various processes in industries. Industries usually use hot water or pressurized

steam to meet their heat requirement because water is easily available and stored, low cost and having good thermal capacity. About 13% of industrial processes require thermal energy up to 100°C, about 27% up to 200°C and the remaining processes require high temperature thermal energy in steel, glass and ceramic industry. Typical industries which use process heat at medium temperatures are dairy, textile, tinned food, non-metallic mineral, paper, pharmaceutical, oil and chemical, meat, beverages, plastics, etc. The main processes in industries include pasteurizing, drying, distillation, dyeing, washing, bleaching, cleaning, sterilization, polymerization etc. Among these industries, food industry and the non-metallic mineral industry requires large amount of heat for their various processes. Some of the industrial processes and required temperature range are shown in Table 1[1]

Table 1 Industrial processes and temperature range [1]

Industry	Process	Temperature (°C)
Dairy	Pasteurization	60-80
	Sterilization	100-120
	Drying	120-180
	Boiler feed water	60-90
Tinned food	Sterilization	110-120
	Pasteurization	60-90
	Cooking	60-90
	Bleaching	60-90
Textile	Bleaching	60-90
	Dyeing	70-90
	drying	100-130

Paper	Cooking Boiler feed water Bleaching	60-80 60-90 130-150
Plastics	Preparation Distillation Separation Extension Drying	120-140 140-150 200-220 140-160 180-200

Dairy industry is an example of a food industry. The various processes requiring heat at medium temperature in a milk dairy are pasteurization, ghee melting, curd preparation, and tray washing. Out of these processes, pasteurization is the most important process, which is the process of heating liquids or foods to kill microorganisms or bacteria that cause various diseases [1].

Nomenclature	
Al	Aluminum
CPC	Compound Parabolic Collector
Cu	Copper
ETA	Evacuated Tube Absorber
ETC	Evacuated Tube Collector
FPC	Flat Plate Collector
HTST	High Temperature Short Time
I	Solar radiation Intensity (W/m ²)
MS	Mild Steel
?w	Mass flow rate of water (kg/s)
N2	Nitrogen
PTC	Parabolic Trough Collector
SS	Stainless Steel
TC	Thermocouple
Tin	Water inlet temperature to the ETA (°C)
Tout	Water outlet temperature from the ETA (°C)

Milk is an excellent medium for microbial growth when stored at ambient temperature. Pasteurization of milk kills and slows down the growth of bacteria and other microorganisms. In dairies, pasteurization is usually carried out by using large amount of thermal energy (hot water or steam) produced by conventional boiler or electrical heater [4]. When milk is exposed to a particular temperature for a known duration of time,

various microorganisms can be killed. The pasteurization methods used in dairy industry based on its holding time and temperature are as shown in Table 2.

Table 2 Pasteurization methods [4]

Method/Product	Time	Temperature (°C)
Batch/Vat (Low Temperature)	30 min	62.80
High Temperature Short Time (HTST)	15 s	71.70
Flash (High Temperature)	1s	88.30

Also, various solar water heating techniques are studied in detail and found that Solar Parabolic Trough Collector (PTC) is best suited for direct steam generation in concentrated solar power plants and medium temperature heat generation in industries [3]. For concentrated solar power plant applications, the length of PTC ranges from 100 to 150 m, aperture width about 6 m and geometrical concentration ratio from 20 to 30. Outlet temperature of fluid from PTC is ranging from 300 to 400°C. Medium temperature applications require temperature from 50 to 250°C, length between 2 to 10 m, aperture width between 1 to 3 m and geometrical concentration ratio within the range of 10 to 20 [5-7].

Since pasteurization is the most energy consuming process in a dairy industry, this work was an attempt to design and fabricate a solar assisted milk pasteurization system for pasteurizing around 20 litres of milk per hour and analyze the performance of the system. In addition, a cost analysis was also carried out to find out the feasibility of replacing the conventional boiler with solar PTC in Milma dairy Wayanad, which producing 5,000 litres of milk per hour.

Jaramillo et al. [7] designed and constructed PTC prototypes with rim angle 45° and 90°. The thermal performance analysis showed that PTC with rim angle 90° was the collector with greatest potential for low enthalpy generation. Peak efficiency of 35% and 67% was obtained with PTC with rim angle 45° and 90°, respectively. Cost analysis shows that the cost per m² of the collector for PTC45 and PTC90 were 172.32 and 167. Ramos et al. [8] have conducted a detailed study on the potential of using solar thermal technology in small-scale food and textile industries in Mexico. The

cost of various fuels like diesel, liquefied gas, natural gas, fuels for producing thermal energy are compared with that of the cost of solar parabolic collector. Li et al. [9] investigated two types of ETCs to measure their heating efficiency and temperature with water and N₂ gas. Results show that heating of water was easier with a flow rate less than 0.0046 kg/s with a maximum temperature of 105°C and efficiency achieved in the range of 70-80%. However, with N₂ gas the maximum temperature achieved was around 320 to 460 °C, with the efficiency less than 40%. 47 USD, respectively. In addition, it was found that PTC with rim angle 90° was more efficient and cost effective. Dereje et al. [10] developed a design support system for PTC where the design parameters are determined from geometric relations for parabola. Jose et al. [11] developed a mathematical model to check the viability of integrating a solar thermal system in a conventional dairy in Spain using Pinch methodology. According to the authors the potential of solar technology in dairy industry could be considered as an energy option. According to Brooks et al. [12], it is not necessary to use glass evacuated tube for temperatures near 100°C. There will not be much difference in the instantaneous efficiency of the solar PTC.

Studies on available solar collectors confirm that FPC and ETC can be used for low temperature applications, whereas for temperatures above 60°C, concentrating collectors are found to be more effective and studies show that PTC is the best collector for process heating applications in industries. PTC with concentration ratio between 10 and 20 is more effective in producing process heat at medium temperature range. The different constraints in using solar technology are non-continuous availability of solar radiation, varying weather conditions at the location and high cost of installation etc. Industries can provide roof top space for installation of solar collectors.

II. METHODOLOGY

A. System description

A simple solar milk pasteurization system is designed and fabricated for a dairy industry, Milma dairy, Wayanad in order to replace the use of conventional boilers partially. The main components of the system are solar PTC, ETA, stand with manual tracking mechanism, pasteurizing unit, temperature control system etc. as shown in Figure 1.

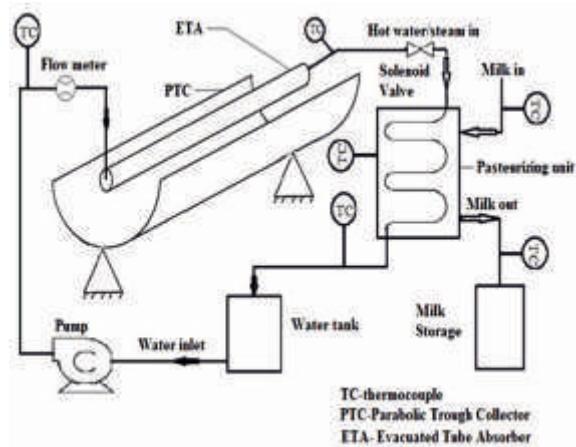


Fig 1 Solar milk pasteurization system

Solar radiations, falling on PTC, are focused on the focal line of the parabola, where an ETA is placed, through which water is passed. This water which is pumped from a tank gets heated to a medium temperature range (60°C-150°C), and flow to the pasteurizing unit through a solenoid valve where milk to be pasteurized is stored. In the pasteurizing unit, which acts like a heat exchanger, the hot water heats the cold milk to a temperature of 62.8°C, and is maintained for 30 min with the help of a temperature control sensor and the on/off solenoid valve. After 30 min, the milk is then transferred to the milk storage tank.

B. Industrial visit

As a part of this study, an industrial visit was carried out at a milk industry, Milma Dairy Wayanad, Kerala, India. The various processes, which require heat at medium temperature level, are pasteurization, ghee preparation, curd preparation, cleaning, and tray washing. Out of these processes, pasteurization is the most energy intensive process. Different processes and temperature requirement are as shown in Table 3.

Table 3 Processes and temperature range

Process	Temperature range (°C)
Pasteurization	72
Ghee Preparation	120
Curd Preparation	90
Cleaning	60 -65
Tray Washing	50 -55

In Milma dairy HTST pasteurization process is employed. The process flow diagram is as shown in figure 2

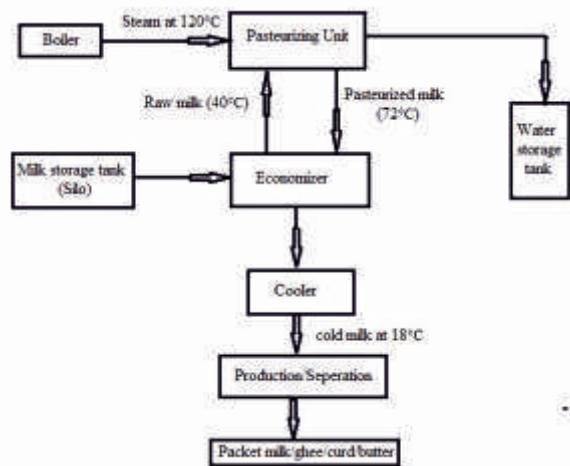


Fig 2 Process flow diagram in Milma dairy Wayanad

Milk from various Milma societies is stored in the milk storage tanks (silos) and passed to the pasteurizing unit through economizer. A plate heat exchanger is used as the pasteurizing unit. The raw milk is heated to 72°C using the steam supplied by the boiler inside the pasteurizer for 15 s and is passed to the cooler through economizer. The outgoing milk from the pasteurizing unit exchanges heat with the raw milk from silos inside the economizer. The pasteurized milk is cooled to 18°C using cold water at 4°C. The cold pasteurized milk is then passed to the separator tank where cream is separated from milk and sends to various production units.

Fire tube boiler of 2000 kg/h capacity, with an operating pressure of 9 bar and efficiency 60% is used for steam generation. Firewood and briquettes are used as fuels in the furnace of the boiler. From the industrial visit to Milma dairy, it is understood that there was a wide scope of using solar thermal technology for providing process heat in dairy industry for pasteurization.

C. Design of a parabolic trough collector

The design parameters are determined from geometric relations for parabola. [10-12]

$$\text{Aperture Width } (W_a) = 4f \tan (\frac{\theta_r}{2}) \quad (1)$$

$$\text{Aperture area } A_a = W_a * L \quad (2)$$

$$\text{Vertical height of parabola } (h_p) = \frac{W_a^2}{16f} \quad (3)$$

$$\text{Total surface area of the concentrator } A_s = S * L \quad (4)$$

$$\text{Concentration ratio } C_R = A_a / A_r \quad (5)$$

Table 4 Design parameters for PTC

PARAMETERS	VALUES
Rim angle (θ_r)	90°
Focal length of the parabola (f)	0.23 m
Aperture Width (Wa)	0.92 m
Collector length (L)	1m
Aperture area (Aa)	0.92 m ²
Vertical height of the parabola (hp)	0.23 m
Arc length of the parabola curve (S)	1.06 m
Concentration Ratio (CR)	10
Receiver area (Ar)	0.0054 m ²
Outer Diameter of receiver tube	1.25"

Based on the design parameters the trough and rib structure of the PTC are designed and are shown in figures 3 and 4.

Design Software – PTC Creo

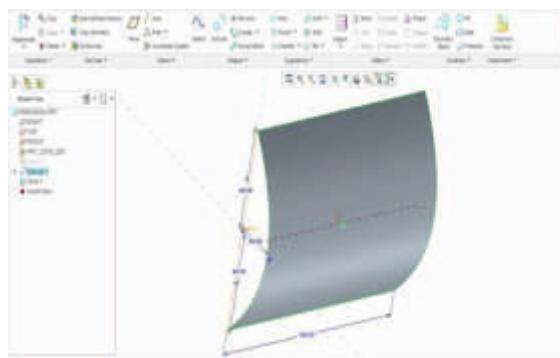


Fig 3 Trough designed in Creo

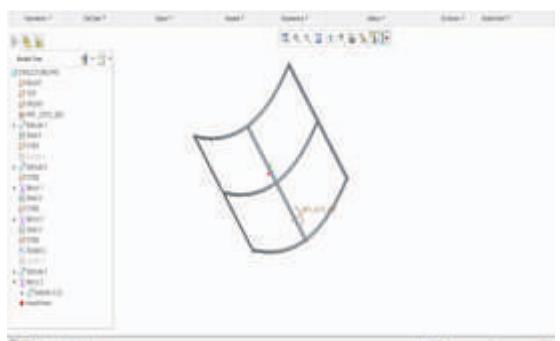


Fig 4 Rib designed in Creo

D. Fabrication of ptc

For fabricating the rigid and robust rib structure, MS flats are used. The thickness of the flat was 4 mm. and are bent and joined by welding to get the desired structure.



Fig 5 Fabricated rib structure of PTC



Fig 6 Fabricated PTC (Al)

E. Manual tracking mechanism

One of the major disadvantages of using solar PTC was the requirement of a separate tracking mechanism. In this work, a manual tracking mechanism was used. A stand was fabricated by using MS flats. Along the center of the stand a shaft was fixed, which can be freely rotated. The trough was bolted on the center, which could be rotated in any angle. So according to the positional changes of the sun, one can adjust the position of the PTC by simply rotating it. A bolting mechanism was provided to lock the PTC at a desired position. Figure 7 shows the photograph of a solar PTC on a stand with tracking mechanism.



Fig 7 Stand with manual tracking mechanism

F. Evacuated tube absorber

In this work, evacuated glass tube usually used in solar ETC water heating systems was used. Borosilicate is the glass material, which has a light transparency greater than 0.92% and the thickness is less than 2 mm. Copper tube coated with light absorbing material is the absorber. The closed end of the glass tube was cut and sealed to maintain vacuum inside the tube.

G. Milk pasteurizing unit

In dairy industry, plate heat exchanger is used as the pasteurizer, where pasteurization of milk is carried out inside the pasteurizing unit. In this experiment, a SS cylinder of capacity 20 litres was used as the pasteurizing unit. Copper tube of diameter 5/8" was used for passing hot water inside the cylinder. Three calibrated K-type thermocouples were attached at the sides of the cylinder to measure the temperature of milk inside. Temperature sensing transistors were also attached on the sides of the cylinder. Pasteurizing unit was insulated to make it heatproof using glass wool and polyurethane.



H. Temperature control system

In low temperature pasteurization process, the milk was heated to 63°C and maintained for 30 min using a temperature control system. The Integrated Circuit (IC) was programmed in such a way that when the temperature of milk inside the cylinder reached

63°C, the solenoid valve connected to the exit tube of ETA closed and restricts the flow of hot water into the cylinder. When the temperature reduced below 63°C the solenoid valve open and allow the flow. The circuit diagram is as shown in figure 10.



Fig 9 Pasteurizing unit

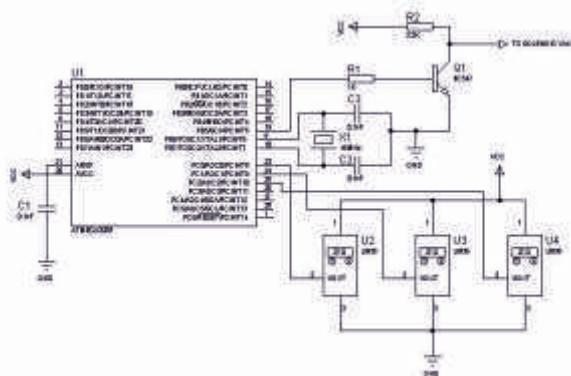


Fig 10 Circuit diagram

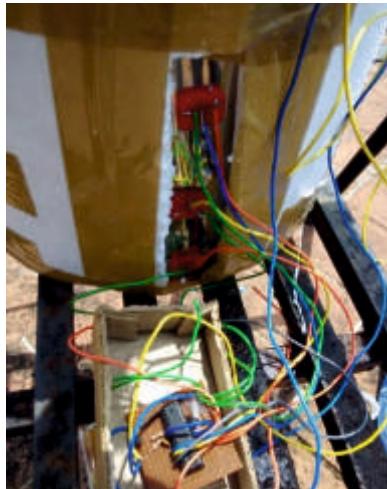


Fig 11 temperature sensor system

I. Solar milk pasteurization system

All the individual components were assembled to get the final solar milk pasteurization system as shown in figure 12.



Fig 12 Solar milk pasteurization system

III. RESULTS AND DISCUSSIONS

A. Optimum flow rate of water

In order to find out the flow rate at which maximum outlet water temperature was obtained, experiments were conducted at various flow rates of water through the ETA located at the focal line of the solar PTC. During this experiment, the intensity of solar radiation was relatively constant. The results of the experiment are in Table 5.

Table 5 Outlet water temperature at different flow rates.

SI No.	\dot{m}_w (kg/s)	I (W/m ²)	T _{in} (°C)	T _{out} (°C)
1.	0.0033	948	26	76
2.	0.0040	952	26	79
3.	0.0056	952	27	84
4.	0.0061	924	27	80
5.	0.0074	960	27	77
6.	0.0091	950	27	74
7.	1.0055	860	27	70
8.	1.2800	945	27	65

B. Experimentation on pasteurization system

The experimental analysis was carried out by using the solar milk pasteurization system. The pasteurizing unit was filled with 10 litres of milk initially. The water in the tank was pumped at a controlled flow rate of 0.0056 kg/s through the ETA placed at the focal line of the PTC. Water from the outlet of ETA was passed

through the on/off solenoid valve to the pasteurizing unit. The hot water from the ETA heated the milk kept inside the pasteurizing unit. The temperature inside the unit was monitored constantly by measuring the voltage across the thermocouple. When the temperature inside the unit reached 63°C, the temperature control system cut the voltage supply to the on/off solenoid valve. As a result, the valve was closed and the water supply to the unit was stopped. When the temperature inside the unit dropped below 63°C, the valve opened and allowed the hot water supply. This process was continued for 30 min. The experiment was carried out with both Al and SS as trough material. The results are as shown below.

- a) With Al as trough material Table 6 Pasteurization with Al PTC

Water inlet temperature to	26°C tube
Water outlet temperature to	63°C -
3°C pasteurizing unit	
Variation of radiation 782 W/m ² intensity	- 946 W/m ²

- b) With SS as trough material Table 7 Pasteurization with SS PTC

Water inlet temperature to	27°C tube
Water outlet temperature to	75°C - 93°C
pasteurizing unit	
Variation of radiation 712 W/m ² intensity	- 919 W/m ²

C. Methylene blue reduction test

Methylene blue reduction test is one of the methods to check the purity and quality of milk sample. In order to check whether the pasteurization process has completely killed the bacteria and other microorganisms present in the milk, dairies are using methylene blue reduction test method. This test is based on the fact that the colour imparted to the given milk sample by adding methylene blue solution will disappear depending on the quality of the milk. The removal of oxygen from milk and the formation of reducing substances during bacterial metabolism is the reason for the disappearance of colour. Bacteria are the responsible agent for the consumption of oxygen, so it is assumed that greater the number of bacteria in milk, the quicker will be the oxygen consumption. The test results are classified as follows [13][14]

- Class 1. Excellent quality, not decolorized in 8 hours.
- Class 2. Good quality, decolorized in less than 8 hours but not less than 6 hours.
- Class 3. Fair quality, decolorized in less than 6 hours but not less than 2 hours.
- Class 4. Poor quality, decolorized in less than 2 hours

Methylene blue is a blue colour dye in the powdered form. For methylene blue reduction test a solution of methylene blue in de-ionized water should be used. 1% aqueous methylene blue solution was prepared by dissolving 1g of methylene blue in 75 ml of De-ionized (DI) water and then diluted to 100 ml.

The test procedure is as follows.

- Sterilized all glass tubes and stoppers in boiling water.
- Transferred 10ml of each milk sample into a test tube, added 1 ml of the methylene blue solution into each test tube, and tightened the tubes mouth with stoppers.
- Gently inverted the tubes at about four or five times to ensure proper mixing.
- Kept the tubes in a water bath to heat the samples 35°C to 37°C within 10 minutes.
- Noted the time elapsed for the colour to turn whitish appearance.

Milk samples were collected in four test tubes.

1. Plane milk (without heating)
2. Boiled milk
3. Pasteurized milk using solar milk pasteurization system (30 min)
4. Pasteurized milk using solar milk pasteurization system (20 min)

The tightened tubes were inverted for proper mixing and heated to 37°C by using a magnetic stirrer. The heated tubes were kept at a place away from light and the tubes were inverted at regular intervals during incubation time to improve the accuracy of the test result. Otherwise microorganisms may not be evenly distributed in the milk sample leading to wrong result interpretations. The test results were as follows.

1. Colour reduction in 90 minutes (poor quality)

2. Colour reduction in 8 hours (good quality)
3. Colour reduction in 48 hours (excellent quality)
4. Colour reduction in 6 hours (good but not excellent quality)

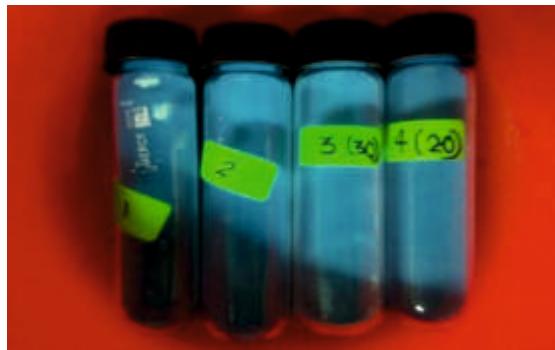


Fig 13 Milk samples



Fig 14 Sample after 8 hours

From the methylene blue reduction test results it was observed that the milk pasteurized using solar pasteurization system possessed excellent quality.

IV. COST ANALYSIS

A. Cost analysis of solar milk pasteurization system

A detailed cost analysis was conducted to verify whether solar milk pasteurization system would be able to replace the conventional boilers in dairy industry and is cost effective. The total cost of the fabricated solar PTC and solar milk pasteurization system was calculated and tabulated in Table 8.

Table 8 Components and cost

Part	Components	Dim/quantity	Cost (Rs)
PTC	S.S. sheet MS flat Rivet	1m*1.1m 30 no's	1500 800 40
PTC Stand	MS flat		2000
ETA	Tube	1	800
Piping and installation			1000
Miscellaneous			600
Total cost for PTC			6740
Total cost per m² of collector area			7319.64
Pasteurizing unit	SS Container Copper tube Insulation Thermocouple	20 litres 5/8" OD	1000 300 100 500
Temperature control unit	solenoid valve IC, Circuit board	¾"	780 300
Miscellaneous			800
Total cost per pasteurizing unit			3780

$$\begin{aligned} \text{Initial cost of the system} &= \text{total cost for PTC} + \\ &\quad \text{total cost for pasteurizing unit} \\ &= \text{Rs. } 10,520 \end{aligned}$$

B. Solar parabolic trough collector in Milma wayanad In this section the cost requirement for installing solar PTC for process heating in a dairy industry has been calculated. Assumptions

1. Good availability of solar radiation for 6 months over an year (above 700W/m²)
2. Good availability of solar radiation for 6 hours in a day (from 9.30 a.m. to 3.30 p.m.)
3. An average water temperature of 85°C is assumed to achieve during sunny days.

Heat added to milk to heat it from 24°C to 72°C = 9,62,064 kJ/h

Amount of heat to be supplied by PTC per hour = 9,62,064 kJ/h

Mass flow rate of water required to pass through ETA to heat it from 27°C to 85°C = 4,783.53 kg/h

For a total mass flow a rate of 4783.53 kg/h the number of solar PTCs required = 171

Total cost for 171 solar PTCs = Rs. 11,52,540

Total collector area required = 157 m²

C. Hybrid system for process heat

The cost requirement for running the plant with boiler, PTC and the combined running cost were calculated.

Table 9 Boiler details

Boiler type	Fire tube boiler (2no's)
Boiler capacity	2000 kg/h
Fuel used	Fire wood + briquette
Average fuel consumption	178 kg/h
Cost of Fuel per kg	Rs. 3
Boiler working hours per day	14 h
Boiler idle time per day	10 h
Fuel consumption during idle time	60 kg/h

Total cost of fuel used in furnace = Rs. 11,400 per day
 Total cost of fuel used in furnace if solar PTC is used for 6 hours
 Daily savings in fuel cost by using solar PTC = Rs. 2124
 Total savings in fuel cost per year = Rs. 3, 86,568
 (Considering the availability of solar radiation for an average of six months over an year)

D. Cost calculations

a. Initial cost

The cost of buying 171 solar PTCs = Rs. 11,52,540

b. Simple Payback period

The time needed for the cumulative fuel savings to equal to total initial investment = 3 Years

V. CONCLUSIONS

A maximum water temperature of 84°C and 93°C were recorded with aluminum and stainless steel reflectors, respectively at relatively smaller radiation intensity. The pasteurization experiment was effectively carried out using the system and the pasteurized milk was found to be of excellent quality upon methylene blue reduction test. The colour reduction started only after 48 hours. The total cost for the solar PTC fabricated in this work was Rs.6,740. The aperture area was limited due to the space constraint and it can be concluded that with increase in aperture and reflectivity of trough material higher temperature can be easily achieved. The total initial investment for fabricating solar PTC for Milma plant was found to be Rs. 11,52,540. With the use of solar PTC in a conventional dairy over 6 months in a year working for 6 hours in a day, daily and annual savings in fuel cost is found to be Rs. 2,124 and Rs. 3, 86,568 and this is a very good achievement.

REFERENCES

- [1] S.A. Kalogirou, "Solar energy engineering: Processes and systems"
- [2] S.A. Kalogirou, "The potential of solar industrial process heat applications", Applied energy., vol.76, pp. 337–361,2003
- [3] S.P. Sukhatme, "Solar energy: Principles of thermal collection and storage"
- [4] J. Franco, S. Luis, V. Javi, R Caso and F Carlos, "Pasteurization of goat milk using a low cost solar concentrator", Solar Energy., vol. 82, pp. 1088–1094, 2008
- [5] S.A. Kalogirou, "Parabolic trough collectors for industrial process heat in Cyprus", Energy., vol.27, pp. 813–830, 2002
- [6] A. F. Garcia, E. Zarza, L.Valenzuela and M. Perez, "Parabolic-trough solar collectors and their applications", Renewable and Sustainable Energy Reviews., vol.14, pp. 1695–1721, 2010
- [7] O.A. Jaramillo, E.V. Reyes, J.O. Aguilar, R.C. García and F.S. Montemayor, "Parabolic trough concentrators for low enthalpy processes", Renewable Energy., vol. 60, pp. 529–539, 2013
- [8] C. Ramos, R. Ramirez and J. Beltran, "Potential assessment in Mexico for solar process heat applications in food and textile industries", Energy Procedia vol.49, pp. 1879 – 1884, 2014
- [9] M. Li and L.L. Wang, "Investigation of evacuated tube heated by solar trough concentrating system", Energy Conversion and Management., vol. 47, pp. 3591–3601, 2007
- [10] D.E. Woldemichael, H. K. Cheng, A. D Woldeyohannes and L.I Chye, "Design Support System for Parabolic Trough Solar Collector", Journal of Applied Sciences., vol.12, pp. 2474-2478, 2010
- [11] J.A. Quijera, M.G. Alriols, J. Labidi, "Integration of a solar thermal system in a dairy process", Renewable Energy., vol.36, pp. 1843–1853, 2011
- [12] M.J. Brooks, I. Mills and T. Harms, "Design, construction and testing of a parabolic trough solar collector for a developing-country application", Proceedings of the ISES solarworld congress, Orlando, Florida 2005
- [13] H. V. Atherton and J. A. Newlander, "Dye Reduction Tests: Methylene Blue and Resazurin Chemistry and Testing of Dairy Products". 4th Edition <http://vlab.amrita.edu/?su>
- [14] <http://vlab.amrita.edu/?sub>

AN EXPERIMENTAL INVESTIGATION OF HEAT PIPE BASED SOLAR CONCENTRATING PV PANEL COOLING SYSTEM

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Abstract: The objective of the research is to enhance the performance of the concentrating photovoltaic (CPV) solar panel by decrease the operating temperature of the PV panel using disk pipe based cooling system. A V - trough PV concentrator of concentration ratio 2, made up of mirror were designed and fabricated. An aluminium disk heat pipe with acetone as working fluid was fabricated and experimentally investigated the performance of the CPV-cooling system. The temperature of the CPV panel reaches 75 °C without cooling system. By installing heat pipe based cooling system the panel temperature limited to 58 °C, results in percentage increase in efficiency about 21.92%. Proposed heat pipe based cooling system has substantially improved the performance of the solar cells.

Keywords: Concentrating photovoltaic panel cooling, Performance analysis, Disk heat pipe.

INTRODUCTION

Even today, most people of the world are away from the grid and do not have proper access to electricity. It is not yet economical to extend power lines from centralized sources to rural areas, and thus, decentralized sources such as the photovoltaic (PV) systems are a promising stand-in. Photovoltaic (PV) electric power generation is a guaranteed technology for generating renewable energy from solar radiation. Inorder to concentrate solar radiation on the solar cells, we use Concentrated Photovoltaic (CPV) systems. CPV systems track the solar radiation for keeping the reflected radiation focused on the solar cell, using lens or mirrors. The main advantages of the CPV systems include high efficiency and comparatively low system cost in a way that we get more PV power output by using less expensive semiconducting PV material required for the same output. The major disadvantage is that the operating solar cell temperature increases due to the direct solar radiation incident on the PV module, which in turn decreases the solar cell efficiency and also the lifetime of the PV module. It is necessary to provide a proper cooling system in the CPV system or increase the efficiency of the solar cell by reducing the operating cell temperature. Air cooling, water cooling, micro channel cooling, heat pipe based cooling etc. can be utilized for cooling of PV cells.

Heat Pipe is a passive heat transfer device. It utilizes the phase change of a working fluid for achieving heat transport. A Heat pipe can transfer heat over considerably long distances with relatively small temperature drop. Due to its significant advantages like light weight, compactness and passiveness, heat pipe finds a wide range of applications to dissipate heat. Heat pipe consists of a metal container and a capillary wick inside the container. The wick may be layers of metallic mesh, simple longitudinal grooves in the wall, or fabricated from porous material. There is an evaporator section where heat is absorbed and a condenser section where heat is rejected in the heat pipe. A working fluid circulates inside the heat pipe. The circulation setup due to capillary action in the wick and so no external pumping is required.

A heat pipe based cooling system is one of the best ways to increase the passive cooling performance of concentrated solar panel system. Pei gang et al. (2011) [1] was developed a dynamic model to predict the performances of the heat-pipe photovoltaic/thermal system. An aluminium plate attached at the back side of PV panel and nine cylindrical Copper heat pipes were attached onto the back of the aluminium plate, and the condenser plate was inserted into a square cooling jacket. With this experimental step up, maximum electrical efficiency

was obtained about 9.4% and thermal efficiency was 41.49%. Akbarzadeh and Wadowski (1986) [2], designed and fabricated a special reflector, so that light will uniformly distribute on the solar cell. Solar cells are mounted on the end of thermosyphon, which is made up of Copper pipe. With this cooling arrangement, the temperature of the cell is limited to 46 °C, which is 38 °C lower as compared to CPV system without cooling. Ben Richard Hughes et al. (2011) [3] conducted a CFD analysis on finned heat pipe based solar panel cooling system in UAE. The study carried out in cylindrical Copper heat pipe and water is used as the working fluid and it attached to the back side PV panel. With this arrangement, the temperature of the panel limited to 45 °C.

Most of the research works have used cylindrical heat pipes for cooling PV panel. As compared to cylindrical heat pipes, flat heat pipes are having more contact area with the source (solar panel). This helps in cooling of solar panel effectively. Disk heat pipe can effectively absorb the heat generated in the solar panel as compared to flat heat pipe while utilising small area [4]. A large portion of the solar panel surface will come into contact with the disk heat pipe, helps to remove the heat, which is generated in the panel. Moreover at the condenser side of heat pipe, the temperature distribution is uniform, will make the cooling more effective. Considering the geometry of solar panel, disk heat pipe can be effectively utilised for cooling the panel.

EXPERIMENTAL SETUP

The concept of use of solar PV concentrator seems to be simple. However, it is difficult to implement, especially for high concentration ratio. But it is possible to use low concentration optics with commercial PV modules in static mode to eliminate continuous tracking of module. Considering all the above concepts, V-trough can be concluded as an attractive option to reduce the price of the PV electrical power using conventional solar PV cells. V - trough structure for a concentration ratio of 2 is developed as per design models based on seasonal tracking. Based on the correlations V-trough parameters are evaluated for concentration ratio of 2. A maximum acceptance angle (θ) of 9° is considered for seasonal tracking design model [5]. An experiment conducted with trough angle (α) from 15° [5]. And set to the angle where the power output is more.

Concentration ratio (C) can be find out using the equation,

$$C = \frac{\sin((2n+1)\varphi + \alpha)}{\sin(\varphi + \alpha)} \quad \dots \dots \dots \quad (1)$$

$$\text{Ratio, } \frac{H}{B} = \frac{\sin[(2n+1)\pi + \alpha] - \sin(\beta + \alpha)}{2\sin(\beta + \alpha) \sin \beta} \dots \dots \dots (2)$$

Using equation (1) and (2), for trough angle 15° calculated the concentration ratio = 2.44 and height of reflector, H = 70.81 cm. Characteristics of the selected solar panel is shown in table 1. Construction details of V – trough reflector is shown in table 2. The fabricated photo of V – trough reflector is shown in Fig. 1.

TABLE 1 CHARACTERISTICS OF SOLAR PANEL

Type of solar panel	Monocrystalline Solar cells
Power rating	10 W
Open circuit voltage, V_{oc}	21 V
Short circuit current, I_{sc}	0.84 A
Voltage at maximum power, V_{mp}	19.5 V
Fill factor, F	0.78

TABLE 1 CHARACTERISTICS OF SOLAR PANEL

Parameter	
Solar cell area	2.5 cm x 3.5 cm
No of solar cell in a module	72
Effective area of solar panel	0.063 m ²
Total reflector area	0.5394 m ²
Inclination angle of solar panel with horizontal	11.25°
Material used as reflectors	Mirror
Frame material	Angle Iron pieces
Solar panel orientation	East – West
Reflectors orientation	North -South



Fig 1: Fabricated V trough concentrator

DESIGN OF COOLING SYSTEM

When the solar panel brings into contact with the heat pipe, there is a possibility that all the surface of the heat pipe will not come into contact with solar panel because of the imperfection in the flatness of the heat pipe. Using this design if any surface is touched with the heat pipe, through that spot, evaporation will take place and cooling occurs. It is the main advantage of this design as compared to the flat heat pipe.

The part of the heat pipe, which is attached at the back side of solar panel, receives heat by conduction, act as evaporator and the plate which is contact with the cooling jacket (sink) act as condenser. Hence top plate act as evaporator section and bottom plate act as condenser section. It is designed in such way that the whole assembly looks similar to a rectangular box. The wick structure are provided on both top and bottom plate. Moreover to transfer the working fluid from bottom plate to top plate, group of wicks are oriented vertically looks similar to pin fins.

Through wick structures working fluid reaches at the evaporator section by capillary action and where it evaporates and the vapour return back to condenser section. Hence, it is clear that the space between the wick structures act as the vapour core of the heat pipe.

The top plate of heat pipe has overall dimension $0.315 \text{ m} \times 0.22 \text{ m} \times 0.008 \text{ m}$ where the condenser section has dimension $0.315 \text{ m} \times 0.22 \text{ m} \times 0.005 \text{ m}$. The distance between the two plates is determined by investigating the capillary action of working fluid. For that, a sealed container is selected, and the wick wrapped around a rod to make the same arrangement of the wick structures inside the heat pipe, and calculated the length lifted by the working fluid (acetone) by capillary action. The 3D modelling of disk heat pipe and dimensions of disk heat are shown in Fig 2 and Fig 3 respectively.

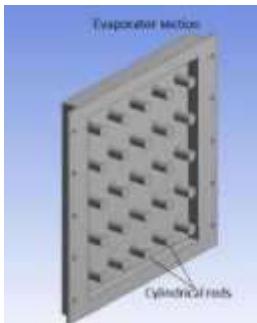


Fig 2a: Top plate with group of cylindrical rods



Fig 2b: Bottom plate with cooling jacket

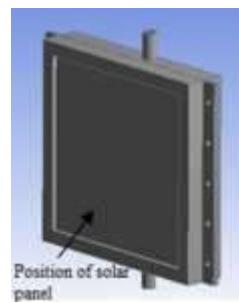


Fig 2: Heat pipe assembly



Fig 3: Dimensions of disk heat pipe

Details of wicks used in aluminium disk heat pipe as shown in table 3.

TABLE 3: DETAILS OF WICKS USED IN DISK HEAT PIPE

Type of Wick	Number of layers	Thickness
Wire screen -mesh number 150	4 layers at top and bottom plate	1mm
	6 layers wrapped around each nylon rod	1.2 mm

The wick structure used are wire screen made up of stainless steel. The wick structure is gripped at the inner surface of top and bottom plate with the help of screws. 4 layers of wick arranged parallel to top and bottom plate, and 6 layers of wick wrapped around each nylon rod to make vertical wick.

Since water is not compatible with aluminium, acetone used as the working fluid in the heat pipe. From the literature survey [6] it is clear that for the temperature range of -50°C to 120°C acetone is compatible with container material like aluminium and stainless steel.

The vapour space is divided into several channels by vertical wicks, which transport liquid from the upper wick to the lower wick. The Fig. 4 shows the wick arrangement in disk heat pipe. Table 4 shows the design details of disk heat pipe.

Material of container	Aluminium
Material of wick	Stainless steel
Working fluid	Acetone
Type of wick	Wire screen mesh
Mesh number, N	160/inch (6299.21/m)
Wire diameter, d	$0.0480 \times 10^{-3} \text{ m}$
Wire spacing	$0.104 \times 10^{-3} \text{ m}$
Dimensions of evaporator plate	$0.315 \text{ m} \times 0.22 \text{ m} \times 0.008 \text{ m}$
Dimensions of condenser plate	$0.315 \text{ m} \times 0.22 \text{ m} \times 0.005 \text{ m}$
Porosity,	0.7507
Effective capillary radius, r_c	$7.936 \times 10^{-10} \text{ m}$
Permeability ,K	$1.285 \times 10^{-10} \text{ m}^2$
Maximum capillary pressure, P_{cm}	517.89 N/m^2
Inclination angle of heat pipe	11.25°
Design temperature	40°C



Fig. 4 Wick arrangement

Fig. 5 shows the fabricated disk heat pipe. After completing the assembly of heat pipe, the leakage test is done by admitting compressed air inside the heat pipe. For the wick, mesh number 150, calculated amount of working fluid (acetone) is 152 cc, and it is at a saturated vapour pressure of 422 mmHg corresponding to the design temperature of 40°C .



Fig. 5 Disk heat pipe assembly

The condenser zone is enclosed in a cooling jacket in which water is circulated for taking heat from the vapour working fluid that condenses in the heat pipe. The disk heat pipe attached to the back side of the panel. In order to get good contact between these two, thermal interface material is used. From the tank, a connection has taken to the inlet of cooling jacket. A valve is connected between these two, to regulate the mass flow rate of water. Auto CAD drawing of heat pipe based CPV panel cooling system is shown in Fig. 6 and photograph of experimental setup is shown in Fig. 7. The temperature measurement at 16 positions in the heat pipe set up is made by using calibrated K - type thermocouples. Temperature measurement also was done using Fluke 62 mini non-contact type infrared thermometer.

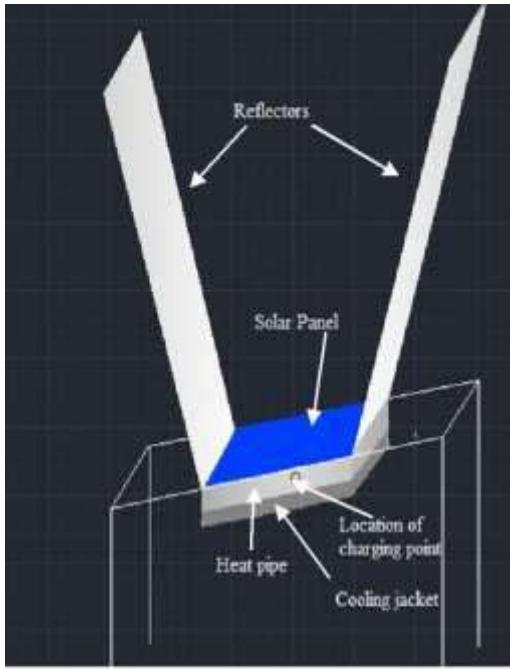


Fig. 6 Auto CAD drawing of heat pipe based CPV panel cooling system



Fig. 7 Photograph of experimental setup

RESULTS AND DISCUSSION

An experiment conducted with constant mass flow rate of 0.0043 kg/s and readings are taken at an interval of 30 minutes, from morning 10 am to evening 4 pm on May 1st week of 2016.

A) I-V Characteristics of CPV solar panel with cooling system

As the temperature of the cell increases, short - circuit current decreases while open circuit voltage increases (Fig. 8). Because increasing temperature decreases band gap. Lower energy is therefore needed to break the bond. In the bond model of a semiconductor band gap, reduction in the bond energy also reduces the band gap. As a result, power output as well as efficiency of the PV panel decreases.

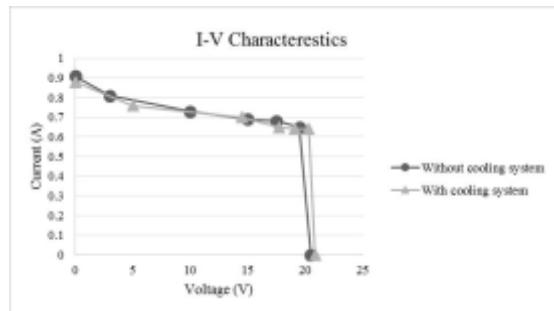


Fig. 8 I-V Characteristics of CPV solar panel with cooling system

B) Variation in power output of CPV solar panel with cooling system.

It has been found that the electrical output of the water cooled CPV is 1 to 2 times more than the PV module (without concentration and cooling). Maximum output power obtained at 12.30 pm, about 14.92 W, which is 40.88% more than CPV panel without cooling system. Variation of Power output of CPV cooling system is shown in Fig. 9.

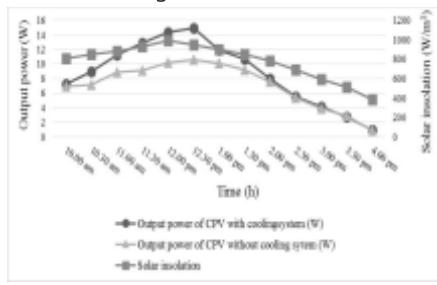


Fig. 9 Variation in power output of CPV solar panel with cooling system

C) Variation in electrical efficiency CPV solar panel with cooling system.

Electrical efficiency is also followed the same trend as same that of power output. Because of it is a function of voltage, time and solar insolation. Voltage and current increases as solar insolation increase. The increment of these two is more predominant than solar insolation, hence electrical efficiency also increases. Variation of Efficiency of CPV cooling system is shown in Fig. 10.

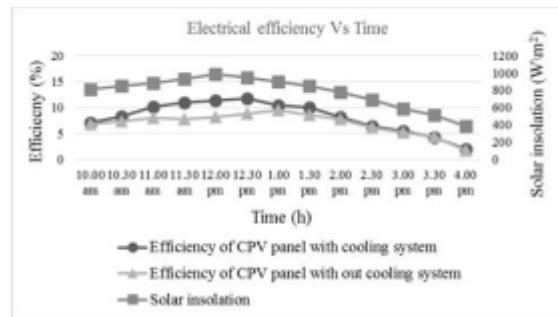


Fig. 10 Variation in efficiency of CPV solar panel with cooling system

From Fig 10, for CPV panel with cooling system, maximum efficiency obtained is 11.79%, which is 21.91% more than CPV panel without cooling system at a mass flow rate of 0.0043 kg/s.

D. Variation in temperature of the CPV solar panel with cooling system

It is important to analyse the temperature distribution in the solar panel and heat pipe. Moreover to understand the effect of temperature rise in the solar panel on its performance. Using heat pipe based solar panel cooling system, the maximum temperature of PV panel limited to 58 °C, which is 17 °C lesser than the CPV panel without concentrating system. And the advantage is that the efficiency of the CPV with cooling system increases. That is with the reduction temperature by 22.66%, improves the efficiency by 21.92% (Fig. 11).

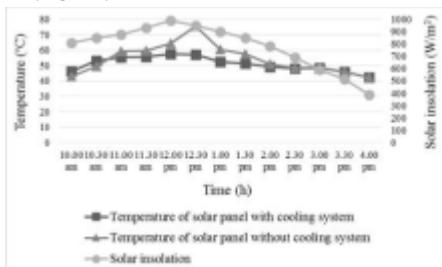


Fig. 11 Variation in temperature of CPV solar panel with cooling system

It is found that a rise in the solar cells temperature by 17 °C from 58 °C to 75 °C results in decreasing the efficiency from 11.79% to 9.67% at noon time i.e., equivalent to a degradation of the cell efficiency by 17.98%. From this, it is clear that increasing cell temperature causes an adverse effect on the performance of solar panel.

Most of the time, the temperature of the panel is below 60 °C. But, heat pipe is designed at a temperature of 40 °C. When the evaporator reaches 40 °C, heat start working and cooling will happen. For the present work, the cooling of solar panel was not uniform, i.e. effect of cooling not reached all sides of solar panel. In addition to that the non-uniformity of the solar radiation on the surfaces of conventional solar cells will produce non-uniform temperature on the solar panel. Due to this the average temperature of panel reached about 58 °C at noon time.

CONCLUSIONS

Experiments were conducted to analyse the performance of disk shaped heat pipe based cooling system. Experiments on CPV and CPV with cooling system were carried out separately and analysed its performance. A V - trough PV concentrator of concentration ratio 2, made up mirrors were designed and fabricated. An aluminium disk heat pipe with acetone as working fluid was fabricated and experimentally investigated the performance of the CPV cooling system. It has been found that the power output of CPV panel with cooling system is 40.88% more than that of CPV panel without cooling system. The temperature of the CPV panel reaches 75 °C without cooling system. By installing heat pipe based cooling system the panel temperature limited to 58 °C, results in percentage increase in efficiency about 21.92%.

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REFERENCES

1. Pei Gang, Fu Huide, Zhang Tao, Ji Jie, A numerical and experimental study on a heat pipe PV/T system, Solar Energy, Vol. 85, 2011,

- pp.911 – 921.
- 2. A. Akbarzadeh, Wadowski. T, Heat-pipe-based cooling systems for PV cells under concentrated solar radiation, Applied Thermal Engineering, Vol. 16 (1) 1996, pp 81 – 7.
 - 3. Ben Richard Hughes, Ng Ping Sze Cherisa, Computational Study of improving the efficiency of photovoltaic panels in the UAE, World Academy of Science, Engineering and Technology, 2011, pp 01 – 22.
 - 4. K.Vafai, W.Wang, Analysis of flow and heat transfer characteristics of an asymmetrical flat heat pipe, International Journal of Heat and Mass Transfer, Vol. 35, 1992, pp 2087 – 2099.
 - 5. C.S.Sangani, C.S. Solanki, Experimental evaluation of V-trough (2 suns) PV concentrator system using commercial PV modules, Solar Energy Materials & Solar Cells, Vol. 91, 2007, pp 453 – 459.
 - 6. S.W.Chi, Heat pipe theory and practice: a source book, McGraw-Hill, 1976.

CONCENTRATED OPTICAL FIBRE BASED DAYLIGHTING/THERMAL SYSTEM

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Abstract: Buildings account for around one third of the global energy use. In order to minimize global energy demand as well as emissions, it is important to make buildings more energy efficient and sustainable. The major areas of energy efficiency improvement in commercial building sector are lighting, HVAC and service water heating. Daylighting is the lighting approach which uses natural sunlight during the daytime to light the interior spaces of buildings. Solar water heaters use the solar energy from the sun to generate heat which can then be used to heat water for domestic and industrial applications. Concentrated optical fibre based daylighting/thermal system, which makes use of visible portion of solar spectrum for daylighting purpose and infrared portion for water heating, has an immense potential to revolutionize the power sector. This paper aims to introduce a novel Fresnel solar collector which can be used as a collector for optic fibre daylighting and as a concentrating solar thermal collector simultaneously. Working of novel Fresnel lens solar collector is based on beam splitting technology using selective absorber. Characteristics of light output from the collector are inspected using spectrophotometer and found that it has a spectrum very similar to human eye response. Experimentation was conducted on concentrated optical fibre based daylighting/thermal system and light output from the system is measured in a miniature dark room. Thermal output of the system is measured as temperature increment of water in the thermal storage tank.

Keywords: Fibre optic daylighting, water heating,spectral beam splitting technology

INTRODUCTION

The world energy consumption in commercial building sector is increasing rapidly. The major areas of energy efficiency improvement in commercial building sector are lighting, HVAC, service water heating. Hence a novel solar collector, which makes use of visible portion of solar spectrum for daylighting purpose and infrared portion for water heating, has an immense potential to revolutionize the power sector. Working of the novel Fresnel lens solar collector is based on spectral beam splitting technology using selective absorber.

The act of utilising natural light to illuminate the building interior has always been an essential part of the architectural process and is generally called as "daylighting". Daylighting forms likeable spaces and has the potential to reduce energy use and promote health and comfort of the building inhabitants

[1]. In addition to electric light savings, the large luminous efficacy of daylight reduces the internal heat gain and thereby decreases the cooling energy load. Fibre optic daylighting system is an emerging technology that provides a solution for daylighting designers. This system use fibre optics combined with

solar light collectors to transport sunlight to spaces really difficult to daylight using conventional methods. This system include a collector, lenses, reflectors, filters, to direct light to the optic fibre cables and a fixture to disperse the light in the space to be lit up. For providing sufficient and consistent lighting, the transmitted sunlight is combined with artificial lights which are dimmable. Since optic fiber is flexible, it allows for adaptability in applying sunlight for indoor illumination.

Solar thermal collectors are devices used for the collection and conversion of solar radiations into useful thermal energy. In any solar collector, the theory usually used is to expose a dark surface to solar radiation so that maximum radiation is absorbed and a part of this radiation is then transferred to a fluid like water or air. Solar water heating (SWH) is the conversion of sunlight into renewable energy for water heating using a solar thermal collector. Solar water heating systems comprise various technologies that are used worldwide increasingly.

Spectral beam splitting technology is a hopeful technology for achieving higher efficiency in solar energy conversion [2]. Hybrid collectors, multi-junction PV receivers and biomass production are the potential

applications of beam splitting technology [3]. Various methods for spectral splitting of sunlight have been proposed. The most popular methods are by using thin-film wave interference optical filters and by using a selective absorber like water, heat absorbing filter etc. A review on the physics of spectrally selective filtering methods has been presented by Peters et al. [4].

CONCENTRATED OPTICAL FIBRE BASED DAYLIGHTING/THERMAL SYSTEM

A. System Description

The concentrated optical fiber based daylighting /thermal system is developed aiming to increase the efficiency of conventional collector for fiber optic daylighting system.

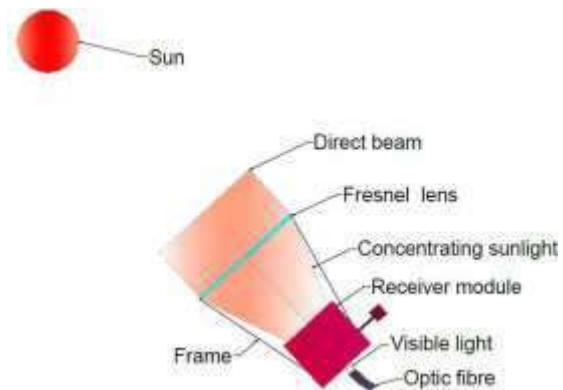
This system differs from conventional daylighting system because of novel Fresnel lens solar collector which is used as light collector for optic fiber daylighting system and as a water heater. Solar spectrum (Fig.1) is a broad band of electromagnetic radiation running through UV, visible light and IR. In terms of energy, sunlight at Earth's surface is around 3 to 5% UV (below 400 nm), 42 to 43% visible light (400 to 700 nm) and 52 to 55% infrared (above 700 nm).

Conventional light collectors for daylighting make use of visible portion of solar radiation and the infrared portion of solar spectrum is considered as waste. This system uses the infrared portion of solar spectrum for water heating which is considered as a waste in conventional daylighting systems. The novel solar collector collects solar radiation using Fresnel lens and concentrates it onto optic fibre through a receiver. The collector that is controlled by two axis tracking system acts as a light collector for optic fibre daylighting system as well as a water heater. It uses the visible portion of sunlight for optic fibre daylighting and infrared portion for water heating. This collector also has the advantage of reducing the cooling load requirement in the building because it is admitting only visible light into optic fibre of the daylighting system.

B. Basic structure description of novel Fresnel lens solar collector

Novel Fresnel lens solar collector (Fig.2) collects the direct beam coming from sun using a Fresnel lens and it is concentrated onto the optic fiber through a receiver module. Receiver module is a specially designed unit which separates visible light and infrared radiation in concentrating sunlight coming from Fresnel lens. Visible light in sunlight is focused onto optic fiber which is later transmitted through it to destination. Novel Fresnel lens solar collector is to be tracked dual axially to ensure that focal spot overlap with the entrance face of optic fiber.

In this novel solar collector, Fresnel lens made with PMMA (150 mm*150 mm) of focal length 190mm is used. At the focus of lens the spot size is 5mm. Concentrated sunlight from the Fresnel lens is focused onto the optic fibre through receiver module (Fig.3). The receiver module has designed according to the Fresnel lens's specifications used in the solar collector system.



In receiver module, concentrated solar radiation passes through the plane glass which is placed on the top. Water is circulating through the receiver. Visible portion of solar radiation passes easily through the water, heat absorbing glass which is placed at bottom and finally reaches at the inlet of the optic fibre. Kodak heat absorbing glass for slide projector was used as heat absorbing glass. It transmits the visible portion and absorbs the IR portion. The energy associated with the infrared portion is converted to heat which is carried away by the incoming water.

Movable heat absorbing plate which is placed in between plane glass and heat absorbing glass in solar collector controls the amount of solar light entering into

optic fibre and thus controls the intensity of light entering into the building according to the requirement. Supporting plate and guide ways are provided for the movement of heat absorbing plate in the prescribed path. An oring (Fig.4) is provided for making the leak proof movement of heat absorbing plate.

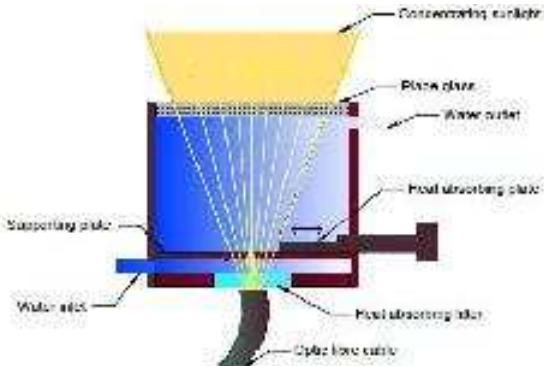


Figure 3. Receiver module (Front view)

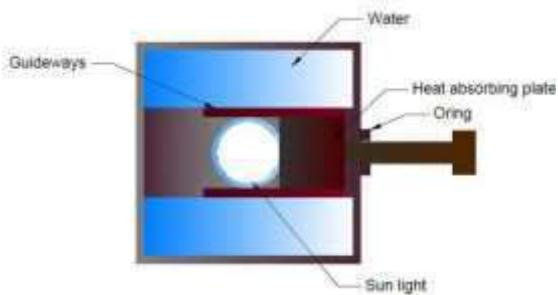


Figure 4. Receiver module(Top view)



Figure 5. Fabricated novel Fresnel lens solar collector

Solar radiation falling on heat absorbing plate is converted to heat which is transferred to the water surrounding the plate. A thermocouple was placed inside the receiver module to measure the temperature of water inside it. The novel Fresnel lens solar collector is fabricated and shown in Fig.5.

C. Dual axis solar tracking system

In the case of concentrating solar collectors, the need for tracking mechanism is very essential as solar radiation need to be concentrated at a point or line. Point focusing Fresnel lens solar collector needs dual axis solar tracking system [5]. Dual axis tracking systems (Fig.6) have two degrees of freedom that act as axes of rotation. These axes are typically normal to one another. Dual axis tracking systems allow for optimum solar energy levels due to their capability to follow the Sun horizontally and vertically. No matter where the Sun is in the sky, dual axis trackers are able to angle themselves to be in direct contact with the Sun. In this work, a manual tracking mechanism was used. A stand was fabricated by using MS flats. On the top of stand, a MS square plate (150 mm*150 mm) of thickness 5 mm was attached and it was made capable of tilting by a joint as shown in Fig.6. This plate was tilted for tracking the sun during seasonal variations. Another plate of the same dimensions was attached to the first plate by a gear mechanism.



Figure 6. Dual axis solar tracking system

By rotating that gear, the second plate can track the sun from morning to evening. A hole was drilled at the centre of top plate for attaching the optic fibre. Novel Fresnel lens solar collector was fixed on to tracking mechanism by bolt. Bolting mechanisms were provided for both axes to lock the solar collector at a desired position.

D. Fiber optic daylighting system

Main parts of the optic fibre daylighting system include light collector, receiver, optic fibre cable (Fig.7) and light diffuser (Fig.8). In this system Fresnel lens solar collector acts as light collector for daylighting system. Concentrated sunlight coming from solar collector enters into the optic fiber cable through receiver and transmitted to light diffuser. The light diffuser was used to spread light in the room.

Miniature dark room, a card board box of dimension 45 cm*45 cm*40 cm was made to measure the light output from the optic fiber daylighting system. The length of miniature dark room was taken as 45 cm because length of optic fiber available was 50 cm. Inner sides of dark room was painted with black for absorbing light entering into it from the bottom side, which was kept opened for measuring light intensity. The light diffuser was fixed at top center of darkroom to which optic fiber end is connected. Direct beam collected by the novel Fresnel lens solar collector was transmitted through optic fiber and finally reaches at diffuser. Light coming from the diffuser spreads like a cone with an angle of 600. From trigonometric relations, at a distance of 40 cm from the diffuser the diameter of cone is approximately equal to 45 cm which is equal to the dimension of one side of the miniature dark room. Light coming from optic fiber was dispersed through the entire cross sectional area of miniature dark room at this distance. Hence intensity of light was measured at a distance of 45cm from the light diffuser.

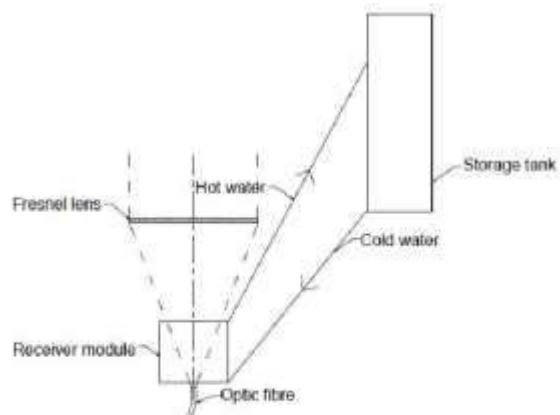


Figure 7. Receiver and optic fibre cable



Figure 8. Light diffuser

E. Solar water heating system



The solar water heating system (Fig.9) designed and fabricated collects thermal energy of the infrared portion of solar irradiation. Novel Fresnel lens solar collector acts as the collector for water heating system and a thermally stratified storage tank is used for storing hotwater. Thermally stratified storage tank was placed 20 cm above receiver module for ensuring the thermosyphon flow[6]. Thermal stratification refers to a change in the temperature at different depths due to the change in density of water with temperature. It is used in thermal systems when the available energy source is irregular or when a time lag exists between the production and the demand. Increase in the aspect ratio (height/diameter) of the storage tank leads to increase in thermal stratification and at the same time it leads to increased heat loss from the thermal storage tank. Thermal storage tank is designed for a capacity of 1 litre and with an aspect ratio of 3[7]. The storage tank was thermally insulated with Plaster of Paris. It was so connected in the system that water flows from the solar collector at the top and cold water flows back to the collector from the bottom. Four K-type thermocouples were placed equidistantly in a PVC pipe inside thermal storage tank for measuring temperature of water.



Figure 10. Thermal storage tank

F. Fabrication of concentrated optical fiber based daylighting/thermal system



Fig 11. Concentrated optical fiber based daylighting/thermal system

Concentrated optical fibre based daylighting/thermal system (Fig.11) consists of a novel Fresnel lens solar collector, fibre optic daylighting system and solar water heating system. The novel Fresnel lens solar collector collects solar irradiation and separates it into visible light and infrared radiation. Visible portion is concentrated on to optic fibre and transported into the miniature darkroom. Infrared radiation is absorbed by the receiver module in Fresnel lens solar collector and converted to heat which is carried away by the water. Water is circulating through receiver module and storage tank by Thermosyphon effect. Novel Fresnel lens solar collector which is mounted on the dual axis solar tracking system is tracked manually during experimentation. Light output from the system is measured in the miniature dark room using Luxmeter. Heat output of system is the increase in water temperature which is measured by the thermocouples.

RESULTS AND DISCUSSIONS

The novel Fresnel lens solar collector was designed and fabricated to act as a light collector for fiber optic daylighting system and as a collector for water heating simultaneously. Receiver module in the novel Fresnel lens solar collector splits the solar radiation. In order to inspect the working of receiver module, it was tested using spectrophotometer.

Spectrophotometers measures light beam's intensity as a function of its wavelength. The light input to receiver module and output from it is analyzed using spectrophotometer. After the testing of receiver module with spectrophotometer, experimentation on concentrated optical fiber based daylighting/thermal system was conducted. Light output from optic fiber daylighting system was measured using Luxmeter. Thermal output of the system was measured and efficiency of water heating was calculated.

A. Testing of receiver module with spectrophotometer

The visible light and infrared radiation in sunlight will get separated in receiver module of the novel Fresnel lens solar collector. Receiver module is tested in direct sunlight using spectrophotometer as shown in Fig.12. Light input to the receiver module is sunlight and light output from it is visible light with a spectrum as shown in Fig.13, which extends from around 400nm to

700nm wavelength, peaking in the general vicinity of greenish light at 550 nm. This means that, major portion of infrared and UV light is getting removed from the solar light while passing through the receiver module of novel Fresnel lens solar collector. Separation of UV light from sunlight avoids harmful effects of UV light on human beings. Separation of infrared portion from the sunlight avoids unwanted heating of building interiors. Light output from receiver module has a quality higher than sunlight because of the separation of infrared and UV portion. It contains light that is similar to human eye response and soothing to human eye and all other radiation is avoided from entering into optic fibre [8].

Light output from receiver module (Fig.13) shows that the visible light of solar radiation is only passed through it and the remaining portion is absorbed in it. The transmitted visible light is focused onto the optic fibre which is later transmitted to room and used for daylighting. Remaining portion of solar radiation is absorbed in the receiver module. Some portion of visible light also is absorbed by the receiver module. Absorbed solar energy is converted to heat and used for water heating.

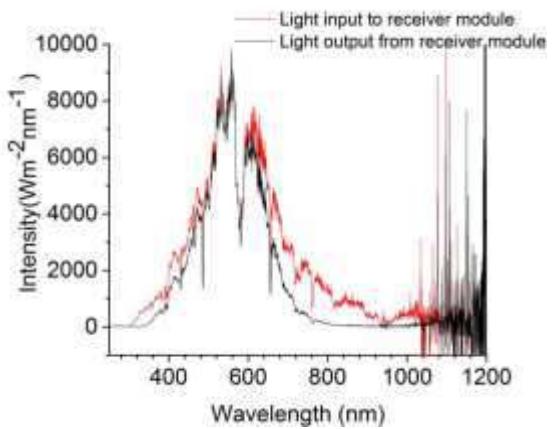


Figure 13. Spectrum of light input and output from the receiver module

B. Experimentation on fiber optic daylighting system

The sunlight collected by the novel Fresnel lens solar collector is transported through optic fibre and used for lighting (Fig.14) the miniature dark room. For getting maximum light output from the fibre optic daylighting system, the collector should be finely tracked. The collector is tracked in such a way that, light coming from the Fresnel lens is focused on the centre of optic fibre end. Lighting intensity is measured at a distance of 40cm from the light diffuser using Luxmeter. Luxmeter readings were taken at 17 points as shown in Fig.15 from morning 10 am to evening 4pm with an interval of 30 minutes. The average lighting intensity in miniature dark room is calculated by taking the average of readings at those 17 points.

Light intensity is maximum at the centre and goes on decreasing while moving towards sides. Lighting intensity or luminance is comparatively low at the corners.



Figure 14. Fiber optic lighting in miniature dark room



Figure 15. Light intensity in miniature dark room at 12:30 pm (26/04/2016)

The variation of average light intensity with time is shown in Fig.16. Light intensity increases from morning and reaches its maximum at noon where solar irradiation is also maximum and then decreases. Most of the average light intensity is above 300lx and at 4pm light intensity falls down to 194 lx which is in the same range light intensity requirement in buildings usually varies from 200 to 500 lx as per literature.

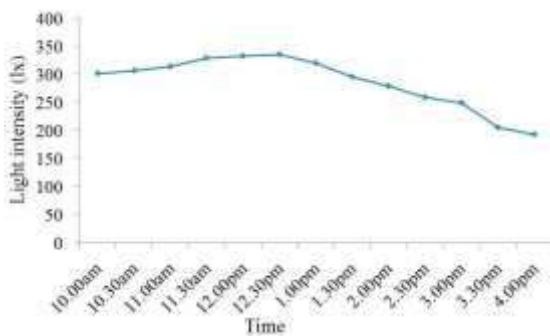


Figure 16. Variation of average light intensity with time (26/04/2016)

C. Experimentation on solar water heating system

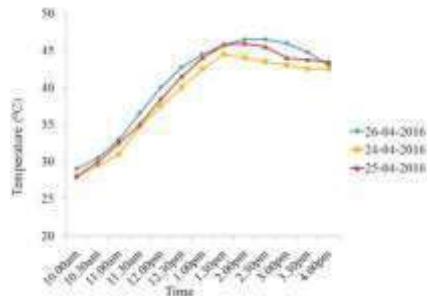


Figure 17. Variation of temperature of water with time

Experiments were conducted on solar water heating system and readings were taken from 24th, 25th and 26th of April 2016 from 10 am to 4pm consecutively. Average temperature of water in thermal storage tank is calculated by taking the average of readings from four thermocouples placed in it and graphs were plotted as shown in Fig.17.

CONCLUSIONS

Novel Fresnel lens solar collector, that can be used as a light collector for optical fibre daylighting system and as a solar thermal collector was designed and fabricated. A concentrated optical fibre based daylighting/thermal system which uses novel Fresnel lens solar collector was also designed, fabricated and experiments were conducted. The output from fibre optic daylighting system is measured in miniature dark room. Maximum average light intensity of 336 lux is obtained in miniature dark room of area 45 cm* 45 cm. Light output from the novel Fresnel lens solar collector has a spectrum very similar to human eye response. Maximum temperature of water in thermal storage tank obtained was 480C

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REFERENCES

- [1] Jeong Tai Kim, Gon Kim, Overview and new developments in optical daylighting systems for building a healthy indoor environment, *Building and Environment*, Vol. 45, 2010, pp 256–269
- [2] Ahmad Mojiri, Robert Taylor, Elizabeth Thomsen, Gary Rosengarten, Spectral beam splitting for efficient conversion of solar energy—A review, *Renewable and Sustainable Energy Reviews*, Vol. 28, 2013, pp 654–663
- [3] H A Macleod, *Thin-Film Optical Filters*. 3rd ed, Bristol: Institute of Physics Publishing, 2001
- [4] Marius Peters, Jan Christoph Goldschmidt, Philipp Löper, Bernhard Groß, Johannes Üpping, Frank Dimroth, Ralf B. Wehrspohn and Benedikt Bläsi, Spectrally-selective photonic structures for PV applications, *Energies*, Vol. 3, 2010, pp 171–93.
- [5] Jifeng Song, Yong Zhu, Zhou Jin, Yongping

- Yang, Daylighting system via fibers based on two-stage sun-tracking model, Solar Energy, Vol. 108 2014, pp 331–339
- [6] Kok Seng Ong, Kevin Osmond and Wei Li Tong ,Reverse flow in natural convection heat pipe solar water heater, International Journal of Low-Carbon Technologies, Vol. 10, 2015,pp 430-439
- [7] Abdul Jabbar N. Khalifa, Ayad T. Mustafa and Farhan A. Khammas, Experimental study of temperature stratification in a thermal storage tank in the static mode for different aspect ratios, Journal of Engineering and Applied Sciences, Vol. 6,2011,pp 53-60

ENHANCED DATA HIDING TECHNIQUE ON TEXTURE IMAGES

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Abstract: This paper proposes an innovative method for hiding data in texture images by means of texture synthesis. Texture synthesis mechanism means creating or forming a large texture from the input texture. Synthesized texture appears larger than the input texture but have similar visual appearance. This approach offers the advantage of message embedding and message extraction mechanism. Enhanced data hiding technique on texture images has larger embedding capacity and security than the existing method. In the existing technique embedding capacity and security is low as compared to the proposed method. As a further enhancement we propose an improved method for hiding data on texture images which has higher embedding capacity and security. In the existing technique the data was embedded in individual source patches where as in the enhanced data hiding method the synthetic image is divided into number of non overlapping blocks. To these blocks data is embedded. Number of data blocks needed is determined based on the size of the message to be embedded.

Keywords: Texture synthesis, Steganography, Source patch, Synthetic image, Header block, Data block

INTRODUCTION

Steganographic concept has received a lot of attention in the field of digital media. Steganography is defined as the process of hiding a secret message inside in an ordinary message. It is an information hiding mechanism that conceals the secret messages in a secure way. Steganographic mechanism is applicable to confidential communication and secret data sharing. The word steganography comes from 2 Greek words "steganos" and "graphia". Meaning of steganos is covered and graphia means writing. So steganography is also called covered writing. Steganographic classification includes text based steganography, video steganography, image steganography and audio steganography. Image distortion is one of the main disadvantage of image steganographic algorithm. Image steganography means hiding of messages in an image. These types of algorithms uses already existing image as the cover medium. So it does not allow embedding of more secret bits because of the fixed size of cover image.

By giving proper security to our data it is impossible for an unauthorized person to access the data. Steganography is a security tool that gives protection to the data and also prevents the data from malicious attackers. Steganography can conceal a secret message with in an object. That object may be

text, image, audio or video. Steganographic cover image means the medium in which the information is to be secretly placed. Stego image means a medium in which the hidden information is placed. Steganalysis is the process of detecting a secret communication. The two main important aspects of steganalysis are detecting hidden information and disabling steganography.

In this paper describes an innovative method of steganography using texture synthesis to hide data in texture images. Texture synthesis mechanism means creating or forming a large texture from the input texture. Synthesized texture appears larger than the input texture but have similar visual appearance. In order to conceal secret messages we combine the texture synthesis process into steganography which hides the source texture and also it hides the embedded secret messages. This method also provides an advantage of reversibility of source texture. Proposed method provides mainly three advantages. It offers increased embedding capacity compared to the existing technique without changing the quality of image. In the existing technique the number of source patches available for data embedding depends on the number of non negative entries in the index table. Next advantage is that increased security. In the existing method the index table contains the information about where the data is being embedded. In this paper the

embedding information is included in the synthetic image itself. Also the data embedded in the synthetic texture is hidden inside the original synthetic texture which is not easily detectable. Proposed system also offers reduced need of data structure because here there is no need of index table. Therefore processing time and work can be reduced.

Texture synthesis can create varying size of texture images. Procedural based and exemplar based classification of texture synthesis existed. In this paper we use patch based texture synthesis approach comes under exemplar approach. Patch based texture synthesis approach provides better result than the other texture synthesis approach. Patch based algorithms uses patches from the source texture. Patch means an image block of an input texture and the size of the patch can be determined by the user. A patch contains two parts .They are the central part and the kernel part. Central part called the kernel region and the surrounding part called the boundary region. In this method we consider the kernel region to embed secret messages and also that region performs texture synthesis. Proposed method offers the message embedding and message extraction procedures and also provides an advantage of source texture recovery so the same texture can used for second time also.

This paper is organized as follows section II describes about the related works. Section III contains proposed method and the Section IV describes about the results and analysis. Section V contains the conclusion.

RELATED WORKS

A. A Effros and T.K Leung used [1] pixel based algorithms to generate synthesized texture image. For choosing the most similar pixel from an input sample texture as the output pixel uses spatial neighborhood comparisons. If a pixel is wrongly synthesized during the processing time it will cause error to the remaining result. Chih -Wei Fang and Jenn-Jier James Lien [2] also uses pixel based algorithm for synthesizing a large image. H.otori and S.kuriyama developed [3] a pixel based texture synthesis for embedding secret data .Secret messages are encoded into coloured dotted patterns and they are pasted on a blank image. Capacity of embedding data depends upon on dotted patterns. This method provides a small propagation of errors during message extraction.

K. Xu et al, M.F Cohen and J. shade developed

[4-5] a patch based mechanism to improve the quality of image instead of pixel based approach. During the texture synthesis process patches are placed within a small overlapped region and to make sure that the patches will accept their neighbors. C. Han, E. Risser, and R. Ramamoorty used [6] patch based synthesis for removing blurriness in an image. Lexing Ying, Aaron Hertzmann, Henning Biermann takes [7] common type of textures such as color, displacement, and transparency are used for synthesizing texture images. Texture synthesis can be done directly on the surface and provides better quality images with less distortion.

L. Liang et al developed [8] a patch based sampling for Real-time textures. Uses the rowing approach for the overlapped regions of nearby patches. Efros and freeman developed [9] an image quilting approach based on patch based algorithms. Dynamic programming technique is used to find the minimum error path between the overlapped regions. This mechanism provides a visually plausible message by patch stitching. Li-Yi Wei and Jianwei Han et al developed an Inverse texture synthesis method [10]. Develop a small texture as output from the input texture. Efficient quality of images is generated with small data size and allows the reconstruction of the original data through the control map concept.

Z. Ni, Y.-Q. Shi, N. Ansari, and W. Su, proposes a Reversible data hiding technique [11] for image. This mechanism allows the restoring of cover image with no image distortion. Uses histogram shifting technique for reversible data hiding method. This technique can control the pixel modifications and also having limited embedded distortion. X. Li, B. Li, B.

Yang, and T. Zeng [12] presented a general framework to histogram shifting without image distortion.

Kuo-Chen Wu, Chung-Ming Wang [13] proposed Steganographic reversible texture synthesis algorithm use patch-based method to embed secret messages through the texture synthesis procedure. The number of source patches available for data embedding depends on the number of non negative entries in the index table. So it offers limited embedding capacity can embed data only to the non negative entries.

ENHANCED DATA HIDING TECHNIQUE ON TEXTURE IMAGES

Enhanced data hiding method takes input as the

source texture. This system can provide the advantage of data embedding and data extraction mechanism. We can embed the data into the data block with the help of header block. Main function of header block is to store the location of embedded data in the blocks. Embedding capacity of this method is higher than the existing technique. In the existing method the data was embedded in individual source patches where as in the enhanced data hiding method the synthetic image is divided into number of non overlapping blocks. To these blocks data is embedded by referring the header blocks.

Enhanced data hiding method offers increased security than the existing techniques. In this method the embedding information is included in the synthetic image itself and also the data embedded synthetic texture is hidden inside the original synthetic texture which is not easily detectable. Another advantage is that reduced need of data structure. Therefore the processing time and work is reduced. Enhanced data hiding method includes the following modules A) Data embedding procedure B) Data extraction and Data authentication procedure C) Source texture recovery.

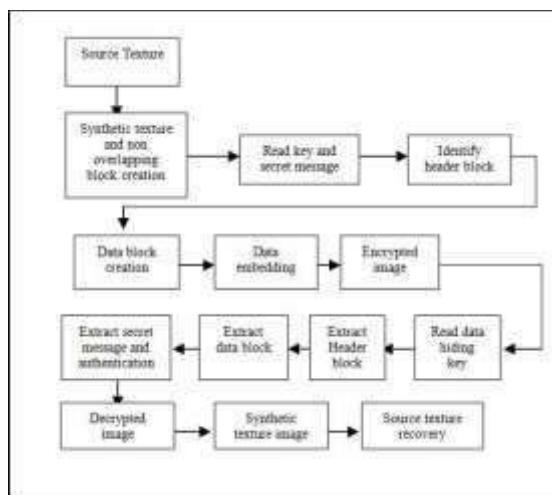


Figure 1: Message Embedding and Extraction Procedure

RELATED WORKS

A. Data Embedding Procedure

In this section describes about the data embedding mechanism. The message embedding procedure consists of mainly 3 steps. They are synthetic image and non overlapping block creation, Header block identification, Data block creation. First step is the synthetic image and non overlapping block creation. It is created in the following manner. Create synthetic image

by using the input source texture. Synthesized texture image appears larger than the input texture but have similar visual appearance. After creating the synthesized texture image next step is the division of the synthetic image. So we divide the synthetic image into non overlapping blocks. In this paper, created synthetic image is divided into 8X8 non overlapping blocks. Next step is the header block identification. For finding the header block initially read the message to be embedded and the data hiding key. One of the numbers from the list serves as the header block in the synthetic image. The main function of header block is to store the location of the block where the data is being embedded. Final step in the message embedding procedure is data block creation. Data blocks are created by considering the pixel values of the header blocks placed in the synthetic image. Pixel values of header block are arranged in a vector form. These pixel values serve as the location of the data block. To avoid overwriting on the same data block check the presence of similar pixel value and if exist ignore it. We can embed data into these data block.

Algorithm for Data Hiding (I, K, M)

1. Load the Source Texture Image, I
2. Create the synthetic image and divide the image into number of non overlapping blocks of size 8 x 8.
3. Input key, K and message M
4. Using the key, generate random numbers, one of which will serve as the header block H
5. Calculate length, len of M.
6. Using len determine the number of data blocks Dn, n=1,2,...Number of Blocks - Number of header blocks
7. Embed data into the blocks using the algorithm given below

We can embed the data into these data blocks by an algorithm. The data embedding [10] algorithm is: For each block B, find minimum element,

1. Subtract minimum element from each remaining element to get the difference block D1
2. On this difference block D1 embed the binary bit sequentially to this block

If bit=='1'

Embedded value of pixel = Current value*2+1 If bit=='0'

Embedded value of pixel = Current value*2

3. Resultant block is the modified difference block D2

Find D = abs (D1-D2)

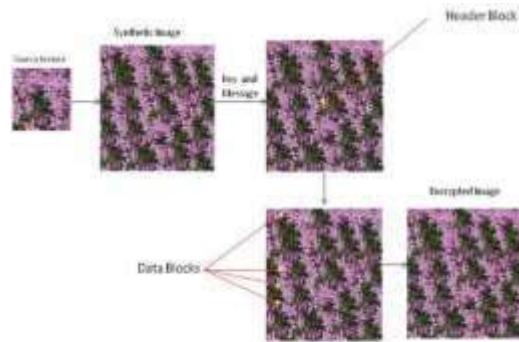


Figure 2: Pictorial Representation of Hiding Data in Texture Images

B. Data Extraction Mechanism and Data Authentication Procedure

Data extraction involves the inverse process of data embedding mechanism. Encrypted image reaches the receiver side. First step involved in the data extraction is the use of secret data hiding key used in the embedding mechanism. Here the same secret key is used for embedding and extraction mechanism. By getting the secret key we can identify the header block. When we get the header block we can also identify the data blocks. Then we can extract the embedded data.

Algorithm for Data Extraction (E, K, M)

1. Load the Encrypted image ,E
2. Divide E into number of non overlapping blocks of size 8×8 .
3. Using the same procedure of data hiding identifies the header and data blocks.
4. Deembed data from the data blocks using the algorithm given below

Data extraction algorithm [10] used for the extraction of data is given below

For each block B, perform the following

1. Subtract minimum element from each remaining element
2. If current pixel value is odd then bit '1' extracted
Original pixel = min+ (current pixel value - 1)/2
3. If current pixel value is even then bit '0' extracted
Original pixel = min+ (current pixel value / 2)

Data authentication is carried out to check that the

message or data has not been modified during their transmission. Data authentication procedure helps the receiver to verify the origin of the message.

C. Source Texture Recovery

After the extraction of data we get the original synthetic image. From the original synthetic image we can recover the source texture which will be exactly the same as the input source texture.

RESULTS AND ANALYSIS

A. Embedding Capacity of the Algorithm

Results of our algorithm are collected by using the system Pentium IV 2.4 GHz, Hard Disk: - 40 GB, Monitor: - 15 VGA Colour and Ram: - 256 Mb. This method offers higher embedding capacity than the existing technique. In the enhanced data hiding method we can embed data in all blocks except the header block. So the proposed method offers larger embedding capacity.

B. Image Quality

To determine the image quality we use Pearson product moment correlation and structural similarity index method, and PSNR [13]. Pearson coefficient of the enhanced data hiding method produce the value very near to 1. This shows that the stego synthetic texture and pure synthetic texture images [13] are highly correlated. Second method adopted is structural similarity index method. SSIM [13] is an image quality determining method. It measures change in contrast, luminance, and structure of any image. The range of SSIM [13] is [-1, 1]. This method produces the result approximately equal to 1. PSNR value of the enhanced data hiding method is also calculated. Enhanced data hiding technique ensures security, image quality and larger embedding capacity than the existing technique.

Image	Total number of bits		Embedding rate
Tile image	40(10x4)	Enhanced data hiding method	38.3938
		Existing method	20.6273
Leaf image	104(13x8)	Enhanced data hiding method	110.677
		Existing method	55.9627
Flower image	160(20x8)	Enhanced data hiding method	156.25
		Existing method	55.0062

TABLE I.EMBEDDING RATE COMPARISON

Texture image	Total number of bits		Enhanced data hiding method	Existing method
Tile image	40(1024)	PSNR	30.21	37.21
		SSIM	0.996199	0.967165
		Pearson coefficient	0.991907	0.967967
Leaf image	104(13x8)	PSNR	30.36	37.17
		SSIM	0.989386	0.963962
		Pearson coefficient	0.983738	0.957207
Flower image	160(20x8)	PSNR	47.91	36.62
		SSIM	0.995289	0.960289
		Pearson coefficient	0.995206	0.956740

TABLE II. IMAGE QUALITY COMPARISONS USING PSNR, SIM AND PEARSON COEFFICIENTS

CONCLUSION

This paper proposes an enhanced method of hiding data in texture images using texture synthesis mechanism. Texture synthesis mechanism means creating or forming a large texture from the input texture. Synthesized texture appears larger than the input texture but have similar visual appearance. In order to conceal secret messages we combine the texture synthesis process into steganography which hides the source texture and also it hides the embedded secret messages. This method offers increased embedding capacity and security and also it can produce visually plausible stego synthetic textures.

REFERENCES

- [1] A. A. Efros and T. K. Leung, Texture synthesis by non-parametric sampling, in Proc. 7th IEEE Int. Conf. Comput. Vis., pp. 1033–1038
- [2] Fang, C.-W. & Lien, J. J.-J. (2006), Fast Image Replacement Using Multi-resolution Approach, Springer, pp. 509–520
- [3] H. Otori and S. Kuriyama, Data-embeddable texture synthesis, in Proc.8th Int. Symp. Smart Graph, Kyoto, Japan, 2007, pp. 146–157
- [4] K.Xu Feature-aligned shape texturing, ACM Trans. Graph., vol. 28, no. 5, 2009, Art.ID 108
- [5] M. F. Cohen, J. Shade, S. Hiller, and O. Deussen, Wang tiles for image and texture generation, ACM Trans. Graph., vol. 22, no. 3, pp. 287–294
- [6] C. Han, E. Risser, R. Ramamoorthi, and E. Grinspun, Multiscale texture synthesis, ACM Trans. Graph., vol. 27, no. 3, 2008, Art.ID 51
- [7] Lexing Ying, Aaron Hertzmann, Henning Biermann, Denis Zorin, Texture and Shape Synthesis on Surfaces , Springer-Verlag London
- [8] L. Liang, C. Liu, Y.-Q. Xu, B. Guo, and H.-Y. Shum, “Real-time texturesynthesis by patch-based sampling,” ACM Trans. Graph., vol. 20,
- [9] A. A. Efros and W. T. Freeman, “Image quilting for texture synthesis and transfer,” in Proc. 28th Annu. Conf. Comput. Graph. Interact. Techn., 2001, pp. 341–346.
- [10] A. S. Sonawane , M. L. Dhore , S. N. Mali “Information Hiding and Recovery using Reversible Embedding”, International Journal of Computer Applications (0975 – 8887) Volume 24– No.5, June 2011
- [11] Z. Ni, Y.-Q. Shi, N. Ansari, and W. Su, “Reversible data hiding,” IEEE Trans. Circuits Syst. Video Technol., vol. 16, no. 3, pp. 354–362
- [12] X. Li, B. Li, B. Yang, and T. Zeng, “General framework to histogramshifting-based reversible data hiding,” IEEE Trans. Image Process., vol. 22, no. 6, pp. 2181–2191, Jun. 2013
- [13] Kuo-Chen Wu and Chung-Ming Wang, Member, IEEE Steganography Using Reversible Texture Synthesis IEEE Transactions on image processing, VOL. 24, NO. 1, JANUARY 2015

A PREDICTION BASED METHOD FOR DETECTION AND RECOGNITION OF TEXT PRESENT ON TRAFFIC PANELS IN A VIDEO USING A SELF-LEARNING DICTIONARY

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Abstract: Text detection and recognition is a major area that is studied for a long time. Traffic signals are assets that are crucial for making transportation safe. Computer vision techniques applied to systems used on road maintenance, are playing a major role. Reading text present natural images has grabbed the attention of many researchers during the past few decades. There is a huge availability of image-capturing devices in low-cost products. The importance of automatic inventory of the traffic panels which are located in roads to aid road maintenance and to assist driver has drastically increased. Randomly oriented text detection from traffic panels has become an increasingly important and yet another challenging task because of the huge variability of such traffic panels. The proposal reads input as a video and then extracts image frames from it. Then local descriptors at some interest points are extracted, after applying white and blue color segmentation. After that, the images are depicted as a Bag of Visual Words (BOVW) and are then classified using classifiers like Naïve Bayes or Support Vector Machines (SVM). This categorization method is a different approach for detecting traffic panels from natural images. Finally, a text detection and recognition method is applied only on image frames where a traffic panel has been plotted, so as to automatically read and predict the information depicted in the panels using a self-learning.

Keywords: Bag of visual words (BOVW), computer vision, traffic panel detection, traffic panel inventory, traffic panel recognition.

INTRODUCTION

This paper is a real application to intelligent transportation systems (ITS) of a method to detect and recognize text in videos. This text reading algorithm has proved to be robust in many kinds of real-world applications, which include indoor and outdoor scenarios with a wide variety of text appearance. These wide varieties can be due to different writing styles, fonts, colors, textures, sizes and layouts, and also the presence of geometrical distortions, different shooting angles and partial occlusions, that may cause deformed text. In this paper, this algorithm is applied with certain modifications and new added functionalities, in order to read the information depicted in the traffic panels. However, text detection from traffic panel detection still remains a challenging problem due to several reasons. First, there is a large variety of traffic panels and each of them represents different information, which is varying in size, shape and color.

Moreover, there can be large viewpoint deviations as the images are captured from a driving vehicle. Occlusions can also come into the picture due to vegetation or the other road users. In addition to this, weather and illumination conditions are another major

problem in any kind of vision-based system. Apart from this, many other elements in the roads or beside them such as vehicle bodies or advertisements can easily be confused with traffic panels.

RELATED WORKS

Traffic panel detection and recognition using computer vision techniques has been an important area of research over the past few decades. A good survey about the major vision-based proposals of detecting traffic panels and adding them for autonomous driver assistance systems is depicted in [2]. Additionally, the work done in [3] depicts a recent contribution which is about an intelligent road sign inventory based on image recognition, related to the application proposed in this paper, but this is for traffic signs instead of traffic panels. Also, it uses images taken from a vehicle instead of images served by Google Street View.

Detection and recognition of traffic panels from natural images has been out of the scope for the researchers because, on one hand, they are informative signs and also their priority is less than the regulatory or warning signs. On the other hand, there is a huge diversity of information which is depicted in these traffic

panels, which is very difficult to recognize. In conclusion, till date, the research on automatic localization and recognition of the information depicted in road panels is not satisfactory. Other than the previous work of the authors in [4] where automatic traffic signs and panels are recognized using an active vision method at night is presented, only two works have been done in this context.

The work proposed in [5] extracts the candidates which have a possibility to be traffic panels, using a method which detects the white and blue regions in the image using the hue and saturation components. These candidates are then classified based on their shapes, so that the rectangular blobs can be extracted. Then, panel reorientation is done using homography in which the four vertices of each blob are aligned. Once the panels are detected and reoriented, the foreground objects segmentation from the background of the panel is performed by analyzing the histograms of luminance and chrominance. Labeling of connected components and position clustering is applied finally for rearranging the different characters on the traffic panels. This algorithm does not depend on the image transformations such as translations, scaling, rotations, and projective distortion, but this is affected by dynamic lighting conditions. In addition to this, there are many thresholds and parameters that are temporarily adjusted. Then, the recognition is applied at character level, but here no language model is used to correct misspelled words. There is no any information about how and where these images are extracted.

Similarly, Wu et al. [6] proposed a technique for detecting the text on traffic panels present in videos. First, regions of the image with same color are extracted by applying the k-means algorithm, and traffic panel candidates are detected by searching for flat regions that are perpendicular to the axis of the camera. Then, the orientation of the candidate planes is estimated using three or more points in two successive frames; hence, this method requires an appropriate tracking method to detect corresponding points in the successive frames of the video. Furthermore, a multiscale text detection algorithm is applied on each candidate traffic panel area for accurately detecting the text. This text detection method combines adaptive searching, edge detection, color analysis deploying Gaussian mixture models. Then, a minimum bounding rectangle is drawn to cover every detected traffic panel.

A feature-based tracking is used to track all detected areas over the timeline and are merged with some other freshly detected texts in the sequence. Finally, all the detected text lines are extracted and is then fed for recognition, but the authors do not specify how the recognition is done here. In detecting the text from this scenario, this method provides nearly good results under varying lighting conditions, and it is not affected by image transformations. This method provides an overall text detection rate of 89% in their own data set. But this data set is not publicly available. So an efficient text detection and recognition automated system is required which can aid drivers in the case of lack of coverage of the GPS.

In this paper, a novel approach is proposed which detects and recognizes text present on traffic panels in a video using a self-learning dictionary by predicting it and then reads out the detected text. A video input is fed to the detection algorithm. After that, the color segmentation and the Bag Of Visual Words (BOVW) algorithm based method are applied on each frame of the video to detect a traffic panel, if present. In case if a panel is detected after applying this method, then the text detection and recognition algorithm developed in [1], is applied, including certain modifications and added functionalities. Then the detected traffic panel is subjected to character segmentation. Then, all the alphabets from "a" to "z", from

"A" to "Z" and the digits from "0" to "9" in the traffic panel is recognized using a character recognizer. However, traffic panels not only contain words and numbers but also they may include symbols such as school ahead, hospitals, petrol station indications and direction arrows. Hence, the system can efficiently recognize such symbols too. The main peculiarity of this approach is that it is not necessary to recognize all the characters present in the panel perfectly.

This can be just estimation, because after applying character recognizer, a word recognizer is applied later. A dictionary of words is created that includes all the words which the system is able to recognize correctly, i.e., name of the cities, places, and other common words that will typically appear in traffic panels of that region. A Predictive Language Model used to recognize each word, which is based on a dynamic dictionary which learns new words.

EXTRACTION OF IMAGE FRAMES FROM INPUT VIDEO

The input to the system is a video sequence, which is taken from a moving vehicle. For further processing, the extraction of image frames from the input video is necessary. So, in order to extract frames one by one from the input video, first the video in AVI format is read and then the histogram difference between two consecutive frames is plotted. Then the mean and standard deviation of difference and threshold of each pixel is calculated. This is continued till the end of the video to extract the frames one by one. If the difference is greater than threshold, then select it as an image frame.

TRAFFIC PANEL DETECTION USING VISUAL APPEARANCE

In this paper, the text detection and recognition algorithm is performed only on those video frames in which a traffic panel is detected, so that the efficiency of the system can be increased. For this purpose, an efficient traffic panel detection method has been developed, which is based on color segmentation and a BOVW approach [7]. This technique has been chosen, since this has become one of the most popular techniques in terms of classifying images based on certain properties. In this paper, BOVW is suitable to correctly find out traffic panels, despite the challenge which includes their huge variability, and depicts that geometrical characteristics are not adequate in the detection of the panel. A combinatorial blue mask is developed specially for the traffic panel detection, and is applied on each frames of the input video. For both the training and testing images, BOVW technique is used only for the certain areas of the image which are given by blue and white color masks. This reduces the time complexity. The reason for applying these color masks will be described in a later session. However, first, we brief explanation the BOVW technique can be discussed.

The BOVW method stems from text analysis. Here, a document is represented by the frequencies with which a word is detected without considering the order in which they appear. Then document classification is performed based on these frequencies. The BOVW approach for representing an image follows the same method. Local image features are the visual equivalent of these words. Therefore, the BOVW technique can represent an image as a sparse vector of frequency of the vocabulary of these local image

features. In other words, it converts a very large data set of high-dimensional local features into a single sparse vector of fixed dimensionality.

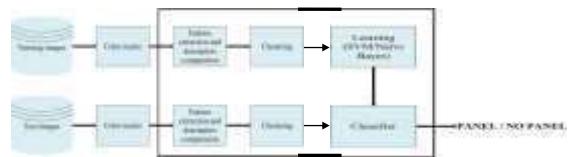


Fig. 1. Traffic panel detection.

Since the traffic panels are located above the road or on the right side, two independent regions of interest are applied on the images. These regions are shown in Fig. 2 Then; features at some keypoints are extracted from the train images and are then translated into feature descriptors, which are high-dimensional vectors. Good feature descriptors should be able to handle all image transformations such as intensity, rotation, scale, and affine etc. Then, these sampled features are then clustered using k-means clustering, so as to quantize the space into a discrete number of visual words. Now, these visual words are the cluster centers and can be considered as a representative of several local regions which are identical to each other. These different classes of the input train images are learned by a classifier. In this paper, support vector machine (SVM) [8] is used for the classification.

SVM constructs an N -dimensional hyper plane that can optimally separate the data sets into two categories. The main aim of SVM modeling is to figure out the most appropriate hyper plane which separates the data clusters in such a way that one category of the data variables are on one side of the plotted hyper plane and the other category are on the other side of the plotted hyper plane. The data points which are closer to this hyper plane are known as the support vectors, and the distance between these support vectors is called margin. An optimum separation must be achieved by the hyper plane that maximizes the margin. In general, the larger the margin is, the lower will be the generalization error for classifier. For a test image, the nearest visual word for each of its features is identified, by evaluating the Euclidean distance between the input descriptors and the cluster centers (visual words). Then the classification decision is made by the SVM classifier, previously trained. Then, feature extraction, training, and testing are applied separately on each region of interest. Here, the features are extracted at certain interest points, which are obtained using the SIFT detector.

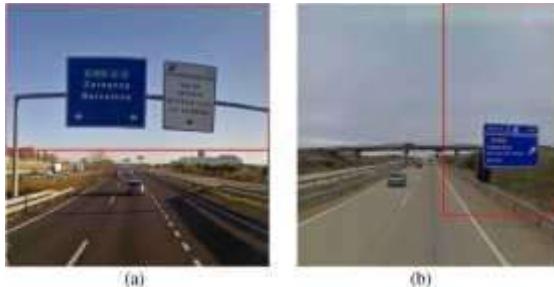


Fig. 2. Regions of interest on the images. (a) Upper region of interest.
(b) Lateral region of interest.

Since BOVW does not account for any spatial information, an initial segmentation stage is adequate in order to aid the matching of keypoints in regions in which there exists a probability that a traffic panel is present in it. A panel is validated only when it is detected in at least two consecutive frames of the input video. This multiframe detection strategy is applied as a simple way of using tracking.

Traffic panels can be distinguished in a global way by their background color. The local features are extracted from those regions of the images, which are white or blue, through two color masks. The color masks used in this scenario are hypotheses which are to be confirmed through the bag of visual words. Then, an alternative approach for traffic panel detection without using edges or other geometrical features is used which integrates prior color segmentation mask and a BOVW technique, as it has been done up to now in the literature. This technique is a generalized method to detect any object in the image which is characterized by a uniform color background.

An efficient method to segment white and blue pixels in the images has been proposed in order to segment the blue regions in the image with a combination of three independent methods:

$$\text{Blue Mask} = g_1(x, y) \text{ AND } g_2(x, y) \text{ AND } g_3(x, y)$$

Where,

- $g_1(x, y)$ – This mask can discard the sky blue regions, but cannot reject darker regions in the image such as black, gray, and dark colors.
- $g_2(x, y)$ – This mask can to reject colors which are other than blue, such as green, red, or orange, but this mask cannot differentiate b/w sky and the panel.
- $g_3(x, y)$ – It applies Otsu's segmentation method [9] in order to improve performance of the first method by efficiently rejecting darker regions in the image and the

second method by rejecting white regions present in the image.

The combination of these three masks efficiently rejects the blue and white regions and the other unwanted regions in the image. This will be highlighted in a bounding box. The output of the mask is then converted to a greyscale image for further processing.

TEXT DETECTION & RECOGNITION FROM THE DETECTED TRAFFIC PANEL

Once the using the previous method, it is found that there is a traffic panel in a particular frame, the text detection and recognition method developed in [1] is applied on the that frame. Moreover, certain modifications and other functionalities are added to it for increasing the efficiency and reducing the number of false positives. Apart from applying the text detection algorithm in the whole image frame, it is applied only on those areas of the image frame given by the blue and white color masks developed in the previous section. This is depicted in Fig 2.

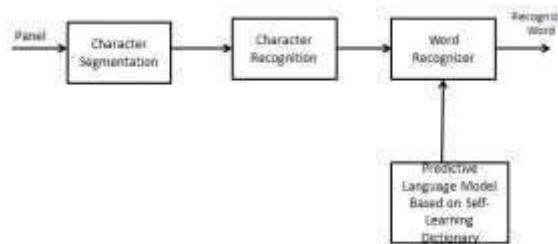


Fig. 3. Text recognition via prediction.

A. Character Segmentation:

Character segmentation is applied on the detected panel. The letters in each frame is in white color. Properties of each letter are identified, using a bounding box. When each letter is identified, then it is cropped out for reducing the overhead.

B. Character Recognition:

The character recognizer proposed in [1] recognizes the letters from "a" to "z" and "A" to "Z" and also the digits from "0" to "9". However, traffic panels not only contain letters and numbers but also other symbols such as hospitals, direction arrows, schools, petrol station indications etc. Hence, the system is modified to recognize this kind of symbols also. Some most common symbols that may appear in the traffic panels are selected, and different samples for each of these symbols are also added to the train data set. The

database consists of the pixel values of the 26 alphabets. The method of detection used is the correlation of the letters. The correlation between the read letter with the letter in the database is computed. The pair with maximum correlation (i.e., 1) will be exactly related to each other. This character recognizer may fail if panels are far, text present in the panel is small, and then it is difficult to segment and recognize this text. Here comes the role of our word recognizer.

C. Self-Learning Dictionary Based Word Recognizer:

Considering the above scenario where the character recognizer can fail, a new idea is proposed. That is, it is not necessary to recognize all the characters in the panel perfectly. This will be just estimation; because a self-learning dictionary based word recognizer is applied on it, which is entirely based on a language model based on the probability with which the word can appear on the panel.

This model restricts the output of the character recognizer and translates it into a set of meaningful words according to their prior probabilities.

In order to increase the effectiveness of the recognition algorithm, a dictionary of words that includes all the words that the system is able to recognize, i.e., name of cities, places, and other common words that typically appear in traffic panels are used. When a letter is recognized, it cross-checks with the dictionary whether there is any matches or not. If there is no match in the dictionary, then it is added to the dictionary for the further reference. Then the text in the panel is detected using the dictionary method in each frame. So the next time it slows down the execution overhead. New Words are recognized and are added to the dictionary. Detected Text is converted to Speech using Text to Speech Functionality. An evaluation is done on the detection and can be viewed as a table log.

EXPERIMENTAL RESULTS

MATLAB is been used for the complex matrix operations that were needed in this work. The panel detection rates are evaluated in this section. The detection rate for Medium Far Panel is evaluated for the existing system as follows:

Panel Detection Rate = 91.40%

Text Detection Rate including all detected panels (for Medium Panel) = 63.85%

Detection rate evaluated for proposed system is depicted in Fig. 4.

	Total	Detected	Percentage
Panel	47	43	91.4894
Word	35	24	68.5714

Fig. 4. Actual text detection rate.

CONCLUSION

In this paper, a real application of the text detection and recognition algorithm using an improved Predictive Language Model and Self-Learning Dictionary is proposed. It consists of reading video as an input and then extracting the frames. The information depicted in traffic panels is extracted from the image frames. This extraction of information is done in such a way that, the text detected initially will be added to a dynamic dictionary and is then used for reducing the further overhead. The main application of this technique is to automatically update the inventories of traffic panels of entire countries. This information is very much applicable for supporting road inventory maintenance and for developing autonomous driver assistance systems in future.

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REFERENCES

- [1] A. González and L. M. Bergasa, "A text reading algorithm for natural images," *Image Vis. Comput.*, vol. 31, no. 3, pp. 255–274, Mar. 2013.
- [2] A. Mogelmose, M. Trivedi, and T. Moeslund, "Vision-based traffic sign detection and analysis for intelligent driver assistance systems: Perspectives and survey," *IEEE Trans. Intell. Transp. Syst.*, vol. 13, no. 4, pp. 1484–1497, Dec. 2012.
- [3] Z. Hu, "Intelligent road sign inventory (IRSI) with image recognition and attribute computation from video log," *Comput.-Aided Civil Infrastruct. Eng.*, vol. 28, no. 2, pp. 130–145, Feb. 2013.
- [4] A. González, M. Garrido, D. Llorca, M. Gavilán, J. Fernández, P. Alcantarilla, I. Parra, F. Herranz, L. M. Bergasa, M. Sotelo, and P. Revenga, "Automatic traffic signs and panels inspection system using computer vision," *IEEE Trans. Intell. Transp. Syst.*, vol. 12, no. 2, pp. 485 – 499, Jun. 2011.

- [5] A. V. Reina, R. J. L. Sastre, S. L. Arroyo, and P. G. Jiménez, "Adaptive traffic road sign panels text extraction," in Proc. 5th WSEAS ISPRA, 2006, pp.295–300.
- [6] W. Wu, X. Chen, and J. Yang, "Detection of text on road signs from video," *IEEE Trans. Intell. Transp. Syst.*, vol. 6, no. 4, pp. 378–390, Dec. 2005.
- [7] G. Csurka, C. R. Dance, L. Fan, J. Willamowski, and C. Bray, "Visual categorization with bags of keypoints," in Proc. Workshop Stat. Learn.
- [8] Comput. Vis. ECCV , 2004, pp. 1–22.
- [9] C. Cortes and V. Vapnik, "Support-vector networks," *Mach. Learn.*, vol. 20, no. 3, pp. 273–297, Sep. 1995.
- [10] N. Otsu, "A threshold selection method from gray-level histograms," *IEEE Trans. Syst. Man Cybern.*, vol. SMC-9, no. 1, pp. 62–66, Jan. 1979
- E. Borenstein and S. Ullman, "Combined top-down/bottom-up segmentation," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 30, no. 12, pp. 2109–2125, Dec. 2008.

IOT : MOD CONS FOR INFURIATING PROBLEMS IN CITIES

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Abstract: Internet of things (IoT) is basically connecting embedded devices into internet. Several billions of devices are connected to each other and then to the internet. IoT gives provision for objects to be sensed and controlled remotely. This feature needn't be limited to homes or offices but can be expanded into cities to make them smarter. This paper discusses about the salient features of IoT. A brief overview about the problems that are faced by a lay person in Kerala state are discussed and how IoT can be used to tackle them effectively are unveiled. A generalized architecture for IoT is also discussed and, looks into some consequences or limitations of implementing IoT and finally concludes with the fact that limitations or problems of IoT is a trivial factor considering the effectiveness of IoT.

Keywords: smart city; urban IoT; embedded; Kerala state; Architecture.

INTRODUCTION

The internet of things (IoT) is the idea of collection and exchange of data within network of physical objects - devices, machines, automobiles, buildings and other things which are embedded with electronics, software, sensors, and network connectivity .The IoT gives provision for objects to be sensed and remotely controlled across existing network infrastructure, thus allowing more direct integration of the physical world into systems based on computer. This results in improved performance, accuracy, efficiency, reliability and economic benefit. When IoT is increased in number with sensors and actuators, the technology becomes an inevitable part of cyber-physical systems, which also includes the technologies such as smart cities, smart homes, intelligent transportation and smart grids. IoT has evolved from the integration of wireless technologies, micro services, micro-electromechanical systems (MEMS), and the Internet. The IoT finds its applications in various fields which encompasses media, environmental monitoring, manufacturing, energy management, healthcare systems, home and building automation, infrastructure management, transportation, large scale deployments etc. Experts estimate that the IoT will consist of almost 50 billion objects by 2020[1].

The Internet of Things (IoT) helps to make cities greener, safer and more efficient. By connecting devices, automobiles and infrastructure everywhere in

a city, governments can reduce energy and water consumption, keep people moving efficiently, and improve safety and quality of life. As a result, IoT transforms the cities by improving infrastructure, implementing more efficient and cost effective municipal services, enabling public transportation, reducing traffic congestion problems, and keeping people safe and effectively engaged in the community. IoT-powered smart cities aim at improving the quality of life of people in a many ways, which includes measures that promote eco-friendly, sustainable environments and providing connected health/care services to people at home and on the move.

People, automobiles, and other things on cities are connected to the digital world by means of sensors, smartphones, devices, and networks which present everywhere. Smart city management technologies, including street lighting, urban mobility, waste collection, and public safety, is changing the way that the city streets are used, experienced, and managed. The use of IoT services transforms the points of physical connection to networked landscapes that enable a range of service innovations. The IoT services will drive rapid smart city management market growth over subsequent decade. Municipal utilities are progressively upgrading to intelligent street lights, smart parking systems, and sensor-enabled waste containers. Sensors are getting used to observe air quality, sound pollution, flooding, and alternative hazards [2]. Streets are also monitored by city transport and public safety

groups through intelligent CCTVs and different systems and are digitally mapped to produce a variety of knowledge services.

Located in the south-western tip of India, Kerala state is bordered by Karnataka to the North, Tamil Nadu to the South-East and the Arabian Sea towards the West with an area of 38,863 2. Thiruvananthapuram being the administrative capital of the state, is a major destination for tourists. Cochin and Kozhikode are the other two major cities with lot of industrial activities. Kerala is very unique in its character with backwaters all along due to its proximity to the coastal area. The economy of Kerala, though small and agro-based, has a lot to look forward in future with the upcoming of IT and allied industries that are willing to exploit the yet-to-be tapped resources. But this development brings along with it chaos and infuriating problems in cities [3].

This paper deals with the study of possibilities of effectively utilizing IoT in Kerala state to control the existing problems. There are several major issues existing across Kerala like traffic congestion, Waste management, City energy consumption, Health care issues etc. IoT can be used in these areas to effectively manage the existing problems.

The organization of the paper is as follows. In section II study of major issues in Kerala is described. Section III deals with the importance of Urban IoT implementation in Kerala. Section IV describes the Urban IoT architecture and Section V includes the challenges in implementing Urban IoT in Kerala. Section VI concludes the findings of this paper.

STUDY OF MAJOR ISSUES IN KERALA

A. Traffic Congestion

Traffic in Kerala has been growing at a rate of 10–11% every year, resulting in high traffic and pressure on the roads resulting in increased travel time for the users. Kerala's annual total of road accidents is among the Nation's highest. Widening of the National Highways is still not accomplished due to Resettlement and Rehabilitation issues [3]. Traffic congestion within the roads may be defined as the condition during which the number of vehicles within the road is larger than the road capacity .The traffic congestion may cause because of varied reasons. The primary reason for congestion might vary relying upon the situation. It happens once the demand exceeds road capacity. The reasons for the traffic jam include increased range of

vehicles within the lane, improper parking, road maintenance work, accident etc. Traffic congestion has several negative effects. Effects of traffic congestion includes wastage of time for the users, delay in reaching the destination, increased fuel consumption, environmental pollution, higher probability of collision etc. The traffic congestion is a serious issue that must be checked.



Fig. 1. Traffic congestion in Kerala

B. Waste Management

Kerala generates approximately 6000 tons of solid waste daily [4]. Only less than half of this removed from the cities. Only a tiny portion of this processed or recycled. Rest is simply dumped in water bodies or at land-filling sites.



Fig. 2. Heap of wastes bumbered near road sides in Kerala

1) Reasons for increase in Waste Generation in Kerala[5].

(a) Increasing urbanization: The Census 2011 figures indicate that 47.7 % of Kerala is urbanized. This is equal to world figures. The trend of urbanization within the state is also totally different from that in the rest of the country. There's an urban-rural time with even the rural

areas displaying distinct urban characteristics like high population densities and composite primary and tertiary occupation structures. The higher the urban population, the greater the quantity of wastes that are generated.

By 2025, the report anticipates that the world's urban population may produce 2.2 billion tons per annum. Given the global expertise, the increase in Kerala's urban population is expected to offer rise to greater waste generation.

(b) **Changing Lifestyles:** Increasing disposable incomes have led to a change in values. The use-and-throw culture is currently more pronounced. There's also an inevitable presence of plastic in our lives. It's not simply plastic baggage that makes the problem. Food, water, phones, computers or other electronic gadgets are creating problem. We have a tendency to use plastic in some type or the other in our daily lives. This simply increases the issues of disposal, as the current composting and usage rates in Republic of India are hardly encouraging.

© **Rise in Tourism:** While tourism is one of major revenue earner for Kerala, there's a serious flip side too. The United Nations Environment programme states, "In areas with high concentrations of tourist activities and appealing natural attractions, waste disposal could be a significant issue and improper disposal is a serious looter of the natural surroundings – rivers, scenic areas, and roadsides. Solid waste and littering will degrade the physical appearance of the water and riverbanks and cause the death of marine animals." The Kerala government has been taking steps to deal with this issue with its Kerala – Waste Free Destination Campaign. However, much more needs to be done to educate both the tourists as well as the tourism industry. Fig 3 depicts the sources of municipal solid waste [4].



Fig 3. Sources of Municipal Solid Waste

2) Impact

Uncollected garbage- pileup and stinking waste across two sides of national highways of Kerala is a usual scene nowadays. Pillar of garbage and litter and failure to adopt state of the art strategies of waste management processes has serious consequences as follows:

Environmental: Pollution from poorly maintained landfill sites are liable to groundwater contamination and facilitate breeding of flies, mosquitoes, cockroaches, rats, and alternative pests.

Public health: chance of frequent outbreaks of communicable diseases, like malaria, dengue, Chickungunya etc, are increased Economic effects: can have negative impact on tourism.

C. Health Issues



Fig 4. Baby affected with deadly disease in Kerala

Kerala is on the brink of a public health crisis. The state, which sets an example for the rest of India and third world countries in providing primary health care, currently gropes in the dark and is fast losing the sting. The great achievements within the fields of mortality and fertility have reached a plateau, the near universal immunization coverage achieved in the nineties has fallen in most districts.

The state is often visited by rising outbreaks of swap fever, dengue fever and other insect borne viral fevers; the newest entrant is Chickungunya. Natural ecology has been tampered with and the once-famous backwaters of the state are impure and weed plagued. Waste disposal within the municipalities and corporation firms still remains a formidable challenge. Conventional methods like land fill evoke furious protests from native inhabitants.

The state health department isn't any longer the prime mover of health development. With less than a third of physicians, beds and establishments under the government, the state health services department is a mute spectator to the speedy decay of health services, significantly primary healthcare. Several primary health centers are unmanned. Drug procurement and distribution systems are outmoded and complaints of drug unavailability appear often in the media. The state-run medical colleges don't have any longer bright young academics to work for. They choose a lot of profitable placement in the burgeoning non-public sector instead. Several super-specialty departments face the threat of closure in the absence of new recruitments.

There are worse problems. Recent studies suggest that Kerala has the highest burden of coronary heart disease, stroke, high blood pressure, polygenic disorder and over-nutrition. Conservative estimates put the number of people with polygenic disorder at 3 million; people with high blood pressure at 4.5 million and people with overweight and obesity at 10 million. Every year in Kerala, between 45,000 and 50,000 people die of heart attacks, while stroke kills over 20,000. In comparison, the annual death toll from HIV/AIDS is just over 200. But both the government and the people understand HIV control as a greater priority than lifestyle interventions aimed at curbing the epidemic of non-communicable diseases [6].

IMPORTANCE OF URBAN IOT IMPLEMENTATION IN KERALA

A. Urban IoT for Traffic Congestion

A potential Smart City service which can be enabled by urban IoT consists in monitoring the traffic congestion within the city. Even though camera-based traffic monitoring systems are already available and deployed in several cities, low-power widespread communication can offer a denser source of data and information. Traffic monitoring may be realized by using the sensing capabilities and GPS installed on modern vehicles, and also adopting a combination of air quality and acoustic sensors along a given road. This data is of great importance for city authorities and citizens: for the previous to discipline traffic and to send officers wherever required and for the latter to arrange in advance the route to reach the office or to better schedule as hoping trip to the city center [7].

Smart Parking: One of the most popular IoT

applications is the use of sensors to track the availability of parking spaces. The search for parking in busy urban centers is frustrating for the driver, intensifies congestion on the roads, and increases pollution from circling cars. Moreover, cities lack the real-time data that would allow them to implement demand-based pricing. A number of startups, including Street line, are trying to enhance the parking process. They use sensors to determine when a car is parked in a given spot. This data can be sent directly to drivers, helping to guide them more quickly to an available spot, or to cities, which can use the data to adjust pricing based on demand [8].

B. Urban IoT in Waste Management

Waste management is an important problem in several modern cities, due to the cost of the service and the problem of waste disposal in landfills. An in-depth influence of ICT(Information and Communication Technology) solutions in this domain, might end in significant savings and economical advantages. As an example, the use of intelligent waste disposal containers, that can detect the level of load and permit for an optimization of the collector trucks route, can scale back the cost of waste collection and enhance the standard of recycling and reuse .To facilitate smart waste management service, the IoT connects the end devices, i.e., intelligent waste disposal containers, to a control center where an optimization software analyze and processes the data and determines the optimal and accurate management of the collector truck fleet. The sensor-enabled trash containers measure waste levels in public containers/bins and compact trash to reduce overflow. The containers share the data with local authorities, allowing them to improve efficiency by planning collection routes where and when collection is needed. The same practice can be extended to house, i.e, home trash inspection and monitoring to facilitate efficient and better collection.

C. Urban IoT in solving health issues

With the emergence of the smart cities concept, people started to realize that to become healthier they have to follow a digital economy. 'Digital economy', 'information economy' and 'knowledge society' began to be recognized as integral components of city planning and sustainable development and growth. Smart cities share certain common characteristics as they move from focusing their speculation on traditional, physical infrastructure to more importance on digital infrastructure, which includes information and

communications technology (ICT) to support the knowledge economy. Enabling the society to become widely connected, networked and data driven is the milestone in health cities. City authorities, policy creators and planners, in their effort to build smart and healthy cities, tend to depend more on information infrastructure to keep society more informed and empowered. The same digital infrastructure enables citizens to actively contribute to, and become important part of the drive for sustainable development, also to self-manage their own health and well-being to live longer and to become healthier.

Digital health which uses smart cards is one example of how people can be emancipated to take care of their own health and play an important role in their own healthcare schemes. They are facilitated to take decisions through better access to quality health information. Digital health has helped patients to stay less in hospitals and more at their home. This can be made possible by means of monitoring sensors and devices, communicating alerts and other important data over the internet and mobile networks.

ARCHITECTURE OF URBAN IOT

For deploying the IoT in smart cities there should be a centralized architecture. This architecture should be able to connect to different peripheral devices from which data is transferred through communication channels into a centralized storage and then further processed. The main challenge or characteristic this architecture should hold is that they should be able to integrate different technologies and also the data should be easily available to the public so that it includes transparency and participation from general public too[7].

We need to think beyond the normal computing paradigm to implement IoT in cities, we need to go beyond the scenarios of limiting everything with your smartphones, but rather include more devices and include technology or embed intelligence in everyday objects. Users should never have a feeling of using something external or artificial rather they should feel the originality, for which the Internet of Things demands: (1) understanding the situation of users and its appliances and communicating this scenario, (2) proper software architectures and communication channels for redirecting the data to right place at right time, and (3) data analytical tools for automatic update and smart behavior. These three fundamental concepts will make

sure smart connectivity and proper computations are done thereby implement smart cities [9]. The different components required to implement an urban IoT system is depicted in Fig.4,

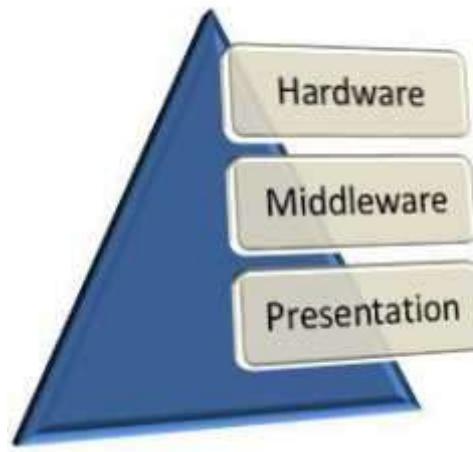


Fig. 3. Architecture of Urban IOT

The figure above depicts the main three high level components required in an IoT: (a) Hardware—this includes the physical components like sensors, embedded communication devices, and actuators (b) Middleware—this includes the mechanism for storing the huge amount of data which is getting generated and analytical tools for deducting information out of the data (c) Presentation—the information should be presented in a way that enables even common man to easily access and understand. A few technologies that will make up the above mentioned components are:-

A. Radio Frequency Identification (RFID)

RFID technology is all about designing microchips for wireless communication, this has been a major breakthrough in the field of communication. They act like electronic barcodes, enabling in identifying anything they are attached to [10, 11]. The passive RFID tags are not battery powered and they use the power of the reader's interrogation signal to communicate the ID to the RFID reader [10]. The main usage lies in transportation sectors where tickets can be replaced with these tags and road toll tags are also now replaced with RFID tags. Of the several applications, the main usage of active RFID tags is in cargo containers [11] in ports.

B. Wireless Sensor Networks (WSN)

Recent development in low power integrated circuits and wireless communications have made available efficient, low cost, low power miniature devices for use in remote sensing applications [9]. This discovery however have given way to gather information from intelligent sensors, enabling the collection, processing, analysis and distribution of valuable information, gathered in a variety of environments [12]. Active RFID and lower end WSN nodes are similar with limited processing ability and storage. The scientific challenges that must be overcome in order to realize the enormous potential of WSNs are substantial and multidisciplinary in nature [12]. Sensor data are distributed among sensor nodes and sent to a distributed or centralized system for further analytics.

C. Addressing schemes

The most important requirement for the success of IoT is the ability to identify data from different devices and also to control these devices through internet. The most critical features of creating a unique address are: uniqueness, reliability, persistence and scalability[9].

Every device connected and those going to be connected with IoT need to be uniquely identified in terms of location and functionalities .Current IPV4 may uniquely identify a group of sensors geographically but not individually. However using IPV6 may reduce some of the device identification problems; however, the heterogeneous nature of wireless nodes, different data types, parallel operations and merging of data from devices aggravates the problem further [13].

To overcome these issues, the Uniform Resource Name (URN) system is considered necessary for the development of IoT. URN creates duplicates of the resources which can be accessed through the URL. With huge amounts of spatial data being gathered, it is most important to take benefits of metadata for transferring the information from a database to the user via the Internet [14].

A reliable network functioning to pave way for the data traffic globally and relentlessly is another aspect of IoT. Even while the TCP/IP takes care of this mechanism by routing in a more reliable and efficient way, from source to destination, the IoT incur a bottleneck at the interface between the gateway and wireless sensor devices. Furthermore, the scalability of

the device address of the existing network must be sustainable and it's a serious concern when new devices or networks hamper the performance of the network. IPv6 is another good option to access the resources uniquely and remotely. The lightweight IPv6 will enable addressing home appliances uniquely.

D. Data storage and analytics

The main outcome of this field is the generation of huge variety of tremendous data. Proper storage, maintenance and expiry of the data are critical issues. Data need to be stored securely and are need to be made available efficiently and its reliability is also of prime concern. An efficient algorithm need to be used for proper channeling and storage of data. State-of-the-art non-linear, temporal machine learning methods based on evolutionary algorithms, genetic algorithms, neural networks, and other artificial intelligence techniques are necessary to achieve automated decision making[9].

E. Visualization

For a common lay person to utilize from this technological advancement he should be able to experience the real convenience or comfort of IoT, so proper means of visualization of information is also a necessary element in development of IoT. With recent advancement in the technologies of smartphones and tablets , data representation from 2D to 3D, have changed the visual impact and thereby can covey a lot more of information. Conversion of data into meaningful information is also a non-trivial task for effectively utilizing the benefit of such advanced innovation.

CHALLENGES IN IMPLEMENTING URBAN IOT

Even though IoT permits unparalleled opportunities to enhance efficiency, improve public safety, and support development, it also has several important challenges that cities will have to overcome in order to realize these benefits.

A. Integrating Design and analysis systems together: Cities already have bunch of data in their existing systems—but the challenge is that they don't have the skills or the technology to use it. In order to make the IoT valuable, cities should make sure that the data-gathering systems are designed together with analytics: the data that is collected should be easily interpreted or understood and to make use of it by the governments that collect it. In addition to improving the systems for

data collection and analysis, governments should also focus on recruiting persons who are well informed about or proficient in the use of modern technology, especially computers.

B. Security and privacy: Cities should take their role in making sure, the privacy and security of every citizen's data. If people have no trust in their governments , it will become more difficult for cities to get this information or data at all. Defense from cyberattacks is also a growing concern, particularly with regards to critical infrastructure-hacking smart meters can cost huge amount, but a more destructive intruder could compromise safety for citizens. In order to implement IoT successfully, cities should make privacy and security a topmost priority [8].

With an innovative smart leadership, Internet of Things has the ability to create a revolution in urban planning and management. By using the potential of IoT, governments can enhance service delivery, increase sustainability, and can make the cities more safer and livable places for all citizens.

CONCLUSION

Despite of the challenges that incur while implementing IoT in cities, we have discussed in this paper a diversified sector of areas where IoT can be implemented effectively to resolve the existing problems that are faced by common people in Kerala state. We have discussed here an Urban IoT Architecture that can be implemented in the state without much barriers. By utilizing the benefit of IoT the government can enhance the services they provide to their citizens and thereby making cities more safer and livable place.

REFERENCES

- [1] Dave Evans, "The Internet of Things: How the Next Evolution of the Internet Is Changing Everything" , Cisco. Retrieved 15 February 2016
- [2] <http://www.smartgridnews.com/story/smart-city-management-internet-things-hits-streets/2016-01-27>
- [3] "Traffic Projections",prefeasibilty report of Delhi Metro Rail Corporation
- [4] http://www.universalecoservices.com/wastemanagement_in_kerala.cfm
- [5] <http://blog.ksidc.org/solid-waste-management-issues-challenges>
- [6] [http://www.boloji.com/index.cfm? md=Content&sd=Articles& ArticleID=410](http://www.boloji.com/index.cfm?md=Content&sd=Articles&ArticleID=410)
- [7] Andrea Zanella, and Lorenzo Vangelista,, "Internet of Things for Smart Cities," IEEE Internet Of Things Journal, vol. 1,pp.22-32, February 2014
- [8] <http://datasmart.ash.harvard.edu/news/article/the-urban-interne-of-things-727>
- [9] Internet of Things (IoT): A vision, architectural elements, and future directions Jayavardhana Gubbi , Rajkumar Buyya , Slaven Marusic , Marimuthu Palaniswami
- [10] E. Welbourne, L. Battle, G. Cole, K. Gould, K. Rector, S. Raymer, et al., Building the Internet of Things using RFID The RFID ecosystem experience, IEEE Internet Computing 13 (2009) 48–55.
- [11] A. Juels, RFID security and privacy: a research survey, IEEE Journal on Selected Areas in Communications 24 (2006) 381–394.
- [12] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, Wireless sensor networks: a survey, Computer Networks 38 (2002) 393–422.
- [13] M. Zorzi, A. Gluhak, S. Lange, A. Bassi, From today's Intranet of Things to a future Internet of Things: a wireless- and mobility-related view, IEEE Wireless Communications 17(2010)43–51.
- [14] N. Honle, U.P. Kappeler, D. Nicklas, T. Schwarz, M. Grossmann, Benefits of integrating meta data into a context model, 2005, pp.25–29.

SOLAR INTEGRATED LI-FI - A PANACEA FOR THE QUEST OF ENERGY EFFICIENT DATA TRANSFER

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Abstract: Light Fidelity is considered to be an excellent method for transmitting high speed data nowadays. Researchers are going on in this area to make this technology available to market. The most recent advancement in Li-Fi technology is Solar Integrated Light Fidelity. This was one of the revolutionary inventions in 2015. The German physicist Harald Haas, the inventor of Li-Fi has demonstrated the prototype and the technology world is looking forward for the commercialized version. In this paper, the advancements in Light Fidelity till 2016 and their impact in the modern world is thoroughly studied.

Keywords: Li-Fi; Li-Flame; Li-X; Solar cells; Energy harvesting; Bi-directional Li-Fi

1. INTRODUCTION

Global village was made possible by the advent of internet and since then there is a high demand in increasing the speed of data transmission. The current wireless networks that connect us to the net are terribly slow once multiple devices are connected [1]. As the number of devices that are accessing the Internet increases, the fixed bandwidth offered makes it more and more difficult to achieve high data transfer rates and connect with a secure network [2]. Wi-Fi is the existing wireless technology that provides internet access to devices that are connected to internet and are within the wireless network range. The main drawbacks of Wi-Fi are less security, speed of transmission, etc. Li-Fi is the best proven alternative for Wi-Fi which addresses these disadvantages. Moreover, for deploying specially equipped LED lighting in the aircraft cabins where passengers are not allowed to connect to mobile phones, laptops and tablets in flight; in hospitals, where radio frequency signals are prohibited data transfer between smartphone and street lighting communications, etc. are fields where Li-Fi find its importance. Li-Fi is gaining acceptance in the industry and, according to unconfirmed reports, the popular iPhone manufacturer, Apple Inc., is looking forward to embed Li-Fi in its future versions of the smartphone.

Harald Haas, from Edinburgh University, cofounder and chief executive officer of PureLiFi, is the man behind this technology. The term Li-Fi was first coined by Prof. Harald Haas. Harald Haas demonstrated the technology for the first time at the TED Global Talks in 2011.

There are two ways to change the ordinary LED lighting of a room to Li-Fi enabled one. We can either buy a Li-Fi access point and connect to our LED bulb, or an LED bulb with an embedded Li-Fi chip. Additionally, we need a data connection to get the data to the lamp. In June 2015, a team from the University of California, Santa Barbara demonstrated 4Gbps data rate at room temperature with a commercial high power 450nm Gallium Nitride LED which are assumed to flicker 1000 times faster than current LEDs. Harald Haas says that we can achieve up to a data rate of 100 Gbps with specific LEDs.

There was a misconception that Li-Fi requires line-of-sight for proper data transfer. We can use the reflected light also for data transfer. That is, if there is enough reflected light, we can also communicate with a receiver which is not directly in line-of-sight with the receiver. To prove this, in 2013, the team demonstrated high speed LiFi from reflections by streaming four videos in parallel.

The most revolutionary invention in this field was the solar integrated Li-Fi. Till now, positive-intrinsic-negative (PIN) Photodiodes and avalanche photodiodes (APD) are used in Optical wireless communication systems because of their ability to provide high speed linear photo detection at practical illumination levels. However, these type of photo detectors require external power to operate. By replacing photodiodes with solar panel at receiver side, this disadvantage could be overcome [1]. The solar panel converts the optical signal to electrical signal

without any external power supply. This also removes the trans-impedance amplifier in the receiver circuitry. Professor Haas demonstrated a prototype to show how Li-Fi can be used with solar cells to receive data along with energy harvesting, TED Global Talks 2015 event in London. He is confident enough that his team can take this to market within the next two to three years [3].

The rest of the paper is organized as follows. Section II focuses on the story of Li-Fi inventions till date. Section III explains the technology behind Li-Fi, its working, and the concept of bi-directional Li-Fi system. Section IV deals with the main focus of this paper which is the working of Solar along with Li-Fi. Section V concludes the paper.

II. STORY OF LI-FI

White Light Emitting Diodes (LED) are introduced to market around the year 2000. Light waves and radio waves are a part of the same electromagnetic spectrum, and Harald Haas found out there is a scope of using light waves as an alternative to radio waves for data transmission, the team made a lot of research to optimize the LEDs to provide high speed communication instead of providing more lumens per watt. Around 2011, they had in hand a technology which can do live video streaming using LED lamp, which is Light Fidelity.

The Li-Fi timeline is given in Fig.1. A company, pure VLC was founded for doing researches in Li-Fi in January, 2012 with seed funding. Rolls Royce and Cisco also came forward for funding their projects. In January 2014, the company pureVLC was rebranded to pureLiFi which is now doing all the researches in this area.



Fig. 1. The timeline of Li-Fi

In September 2013, the first commercial product called Li-1st was brought to public. This product offers full duplex communication with a data rate of 11.5 Mbps in both the uplink and downlink over a range of up to 3m along with ample desk space illumination. Depending upon the strength of the light source, distance achieved by the system varies. Li-1st

offers a simple plug-and-play solution which provides secure wireless point-to-point access of Internet and has been developed to provide a platform for pilot projects with pureLiFi partners [4].

The development of the next product of the company, Li-Flame was completed in December 2014 and brought to public at Mobile World Congress in Barcelona in March 2015. Li-

Flame is the world's first optical atto-cell network that can provide multi-user access, along with handover methods which helps users to move around inside a boundary with uninterrupted access by connecting to the best serving LED. It provides half duplex communication with a data rate of 10Mbps both downlink and uplink over a range of up to 3m; a data rate density of 2Mbps per square meter. It consists of two parts - Li-Flame Ceiling Unit (CU) which is connected with a standard Ethernet port from where it gets both data and power, and Li-Flame Desktop Unit (DU) that connects to client device via USB. The Ceiling Unit connects to an LED light unit which forms an atto-cell covering a wide area and it has handover control that enables seamless switching between access points. The portable Desktop Unit provides uplink to the ceiling unit and is powered using a battery. There is a provision to adjust the transceiver swivel head to adjust the connection [5].

Li-Fi using solar cells was demonstrated in November, 2015. This is the most discussing topic nowadays and it is believed to be useful for smartwatches which require frequent charging. Many Internet of Things (IoT) device manufacturers have been looking for extending the battery life of sensors so that they work efficiently up to ten years without any replacement. There are around four billion people all across the world who have no internet access [6]. Solar connected Li-Fi will give immense impact for developing countries and rural community dwellers who are not having electric power [7].

The world's first Li-Fi dongle, Li-X was developed in December 2015 and unveiled in public at Mobile World Congress in February, 2016. LiFi-X which is having the size of three quarters of a credit card, supports roaming, multiple access, complete mobility, etc., that is comparable and more secure than existing wireless technologies like Wi-Fi. This dongle can be operated from any USB 2.0 enabled mobile and is a 5G technology which offers a transmission rate that is 100

times higher than that of existing ones. Li-X provides full duplex communication with a data rate of 40Mbps both downlink and uplink; also eliminates external network intrusion. The Li-X access point (AP) support power line communications. It also consists of LiFi-X Station (STA) which is powered through a USB [8].

III. LI-FI – AN OVERVIEW

Li-Fi can be implemented simply by using the LED (Light Emitting Diodes) lights which we use commonly in our day to day life. It doesn't require any complex transmitter and receiver sections like that in Wi-Fi. This technology transmits data through the illumination of LED light bulbs.

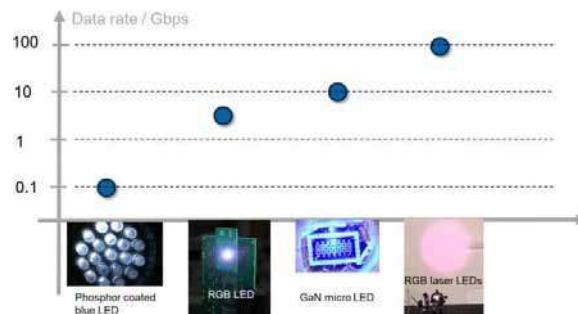


Fig. 2. Data Rates (in Gbps) Vs Different LEDs

Mainly, two types of white LEDs are available – One is blue chip LED with a yellow phosphor layer on top [9], [10]; and the other is LED consisting of individual red-green-blue (RGB) chips whose output is mixed precisely to generate white light [11], [12]. The phosphor coating of the former LED decreases the device's modulation bandwidth due to its relatively slow time that is required for absorption and re-emission of yellow phosphor. In order to eliminate the slow components of the emitted spectrum, a narrow band blue filter is often used at the receiver. Using the white off-the-shelf phosphor coated LED, a data rate of 1 Gbps has been achieved [9]. However, due to signal filtering, the received signal power is compromised with the increase in bandwidth. High data-rate visible light communication can be achieved by using RGB LEDs. With a commercially-available RGB LED, we can achieve a data rate of 3.4 Gbps theoretically [12]. The faster data is achieved when using micron sized Gallium Nitride based LEDs. The data rates achieved by using different LEDs are shown in Fig. 2.

A. Working of a Simple Li-Fi System

The data is transmitted by modulating the

intensity of the light rays emitting from the LED lamp. The intensity of the light and the rate at which the LED flickers are adjusted according to the data we want to transmit. The modulation is done in such a way that the variation in intensity is so fast that it cannot be detected by human eyes. It will appear like a normal light. The unique characteristics of Li-Fi is that the same visible light that we use for illumination is used as the means for communication.

This technology mainly requires a light source, such as a standard LED bulb, an internet connection and a photo detector. When a constant current supply is given to an LED light bulb, it emits a constant stream of photons from the bulb which is observed as visible light. If the current applied is varied slowly, the intensity of the output light dims up and down. When the LED is ON, a digital '1' is transmitted, and if it is OFF a digital '0' is transmitted. Hence by switching an

LED between on and off, we can transmit binary signals very quickly achieving very high data rates. The data input to the LED is given through a signal processing unit which act as a varying current. At the receiver side a photo sensitive detector will be placed which also contains a signal processing unit. It detects the minute variations in the incoming light signals and convert it back into electrical signals [13]. The wireless data connectivity is achieved by modulating the incoherent light generated by LEDs using a modified version of orthogonal frequency division multiplexing. With this technique, we can use all four dimensions such as time, frequency, colour and space. Light signal is demodulated and converted into continuous stream of binary data consisting of video, audio, multimedia etc. which can be consumed by any internet enabled device. Fig. 3 shows the block diagram of a simple Li-Fi system.

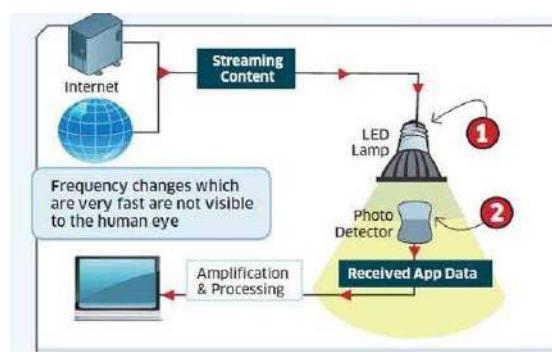


Fig. 3. Block Diagram of a Simple Li-Fi system

Data Communication using Li-Fi is just as seamless as that using radio frequency signals, as intensity modulation is imperceptible to the human eyes. It helps to achieve high speed data transfer with a data rate up to 10 gigabytes per second which is around 100 times faster than the existing fastest broadband connection available [14]. The technology is secure because light cannot penetrate through walls. This can be a disadvantage also; but because of this property of light, the same spectrum can be used in the adjacent room without any interference.

B. Bidirectional Li-Fi system

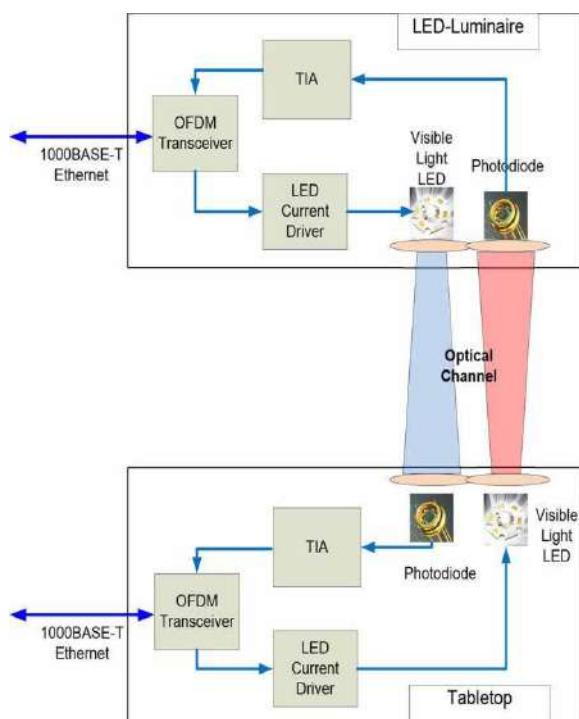


Fig. 4. Block diagram of a bi-directional Li-Fi system

Wavelength division multiplexing is the most suitable technique for the uplink of full duplex communication, in which two different channels are established over different wavelengths. The most viable option to link mobile terminals to optical access points is IR transmission. The small cell concept is used in VLC and these access points are dubbed attocells that are analogous to femtocells. They improve bandwidth reuse, coverage and also lack interference with macrocellular networks. Long term goal is to enable seamless interoperation between optical attocells and radio frequency macrocells/femtocells [15].

Recently, the team demonstrated a real time, bidirectional, line of sight visible light communication system which is shown in Fig. 4, where TIA represents Trans-Impedance Amplifier [16]. The system which uses rate adaptive OFDM, is currently providing only half duplex communication, the system relies on rate adaptive OFDM and is implemented with feedback through a reverse link. The transceivers include proprietary VLC transmitter and receiver modules which are capable of offering a bandwidth of up to 180MHz and are linked to 1000BaseT interfaces. This system provides a data rate of 200 Mbps per user in a circle of diameter 60cm, provided distance between the ceiling and table top is 2m.

IV. SOLAR AS LI-FI RECEIVER

The researchers have developed a new technology by integrating data reception and power gathering in solar panels to change them as communication devices. Now, solar panels can be developed to receive high speed data also, thus enabling them to provide energy for Li-Fi technology effectively and act also as a broadband receiver.

Solar cells inside the panel are designed to become communication nodes that receive data having high bandwidth along with providing electric power for the operation of the node. These self-powered nodes will help in the growth of data communication. Solar connected Li-Fi systems can be simultaneously powered and connected to internet through light. A solar cell can be used to charge a mobile phone by the electrical energy generated by conversion of absorbed light. In Li-Fi data is encoded as change in brightness of light. This fluctuations in incoming light results in the fluctuations in the energy harvested. It is proved that we can receive a data rate of up to 50 Mbps from a standard solar cell. The speed of data transmission can be increased by encoding the signal using OFDM.

In TED Global Talk 2015, Harald Haas successfully demonstrated a prototype of the Li-Fi with a solar receiver. He used a standard LED bulb, a laptop and an instrument to show the amount of energy harvested. He publicly unveiled the technology by simultaneously streaming a video in laptop and harvesting energy [3]. Additionally, he proved that the solar cells can work reasonably well in the presence of fog also. There was a reduction in the amount of energy harvested but the video streaming continued uninterruptedly.

A. Solar Panel As Self - Powered Receiver

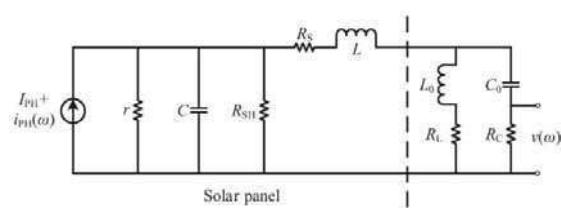


Fig. 5. Solar panel for data transfer and energy harvesting

Zixiong Wang et al. proposed a circuit to convert solar panel as a receiver as shown in Fig. 5. A first generation multi-crystalline silicon solar panel is used here to work as a broadband receiver in an indoor environment. The photo current contains both DC component, IPH and AC component, iPH. A diode can be connected parallel to the photocurrent source to model the current and voltage at the output of solar panel. A small signal equivalent resistor r is used instead of the diode because the AC component will have a small variation compared to the DC component. The leakage current in the solar panel is modelled by the shunt resistor, R_{SH} . In order to measure the internal capacitive effects of solar panel, a capacitor C is added parallel to the shunt resistor. Due to cell interconnections, there will be internal voltage loss and to represent this, a series resistor R_S is used. The inductance of wire connections are modelled by the series inductance L . The capacitor C_0 and load resistor RC collectively forms the communication branch. The inductor L_0 and the resistor RL forms the energy harvesting branch which could be used as a battery in real world. L_0 which is being used as an RF choke, removes ripples from the DC signal by attenuating the AC signal and also improves the gain of the signal. The data is retrieved as the voltage, $v(\omega)$ across the load resistor. C_0 is added before RC to block the DC component of the received signal thus allowing it to pass through the energy harvesting branch only [1].

B. Working of Solar Integrated Li-Fi System

Fig. 6. shows a block diagram to illustrate the working of Solar integrated Li-Fi. The data is to be transmitted from the server and internet. The LED lamp, which is driven using lamp driver, is used as the data transmitter. The encoded data is received and decoded by the solar cell. The output of the solar panel is displayed on the laptop screen. The solar cell works properly till it is getting enough changes in brightness of light.

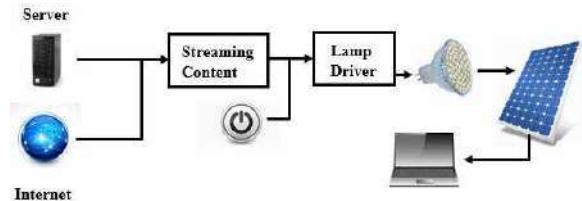


Fig. 5. Block Diagram of Solar Li-Fi System

C. Applications of Solar Integrated Li-Fi

The Solar connected Li-Fi can increase the pace of electronics inventions. Some of the areas where it is supposed to make an impact are listed below.

1) Developing Countries: The technological growth in developing countries can be increased using Solar integrated Li-Fi. The rural areas in a developing country lacks technological advancement because of the restricted amount of power obtained. Generally, solar energy is the source of electricity in these areas. We can enable internet by integrating Li-Fi system to these existing solar powered areas. Thus, the roofs with solar panel become smart roofs.

Majority of Indians live in rural areas [17]. The Prime

Minister's Digital India Programme mainly focuses on connecting these rural dwellers. The solar-powered WiFi system was launched by Minister of Communication and IT, Ravi Shankar Prasad on July 6, 2015 as a part of the Digital India week [18]. Solar powered Li-Fi system will be launched soon. Harald Haas said that they have already spoken to Indian government regarding data connection for dwellers in rural areas using solar connected Li-Fi, thus contributing to Digital India [19].

2) Internet of Things: Today, IoT is in a position to monitor everyday aspects of life such as water, electricity, garbage, traffic, wind speed, temperature, and air quality, among others [20]. This technology is said to have numerous nodes and each node is expected to be wireless. A solar panel on the roof top of a building, street lights, and many devices which contributes to the IoT can make use of this technology. The IoT devices requires frequent charging as they consume more power. Light is a good source source for energy and it will be excellent, if these devices can be powered by using light. As technology grows, more and more sensors are added and self-powered devices can make a real difference.

- 3) Big Data: With tremendous growth of mobile devices across the globe, more than 10 billion mobile devices would exchange 36 quintillion bytes of data and information each month [20]. Researchers estimate that smartphones and tablets will exchange 35,000,000,000 gigabytes of information monthly by 2019 [21]. While this is the case with just mobile devices, we have to consider big data servers also which transfers huge amount of data. Our current infrastructure cannot handle this high data volume and this can be handled by the new solar powered Li-Fi systems.
- 4) Carbon Footprint: Carbon footprint is the total amount of greenhouse gases produced by an organization, event, individual or product [22]. In an increasingly carbon-constrained world, solar energy technologies represent one of the least carbon-intensive means of electricity generation. Solar power produces no emissions during generation itself, and life-cycle assessments clearly demonstrate that it has a smaller carbon footprint from "cradle-to-grave" than fossil fuels [23]. Thus Solar integrated Li-Fi will help in reducing carbon footprint to a reasonable level. This could be another selling point.

V. CONCLUSION

The researches going on in the Li-Fi technology are studied. The solar panels which are used in the rural areas having no electric power, has been demonstrated to serve as broadband receiver that provide data connectivity. This invention can pave the way for a smart world which can be powered simply by using visible light which is renewable and abundantly available. Scientists are researching to improve the data rate even more and replace the concept of W-Fi completely with Li-Fi. This is not the limit of researches and Li-Fi can make revolutionary changes in the lifestyle of people. The prototypes which are discussed in this paper will be into the hands of common man in the near future.

REFERENCES

- [1] Zixiong Wang, Dobroslav Tsonev, Stefan Videv, and Harald Haas, "On the Design of a Solar-Panel Receiver for Optical Wireless Communications With Simultaneous Energy Harvesting," IEEE Journal On Selected Areas In Communications, vol. 33, no. 8, August 2015.
- [2] Shyamli Ugale and Ankit Mune, "LI-FI The Powerful Technology (Transmission of Data Through Light)", International Journal of Pure And Applied Research In Engineering And Technology, vol. 4, pp. 834–843, May 2016.
- [3] https://www.ted.com/talks/harald_haas_a_breakthrough_new_kind_of_wireless_internet/transcript?language=en
- [4] <http://purelifi.com/lifi-products/li-1st/>
- [5] <http://purelifi.com/lifi-products/li-flame/>
- [6] <http://news.softpedia.com/news/World-Wide-Web-Creator-The-Internet-Must-Be-a-Human-Right-467281.shtml>
- [7] <http://www.researchinnovation.ed.ac.uk/News/LatestNews/news/latestnews/edinburghheraldssolarenergylifiasfutureofwirelesscommunication3>
- [8] <http://purelifi.com/lifi-products/lifi-x/>
- [9] A. M. Khalid, G. Cossu, R. Corsini, P. Choudhury, and E. Ciaramella, "1-Gb/s transmission over a phosphorescent white LED by using rate adaptive discrete multitone modulation," IEEE Photon. J., vol. 4, no. 5, pp. 1465–1473, Oct. 2012.
- [10] J. Vucic, C. Kottke, S. Nerreter, K.-D. Langer, and J. Walewski, "513 Mbit/s visible light communications link based on DMT-modulation of a white LED," J. Lightw. Technol., vol. 28, no. 24, pp. 3512–3518, Dec. 2010.
- [11] J. Vucic, C. Kottke, K. Habel, and K.-D. Langer, "803 Mbit/s visible light WDM link based on DMT modulation of a single RGB LED luminary," in Proc. OFC/NFOEC, 2011, pp. 1–3.
- [12] G. Cossu, A. M. Khalid, P. Choudhury, R. Corsini, and E. Ciaramella, "3.4 Gbit/s visible optical wireless transmission based on RGB LED," Opt. Exp., vol. 20, no. 26, pp. B501–B506, Dec. 2012.
- [13] M. V. Bhalerao, S. S. Sonavane, and V. Kumar, "A Survey of Wireless Communication Using Visible Light", International Journal of Advances in Engineering & Technology, Vol. 5 Issue 2, p. 188, Dec 2012.

- [14] S. Samir Khushu, "Li-Fi (Light Fidelity) - An Advancement For Future Wireless Communication," International Journal of Advanced Research in Computer Science & Technology (IJARCST 2014), Vol. 2, Issue 2, Ver. 1, April - June 2014.
- [15] <http://www.newelectronics.co.uk/electronics-technology/can-leds-help-to-solve-the-looming-spectrum-congestion-problem/59424/>
- [16] Klaus-Dieter Langer, Jonas Hilt, Dominic Schulz, Friedrich Lassak, Florian Hartlieb, Christoph Kottke, Liane Grobe, Volker Jungnickel, and Anagnostis Paraskevopoulos, "Rate-adaptive visible light communication at 500Mb/s arrives at plug and play," SPIE, 2013.
- [17] <http://blogs.fco.gov.uk/sunilkumar/2016/03/04/li-fi-brings-digital-enlightenment-to-india/>
- [18] <https://thelogicalindian.com/news/c-dot-launch-broadband-products/>
- [19] <http://www.livemint.com/Companies/gecEoWgpYXpTYH3M379gHO/LiFien able d solar panels can help Digital India Harald Ha.html>
- [20] <https://www.promptcloud.com/blog/what-li-fi-can-contribute-to-big-data-and-internet-of-things>
- [21] <http://softwarefocus.net/iot/lifi-will-take-big-data-and-iot-to-the-next-level.html>
- [22] https://en.wikipedia.org/wiki/Carbon_footprint
- [23] <http://unchronicle.un.org/article/promise-solar-energy-low-carbon-energy-strategy-21st-century/>

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