



Estd. in 2001

Your Platform to Build a Bright Future

ISO 9001:2015
Certified
Institute

NBA
Accredited
Programs

NAAC Accredited
Institute
with 'A' Grade

AICTE-CII Survey rating
in Platinum category for
Industry linkages

78th All India Rank
published in Outlook
survey on 24th May 2018



Proceedings of International Conference on Trends in Electronics & Communication - 2019



Organized by: **Department of Electronics & Telecommunication & Electronics Engineering**



Editors

Dr. Vinitkumar Dongre

Mr. Hemant Kasturiwale

Ms. Sujata Alegavi

Ms. Rutvi Thakar

Mr. Deepak Kr. Sinha

In Association With



Tagdu Singh Charitable Trust's (Regd.)

THAKUR COLLEGE OF ENGINEERING & TECHNOLOGY

(Approved by AICTE, Govt. of Maharashtra & Affiliated to University of Mumbai*)

Institute Accredited by National Assessment and Accreditation Council (NAAC), Bangalore#

• ISO 9001 : 2015 Certified • Accredited Programmes by National Board of Accreditation, New Delhi**

*Permanent Affiliated UG Programmes : • Computer Engineering • Electronics & Telecommunication Engineering • Information Technology (w.e.f. A.Y. 2015-16)

• Electronics Engineering (w.e.f. A.Y. 2017-18)

**1st time NBA Accredited UG Programmes : • Computer Engineering • Electronics & Telecommunication Engineering • Information Technology (3 years w.e.f. 16-09-2011)

**2nd time NBA Accredited UG Programmes : • Computer Engineering • Electronics & Telecommunication Engineering • Information Technology • Electronics Engineering (3 years w.e.f. 01-07-2016)

1st cycle of NAAC Accreditation : • "A" Grade for 5 years (w.e.f. 30-10-2017)



Estd. in 2001

ISO 9001:2015
Certified
Institute

NBA
Accredited
Programs

NAAC Accredited
Institute
with 'A' Grade

AICTE-CII Survey rating
in Platinum category for
Industry linkages

78th All India Rank
published in Outlook
survey on 24th May 2018



IC-TELCON – 2019 Conference Proceedings



In Association with





"International Conference on Trends in Electronics & Communication (IC-TELCON 2019)"

Chief Patron

Mr. V. K. Singh, Chairman, TEG

Patron

Mr. Jitendra R. Singh, Trustee, TEG

Mr. Karan V. Singh, CEO, TCET, TIMSR, TIMSCDR

Program Chair

Dr. B. K. Mishra, Principal, TCET

Technical Chair

Dr. Lochan Jolly, Dean - SSW, Professor, EXTC Dept.

Convenor (IC TELCON 2019)

Dr. Vinitkumar Dongre, Professor and HOD, EXTC Dept.

Joint Convener (IC TELCON 2019)

Dr. S.C.Patil, Associate Professor and Deputy HOD, ETRX Dept

Co- Convenor (IC TELCON 2019)

Mr. Sanjeev Ghosh, Associate Professor, EXTC Dept.

Mr. Hemant Kasturiwale, Associate Professor, ETRX Dept.

Treasurer

Ms. Archana Deshpande, Assistant Professor, EXTC Dept.

Publication Committee

Ms. Sujata Alegavi, Assistant Professor, ETRX Dept.

Ms. Rutvi Thakar, Assistant Professor, EXTC Dept.

Ms. Kalawati Patil, Assistant Professor, EXTC Dept.

Ms. Sukruti Kaulgud, Assistant Professor, EXTC Dept.

Ms. Megha Gupta, Assistant Professor, EXTC Dept.

Ms. Rashmita Kumari Mohapatra, Assistant Professor, EXTC Dept.

Mr. Nikhil Tiwari, Assistant Professor, EXTC Dept.

Mr. Niket Amoda, Assistant Professor, EXTC Dept.

Ms. Purnima Chandrasekar, Assistant Professor, EXTC Dept.

Ms. Archana Belge, Assistant Professor, ETRX Dept.

Mr. Sunil Khatri, Assistant Professor, ETRX Dept.

Mr. Sumit Kumar, Assistant Professor, ETRX Dept.

Ms. Jalpa Pandya, Assistant Professor, ETRX Dept.

Mr. Deepak Kumar Sinha, Assistant Professor, EXTC Dept.

Ms. Shikha Sharma Gupta, Assistant Professor, EXTC Dept.

Ms. Jeslin Edison, Assistant Professor, EXTC Dept.

Mr. Deepak Singh, Assistant Professor, EXTC Dept.

Mr. Chandresh Yadav, EXTC Dept.

Mr. Dinesh Kanswal, EXTC Dept.

Ms. Asmita Parab, EXTC Dept.

Ms. Jinal Rathod, EXTC Dept.

Ms. Kinjal Joshi, EXTC Dept.

Ms. Pranjali Naik, EXTC Dept.

Ms. Varsha Murukate, EXTC Dept

Mr. Brij Kishore Dubey, ETRX Dept.

Ms. Priyanka Sawant, EXTC Dept.

Technical Review Committee

Mr. Tarry Singh, CEO & Founder, deepkapha.ai, Netherlands

Dr. S.G. Bhirud, (I/c) Registrar University of Mumbai, India

Dr. S. V. Dudul, Prof. & Head, Applied Electronics Department, SGBAU, Amravati, India

Dr. S. B. Deosarkar, Prof. Electronics & Telecommunication Engineering Department, BATU, Raigad, India

Dr. U. S. Sutar, Principal, Jaywant College of Engg. & Management, Sangli, India

Dr. U. D. Kolekar, Principal, A P Shah Institute of Technology, Thane, India

Dr. S. S. Mande, Professor & BOS Electronics Engg. -UOM, Mumbai, India

Dr. Kishor Kinage, Professor, Pimpri Chinchwad College of Engineering, Pune, India

Dr. Amit Deshmukh, Professor & Head of EXTC Dept., D. J. Sanghvi College of Engineering, Mumbai, India

Dr. (Mrs.) Sujata N. Kale, Associate Prof., Applied Electronics Department, SGBAU, Amravati, India

Thakur College of Engineering & Technology, Mumbai, India

Copyright©2019 by the International TCET. Permission to make digital or hard copies of portions of this work for personal or classroom use is granted without fee provided that the copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page, Copyrights for components of this work owned by others than above mentioned bodies must be honored, Abstracting with credit is permitted.

To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and or a fee. Request permission to republish from: Publications Dept. TCET. For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through the Copyright Clearance Center.

Notice to Past Authors of Multicon-W Published Articles

TCET intends to create a complete electronic archive of all articles and or other material previously published by TCET, if you have written a work that was previously published by TCET in any journal or conference proceedings prior to 2015, and you do NOT want this work to appear in the TCET digital Library, please inform multiconw@thakureducation.org, stating the Title of the work, the author(S), and where and when published.

ISBN Numbers

ISBN: 978-1-7329562-0-9

Printed in India

Thakur College of Engineering & Technology, Mumbai India

Preface

Thakur College of Engineering and Technology (TCET) with great pleasure invites you to IC-TELCON 2019 organized by Electronics (ETRX) and Electronics & Telecommunication Engineering (EXTC) Department. International Conference on Trends in Electronics & Communication (IC-TELCON) aims to bring together researchers, engineers and scholar students to exchange and share their experiences, new ideas and research results about all aspects in the fields of Electronics Engineering and Communication. IC-TELCON 2019 provides a platform to researchers from both academia as well as industry to meet and share cutting-edge development in the field and it aims to provide an opportune forum and vibrant platform for researchers.

This year, IC-TELCON 2019 is planned on 22nd and 23rd February 2019. IC-TELCON 2019 solicits research papers describing significant and innovative research contributions in the field of Signal Processing and Applications, Communication, Antenna and Microwave Engineering, Electronic Devices and VLSI, Robotics Automation and Embedded Systems. IEEE-TCET and IETE - TCET is a Professional body which provides a platform for all students to enhance their technical skills and expand their knowledge in all domains through various workshops. This year IEEE-TCET organized 2 days hands on session on Scilab, IoT/Embedded Systems and Virtual Reality.

Electronics and Electronics & Telecommunication Engineering is considered to be the major discipline of engineering which can be considered as backbone of progress and technology. The aim of the IC-TELCON 2019 is to encourage Academic Teachers, Scientists, Students, Research Scholars and Industry professionals to innovate and invent new technology by incorporating their new ideas. IC-TELCON 2019 is a platform for discussions, deliberations and exchange of knowledge, to create new products and innovations in technology for the coming era. This year we have received two International and 120 papers from all over the country. IC-TELCON 2019 has been able to associate with world recognized publication houses like Scientific Research Publishing, IGI Global, SciPress, IOS Press. We have got affiliations with Web of Science, Scopus index and UGC recognized journals. We are indeed fortunate to have being associated reputed journals International Journal of Engineering and Technology (IJET) through special issues like "Evolving Nanotechnology based Devices and Applications" and Intelligent Decision Technologies(IDT) "Soft Computing approaches for image analysis in practical scenario : Challenges, Solutions and Applications" which is Scopus indexed journal.

The organization of IC-TELCON 2019 is very much a team effort of TCET. I would like to take this opportunity to thank all the members of the conference committee, who have carried out a huge and complicated task to make such a grand event possible. I also wish to thank the Management of Thakur Education Group for providing us the world class infrastructure and unstinted support in all our endeavors to make this kind of event see the light of day.

Dr. Vinitkumar Dongre
Convenor IC-TELCON 2019

Dr. S.C. Patil
Joint Convenor IC-TELCON
2019

CONTENT

Preface

CAME - 2019

1	GPS Based Health Monitoring System for Animals <i>Akshay Prabhu, Yash Patel, Rahulkumar Jha</i>	1
2	CDCO-OFDM For Indoor Optical Wireless Communication <i>Jayasudha Koti, B K Mishra</i>	7
3	An Enhanced Algorithm For Density Based Traffic Light Control System <i>Satyam Bhikadiya, Mayank Mishra, Shikha Mishra, Ms. Megha Gupta</i>	13
4	Testing And Troubleshooting Of Intel Celeron Series J1800 On Linux System <i>Sunilkumar Gupta, Shubham Singh, Anand Shukla</i>	17
5	Design Of VHF Yagi Uda Antenna For Durdushti Ground Station <i>Vijay Rasal, Sandesh Sawant, Vighnesh Mane, Kiran Rathod</i>	19
6	Quad-band Annular-Ring antenna with Defective Ground Structure for calling Tablet <i>Mahesh Munde, Anil Nandgaonkar, Shankar Deosarkar</i>	23
7	Implementation Of Faculty Management System In Erp <i>Niket Amoda, Deepak Kumar Sinha</i>	29
8	Research On Suspicious Activity Detection Critical Review <i>Shital Mali, Dr. Uday Pandit</i>	35
9	Power Consumption And Delay In Wireless Sensor Networks Using N-Policy M/M/1 Queuing Model <i>Sanjeev Ghosh, Srija Unnikrishnan</i>	41
10	STBC Based OFDM For M-Ary QAM Modulation Technique <i>Chandrashekhar Beral</i>	47
11	Design And Deployment Of Ethercat Master And Performance Evaluation <i>Chandrashekhar Beral, Pavan Borra, Chinmay Kargutkar, Meet Gopani</i>	51
12	Python - A Language For Embedded Systems <i>Jalpaben Pandya, Leena Chakraborty, Roohi Mehta</i>	57

SPA - 2019

13	Image Analysis Using Deep Learning Machine Algorithms <i>Shital Patil, Surendra Bhosale</i>	61
----	--	----

14	Efficient Classification Of Remotely Sensed Images Using Pretrained Convolutional Neural Networks Sujata Alegavi	67
15	Image Superresolution Technque: A Novel Approach For Leaf Diseased Problems Sanket Kasturiwala, Hemant Kasturiwale	73
16	Implementation of Automatic Speech Emotion Recognition System using Convolution Neural Network Bhumika Sharma, Aasman Patel, Anamika Pandey	79
17	Online Signature Verification using Altitude Parameter Deviprasad Pandey, Kusum Mishra, Manoj Chavan	85
18	Techniques for Estimating Vocal Tract Shape for Speech Training Aids Shilpa Chaman	91

ED&V - 2019

19	Automated Circuit Level Testing Of Digital Stethoscope Sayali Shinde, Om Patel, Adarsha K, Surendra Bhosale	97
20	Design and Development of Double Acting Single Phase Generator Aditi Jain, Anirudh Pednekar, Ankita Jha	101
21	Telemetry Monitoring of Solar Panels for Rural India Pratik Bole, Somiyan Guchait, Pawan Sakpal	107
22	Automated Speed Regulation of BLDC Motor Vishal Singh, Talha Shaikh, Sunil Yadav	111
23	Temperature Based Jacket with Tracking System Tanmay Kalal, Akanksha Rai, Abhishek Singh	113
24	Design of Reduced Graphene Oxide based Piezo-Resistive Acoustic Sensor on flexible Kapton for Underwater Applications Smitha Pai B	117
25	Making Paver Blocks using Plastic Waste Narpinder Singh Pannu, Divya Pawar, Saurabh Amburle, Punit Deshmukh	123
26	Proposed High Performance Subtle Light Intensity Variation UV Photodetectors Jaya Gaitonde, Rajesh Lohani	127
27	A Three-Dimensional Simulation Of Double Gate Carbon Nanotube Field-Effect Transistors With Doped Wells And Morphological Analysis Pooja Shimpi, Deepak Singh	135

RA & ES - 2019

28	IoT for Agricultural India – A Case Study Karunesh Loke, Imran Tamboli, Surendra Bhosale	141
29	Mobile Border Surveillance Robot Rutvi Thakar, Ram Makwana, Pooja Gohil, Khushboo Maurya	145
30	3D Printer using Fused Deposition Modeling Rutvi Thakar, Aachala Singhan, Smit Mistry, Jinit Thakkar	151
31	We-care: An IoT Based Health Care System for Elderly People Chetana Kabre	155
32	Intellisense Food Dispenser (IFD) Hari Khatavkar, Rahul Kini, Suyash Pandey	161
33	Co-relational Analysis by using Different Modeling Techniques in Robotics Application Navneet Sharma, Aboli Sawant, Shubham Shukla	165
34	Pick-N-Place Robotic Vehicle Using Microcontroller 8051 Yash Shah, Shalini Rai, Rutvi Thakar	171
35	Programmable sketching and writable machine Parth Shah, Vishal Sawant, Vishal Rawat	177
36	Water Cleaning Robot Saurabh Suresh Mohade, Prathamesh Pradeep Mhatre, Saurabh Suresh Sankpal, Suvaish Subhash Ambhore, Nilesh Barshe Patil	183
37	Intrusion Detection System Purva Ghag, Sonali Ghogale, Manasi Jadhav, Amar Palwankar, Suraj Shete	187
38	Indoor GPS Technology Sanjay Patil, Sunil Khatri, Sumit Kumar	191
39	Algorithm of Identifying and Reporting of Potholes and Humps using IOT Smita Saitwadekar, Payel Saha	197
40	Indoor positioning system Mohinish Sharma, Shraddha Upadhyaya, Tejas Tawadia, Aditi Rajmane, Kiran Rathod	203
41	Zero touch network: A Comprehensive Network Design Approach Vaibhav Gijare, Poorva Waingankar	207

GPS Based Health Monitoring System for Animals

Mr. Akshay D. Prabhu
Dept of Electronics
Thakur college of engineering
and technology
akshayprabhu301@gmail.com

Mr. Yash A. Patel
Dept of Electronics
Thakur college of
engineering and technology
hello_yashpatel@yahoo.com

Mr. Rahul Kumar Jha
Dept of Electronics
Thakur college of
engineering and
technology
rahuljha0609@gmail.com

Mrs. Sujata Alegavi
Dept of Electronics
Thakur college of engineering
and technology
sujata.dubal@thakureducation
.org

Abstract - Livestock Management is a laborious task as the various subtasks are involved in the daily activities of the livestock. Whether it is pasturing of livestock or health checkup of the livestock, each task requires equal attention and careful analysis which is to be done by humans. Technology has started penetrating the livestock management sector and it is relieving the livestock from the tedious jobs and making the tasks simpler by the click of a button. This paper describes the use of a GPS based leather collar which would be used for the real time tracking of the livestock. The livestock can be tracked using an android application. The application is equipped with a notifier which notifies the owners regarding the health checkup dates and also creates an alert when the livestock has moved very far away from its local dwelling. This paper also describes the safety siren which is inbuilt with the collar which would be used for protecting the animal from predator attacks. The sound sensor which is attached to the system will also warn the owners if their cattle is suffering from some illness or if it is facing some problem. In comparison to the existing technologies available in the market, our technology has an edge in terms of integrating the major activities of livestock management.

Keywords: GPS, Real Time Monitoring, WSN, RFID, mBed, Android App.

I. INTRODUCTION

In an agricultural economy like India, animal husbandry practices like dairy farming, poultry farming etc is widely carried out throughout the country. But India being a developing economy, dairy farming and other animal husbandry practices are not equipped with technology. These practices are carried out in the age old traditions of animal monitoring which utilizes extensive human labour and energy. Due to lack of technology based animal husbandry practices, the yield of such practices is low if we compare them with animal husbandry practices of foreign countries. Pasturing of animals or livestock is an important activity as it requires an extensive labour and energy. Taking animals for pasturing and bringing the herd back to the stable is a time consuming and tedious task and even difficult to be handled by a single person. Animal Husbandry is an important source of self-employment as the owners are not dependent on anyone for their earnings except for the cost of fodder and medical care for the livestock. Livestock Management is an important aspect which requires intensive human involvement. The major problem associated with endless grazing of dairy farm animals is the loss of vegetation with time

and soil erosion [1]. Dairy farm practices should be such that reduces the environmental degradation and at the same time it should take proper care of animals and thus enhance the milk production levels [2, 3]. Animal Health monitoring is also an important aspect of good dairy farming practices.

II. RELATED STUDY

Wireless Sensor Networks [WSN] is one of the widely proposed system for livestock management. WSN basically means deploying small sensors larger in number throughout the animal roaming area to monitor the behaviour of animals and at the same track the animals. In WSN based systems sensors are deployed heavily in and around the dairy farm area because the chances of sensors failure is very high in such networks. In this system a central gateway is required which enables the communication between the base station and the sensors. WSN can be implemented in a variety of scenarios like terrestrial WSN [4], underground WSN [5], multimedia WSN [6], mobile WSN [7] etc. The most recent advancement in the WSN based system is the use of LoRA as a protocol for ultra-low and long range communications [8]. The use of newer protocols for communications has improved the reliability of WSN by reducing the power requirements and enhancing the communication range. But the major hurdle which lies in the deployment of terrestrial WSN is the static deployment of dense sensor networks. As the sensors are static in their position and even their failure is also unpredictable. Static sensors cannot be employed for the purpose of animal tracking and monitoring purposes.

Radio Frequency Identification [RFID] is one of the blooming technology for animal tracking and monitoring systems. Usually RFID tag is pierced in the ears of the animals and hence each animal bears a unique identification number. RFID tags basically consists of an antenna and a microchip. Whenever the tag is in the vicinity of RFID receiver, the signals sent from the receiver to tag energizes the tag and hence a return signal is being transmitted by the tag to the receiver. The major advantage which lies in the RFID technology is that it does not require the tag to be lying the straight line of sight location of the receiver and moreover it can be inserted into the animal's body for sensing different parameters [9]. RFID can be used effectively to segregate the genetic dissimilar species or different breeds of animals or depending upon the feeding habits of the animals and hence maintaining a record of entire livestock in an ordered manner using an

integrated software for database management [10]. RFID technology has drastically reduce the labour required for the livestock management and introduced transparency in the process of livestock management when the livestock are shipped or transported to different locations. RFID technology is far better than the traditional method of animal monitoring and management systems as the traditional methods involved manual checking which introduces human error and labour costs [11 – 14]. One of the major limitation which exists in the RFID technology is that RFID tags are pierced in the ears of the animals because of which it leads to ear infection called as otitis media which means the infection of middle ear. The ear infection normally remains unnoticed and hence chances are there that it may further worsen the health condition of the cattle by attacking the inner ear and in worst condition it also causes meningitis. Cattle suffering from otitis media is mentally dull, has a poor appetite and also has a fever. The diseased cattle may also develop pneumonia and problems in respiratory system. It has been proved that ear tagging of animals provides a passage for the entry of bacteria in the ear cavity and at the same time the chances of the animals contracting tetanus is greater in ear tagged animals [15]. RFID technology does not provide the real time location of the animals and hence it is also one of major hurdle in the development of RFID technology for outdoor applications.

III. METHODOLOGY:

Tracking and monitoring the animals in a dairy farm should be carried out with proper use of technology which does not cause any pain and discomfort to animals and at the same reduces the human labour and error involved in the process. There are limitation which exists in the proposed system for livestock management and hence new system should be a combination or rather a hybrid of existing system which collects the benefits from each system and at the same time eliminates the drawbacks involved in them. Based on the study carried out and based on the comparisons of various systems, we have developed asystem named Tracamal which is just mixture of above two mentioned system with greater usability and limited drawbacks. The proposed system does not cause any kind of injury to animals and at the same time it will not hurt the animals. The basic diagram of the system depicting the flow of data in the system is represented as below:

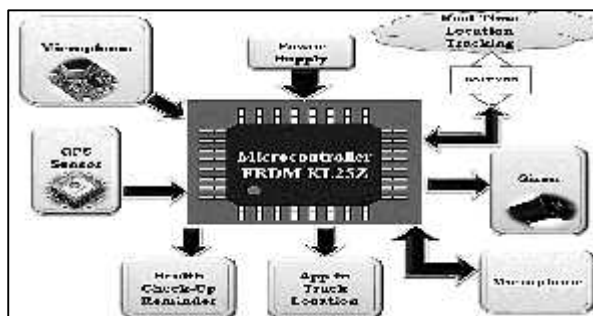


Fig. 1 System Diagram showing various blocks

The system describes the functional diagram of the system. The brain of the system is the FRDM KL25Z development board. The data from the GPS module is directly sent to the board which uploads the data on the application using ESP8266 Wi-Fi module. The main feature of this proposed system is that it is totally safe for the animals as the entire system is fitted inside a collar which is tied around the neck of the animal using a leather strap. Hence this system ensure complete that the cattle under supervision is devoid of any health risks due to the implanted technology. The system though it is sued for tracking and monitoring of the dairy farm animal especially cattle, it can also be used for checking health status of the animal. The accelerometer present on board as well as the microphone which is attached in the system can be used to detect if the cattle suffering from any kind of disorder. Accelerometer is a very important device which can be used detect disease like fever, lameness, mastitis, ovarian cysts, pneumonia etc [18].

The Android Application which will be provided with this collar is a user-friendly application which can be easily used by the farmers to track their animal real time using the map. The application also has a notifier which will help the farmers to schedule their cattle health checkup dates and at the same time get reminders about the health check-up dates well before time so that health checkup will not be missed. Moreover the farmer or dairy farm owner can use this application to sense if the cattle is suffering from any diseases or problems. The application also has an inbuilt feature which warns the farmer or dairy farm owner when the cattle is goes to very long distance for pasturing. This feature also helps the famer to check if its cattle are not stolen by anyone as the application notifies the farmer accordingly that the cattle has gone far away from its shed.

The system as mentioned contains the GPS sensor which continuously updates the real time location of the animal on the Android App. The perimeter bound tracking of the animal enables the owner to keep a check that the animal has not gone beyond the natural limits of the grazing area. If the animal is leaving the designated area, the app notifies the owner regarding this problem. The system also monitors continuously the sound of the animal and if the animal is continuously making sounds, then the owner is informed that the animal is in some problem as the cattle moo's continuously only when it is attacked or when it suffering from any disease. The app also allows the owner to create notifications regarding the health checkup to be done for the concerned animals periodically.

IV. RESULTS AND DISCUSSION:

MIT App Inventor v2 has been used for developing and the construction of the app. The modelling of the android application has been carried out using the visible components such as Image Picker and non-visible components such as Notifier and Clock. The entire backbone and base structure of the application is constructed using the software, allowing Tracking and Health Checkup as well as the other functions such as the Perimeter Bound Alert as well. Each of the

components in the application have been made interactive by applying a decision making algorithm and flow structure with the help of MIT Blocks that are pre-programmed. The real-time Longitude and Latitude along with the Sound Level is being processed and analysed within the system at a timely interval and being pumped out in the form of location of the animal meshed along with the safety of the animal. This is carried out by sharing of data between each of the screens used in the app that have a common Database specific for the installed app on the device that is TinyDB. Along with implementation of excessive safety protocols and functions to store the detailed information of each user that creates an exclusive account for the application, which creates a tag along with its value structured in a table format in the Real-time Firebase Database. The proper working and functionality of the device has been incorporated with Mbed Online Compiler. The data that is being transmitted from the GPS as well as the Sound Sensor is being received and stored in the Realtime Firebase Database which is then accessed by the application to accurately track and provide real time feed on the animal. Thus the link between the device and app has been established using the Firebase DB. The Belt containing the device acts as a beacon which allows the user to pinpoint the whereabouts of the animal, the use of GPS makes sure the data being processed and analysed is quick and available over a very large range.

The collar which would be tied around the neck of the animal can be depicted as below:

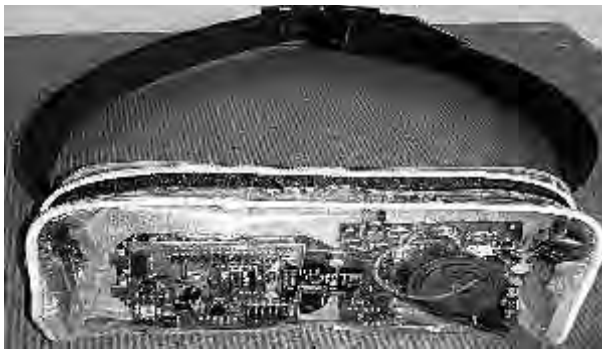


Fig. 2 Collar to be tied around cattle's neck



Fig. 3 Basic System Implemented on a board

The collar which is made is completely safe for the animals as it is made from leather and at the same time

the functioning of the system would be indicated by the light emitted from the LED. If the LED is ON it indicates that the system is functioning properly and if the LED light goes low, it indicates that the system battery needs to be recharged or replaced.

The accelerometer MMA8451Q which is present on board is used to measure the tilt of the cow's head. The position of cow's head displays a wide range of information regarding the health status of the cattle. The accelerometer was tied around the neck of the cattle. It was observed during the study that cattle with diseases like cerebral hypoplasia, bacterial meningitis etc have drooping head. The head droops towards the left or right side or remains in the intermediate position. Even when the cattle suffers from ear infections, the head of the cattle tilts towards the side of infected ear. The graph shown below demonstrates the accelerometer values for the calf suffering from ear infection in the left ear and the head remains tilted towards the left side of the calf.

TABLE I. TABLE OF TILT ANGLES FOR LEFT SIDE TILTED HEAD OF CALF

X axis Tilt Angles	Y axis Tilt Angles
1.011	1.999
1.009	2.001
1.010	2.002
1.015	2.002
1.015	2.003
1.017	2.008
1.012	1.999
1.007	1.992
1.015	2.009
1.014	2.004
1.017	2.005
1.009	2.001
1.016	2.002
1.014	2.002
1.014	2.001

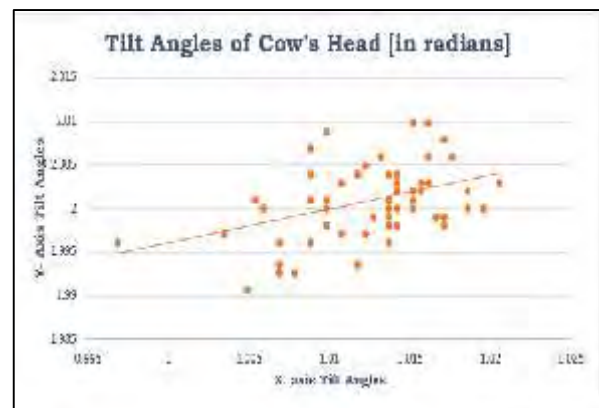


Fig. 4 Graph of Tilt Angles for Left Side Tilted Head of Calf

The graph shows the various accelerometer readings which is taken for the calf suffering from left ear infections. The tilt usually lies in range of 1.01 – 1.05 radians for X-axis and for Y- axis the tilt angle lies in the range of 1.98 -2.00 radians. The accelerometer data is clustered for only these ranges of values.

When the neck lies in the intermediate positions, it indicates that the infections is not severe and the cattle should will take lees time to recover. The graph below shows the accelerometer values of the calf's head in intermediate drooping position.

TABLE II: TABLE OF TILT ANGLES FOR INTERMEDIATE TILTED HEAD OF CALF

X – AxisTilt Angles	Y-AxisTilt Angles
0.406	1.785
0.357	1.757
0.362	1.768
0.316	1.732
0.308	1.723
0.279	1.698
0.288	1.701
0.275	1.684
0.288	1.695
0.269	1.686
0.263	1.673
0.254	1.656
0.247	1.653
0.248	1.653
0.194	1.570

The X- axis tilt range of the calf's head for low infection is from 0.17 – 0.18 radians and for the Y- axis the tilt angles ranges from 1.55- 1.6 radians.

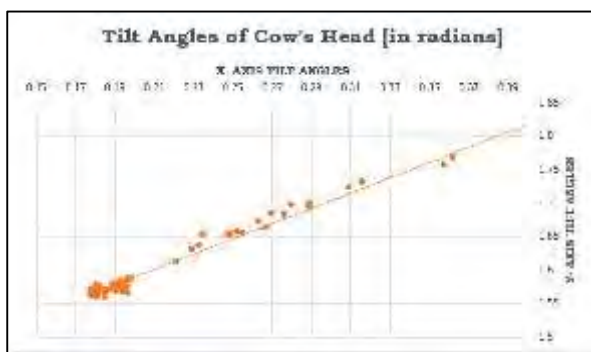


Fig. 5 Graph of Tilt Angles for Intermediate Tilted Head of Calf

When the calf is suffering from the infection in right ears, the head of the cattle gets tilted towards the right side of the body. The accelerometer values for the right sided drooped head are plotted in the following graph:

TABLE III. TABLE OF TILT ANGLES FOR RIGHT SIDE TILTED HEAD OF CALF

X-Axis Tilt Angles	Y-Axis Tilt Angles
--------------------	--------------------

1.749	1.718
1.737	1.724
1.692	1.709
1.726	1.696
1.718	1.623
1.658	1.697
1.646	1.732
1.663	1.756
1.66	1.747
1.653	1.734
1.657	1.740
1.643	1.744
1.645	1.736
1.641	1.746
1.634	1.746

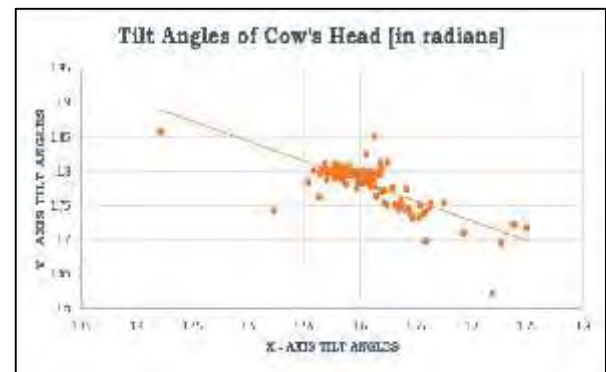


Fig. 6 Graph of Tilt Angles for Right Side Tilted Head of Calf

For right side drooped head, the X- axis tilt values lies in the range of 1.55 – 1.62 radians and for the Y- axis the tilt angle values lies in the range of 1.75 – 1.8 radians.

It is not necessary that drooping of cattle's head for a prolong period of time indicates only ear infections but also it indicates a wide variety of other diseases like fever, lameness, mastitis, milk fever etc. Accelerometer can also be used for determining the feeding behaviour of the cattle as well as they can also be used for determining the behaviour of the animal. [19 – 22].

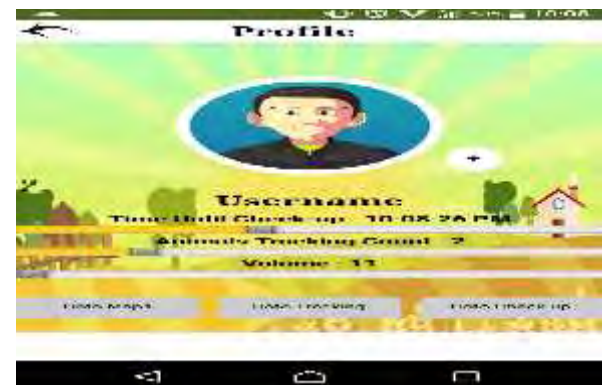


Fig. 7 Profile Description with Photo for Users

Whenever the Android application is given to any new user, the app allows the user to create its own profile on the application. The profile page of the application gives a short information to the user regarding the time remaining till the next health check-up, number of cattle currently being tracked and at the same time also allows the user to set volume level for the notification purposes. The profile page also allows the user to quickly navigate to other pages like animal tracking or health check-up reminder.



Fig. 8 Real Time Location of Cattle Shown on Google Map

The Android application was also tested for various test cases. The real time location of the cattle was also tracked using the Google map feature of the app. The picture shown above represent the real time location of the cattle using the application.



Fig. 9 Notifier for Health Check-up Reminder

The notifier which is present in the app reminds the owner regarding various health check-up dates for the cattle. Health-Checkup function of Tracamal provides top notch and timely notification alert whenever the User needs to take the Animal for a checkup. Depending on the needs of the User, there are various other options to notify the User such as through Ring alert or a Message as well set the time simply by putting appropriate date and time. The testing of the notifier is as shown above.



Figure 10. Perimeter Bound Tracking for Cattle Safety

Perimeter bound tracking is one of the key feature of this system which alerts the owner whenever the cattle leaves certain specified boundary region. The testing of this functionality of the app is as shown above.

In case of some diseases, cattle moo's continuously because the cattle feels uneasy and uncomfortable in such conditions. The mooing of cattle is detected by the microphone present in the system and this data is sent to the app which displays an alert message for the owner to take a quick action.



Fig. 11 Sound Detection & Alert Mechanism of App

The app is also equipped with a notification which warns the owner when the cattle is making loud mooing sound continuously.

V. CONCLUSION

The system proposed in this paper is effective for the purpose of livestock management and it is also equipped with multiple features which can be utilized for monitoring the livestock including the health of the livestock, health checkup reminders as well as the safety siren which will protect the cattle from the predators. The proposed system is also efficient in tracking the animal using the Android application which can be easily installed on the smartphone of the dairy farm owner or the farmer. The application is provided free of cost to the farmers or dairy farm

owners along with the collar for the animal. The system mentioned in this paper can be directly utilized for the purpose of an integrated animal tracking and monitoring system. The system is a complete model for tracking the animal while pasturing and at the same monitoring the health conditions of the cattle. The major limitation which exists in the current system is that the entire system is not placed on a single board. It is possible to include the entire components on one single board which reduces the spaces required for the entire system and at the same time it will also reduce the power consumption of the system. The system can also be equipped with certain more sensors like temperature sensors, load sensors etc which can be used to determine if the cattle is suffering from diseases like fever, pneumonia etc. The system is checked for all the test cases which includes the testing of the system for sound notification, perimeter bound testing and also the notification for the health check-up. All the notifications were notified accordingly on the Android application and the application is also functioning successfully. This system is the first of its kind for an integrated animal tracking and health monitoring system.

REFERENCES

- [1] Dorrough, J.; Yen, A.; Turner, V.; Clark, S.G.; Crosthwaite, J.; Hirth, J.R. Livestock grazing management and biodiversity conservation in Australian temperate grassy landscapes. *Aust. J. Agr. Res.* **2004**, *55*, 279-295.
- [2] Ganskopp, D.; Cruz, R.; Johnson, D.E. Least-effort pathways?: A GIS analysis of livestock trails in rugged terrain. *Appl. Anim. Behav. Sci.* **2000**, *68*, 179-190. *Sensors* **2009**, *9*
- [3] Turner, L.W.; Udall, M.C.; Larson, B.T.; Shearer, S.A. Monitoring cattle behavior and pasture use with GPS and GIS. *Can. J. Anim. Sci.* **2000**, *80*, 405-413.
- [4] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, A survey on sensor networks, *IEEE Communications Magazine* **40** (8), 104-112, 2002.
- [5] M. Li, Y. Liu, Underground structure monitoring with wireless sensor networks, in: *Proceedings of the IPSN, Cambridge, MA, 2007*.
- [6] I.F. Akyildiz, T. Melodia, K.R. Chowdhury, A survey on wireless multimedia sensor networks, *Computer Networks Elsevier* **51**, 921-960, 2007.
- [7] Jennifer Yick, Biswanath Mukherjee, Dipak Ghosal, Wireless sensor network survey, Elsevier, *Computer Networks* **52**, 2292-2330, 2008.
- [8] Eyuel D. Ayele, Nirvana Meratnia, Paul J.M. Havinga, "Towards A New Opportunistic IoT Network System for Wildlife Monitoring System", Pervasive Systems Research Group, University of Twente, Enschede, the Netherlands.
- [9] Finkenzeller, K., "RFID Handbook Radio-Frequency Identification Fundamentals and Applications", second ed. John Wiley & Sons, 2004.
- [10] Voulodimos, A.S., Patrikakis, C.Z., Sideridis, A.B., Ntakis, V.A., Xylouri, E.M., "A complete farm management system based on animal identification using RFID technology", *Computers and Electronics in Agriculture* **70** (2), 380-388, 2010.
- [11] Chansud, W., Wisanmongkol, J., Ketprom, U., "RFID for Poultry Traceability System at Animal Checkpoint" Paper read at Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology, 2008. ECTI-CON2008. 5th International Conference on, 14-17 May 2008.
- [12] Wisanmongkol, J., Pongpaibool, P., "A Passive UHF RFID tag for poultry traceability". In: *The 2009 International Symposium on Antennas and Propagation (ISAP 2009)*.
- [13] Trevarthen, A., "The national livestock identification system: the importance of traceability in e-business". *Journal of Theoretical and Applied Electronic Commerce Research* **2** (1), 49-62, 2007.
- [14] Luis Ruiz-Garcia, Loredana Lunadei, "The role of RFID in agriculture: Applications, limitations and challenges", *Computers and Electronics in Agriculture* **79** (2011), Pg: 42-50.
- [15] B. Valgaeren, P. De Schutter, B. Pardon, V. Eeckhaut, F. Boyen, F. Van Immerseel, P. Deprez, "Thermal dehorming and ear tagging as atypical portals of entry of *Clostridium tetani* in ruminants", *Vlaams Diergeneeskundig Tijdschrift*, Volume 80, Pg - 351 - 354, September 2011.
- [16] FRDM KL25Z User's Manual, Rev. 2.0, October 2013.
- [17] NEO - 6 u - blox 6 GPS Module Data Sheet.
- [18] Amruta Awasthi, Anshul Awasthi, Daniel Riordan and Joseph Walsh, "Non-Invasive Sensor Technology for the Development of a Dairy Cattle Health Monitoring System", *Computers, Volume -23, Issue- 5, Pg No.: 1 - 11, Oct. 2016*.
- [19] Gabriele Mattachini, Elisabetta Riva, Francesca Perazzolo, Ezio Naldi, Giorgio Provolo, "Monitoring feeding behaviour of dairy cows using accelerometers", *Journal of Agriculture Engineering*, XLVII:498, Pg No.:54 -58, 2016.
- [20] R.M. de Mol, E.J.B. Bleumer, P.H. Hogewerf and A.H. Ipema, "Recording of dairy cow behaviour with wireless accelerometers", *Precision Livestock Farming*, Pg No.: 349 - 356, 2009.
- [21] Amruta Helwatkar, Daniel Riordan, Joseph Walsh, "Sensor Technology For Animal Health Monitoring", *Proceedings of the 8th International Conference on Sensing Technology*, Pg No. - 266 to 271, DOI: 10.13140/2.1.1305.0242, September 2014.
- [22] Jorge A. Vázquez Diosdado, Zoe E. Barker, Holly R. Hodges, Jonathan R. Amory, Darren P. Croft, Nick J. Bell, Edward A. Codling, "Classification of behaviour in housed dairy cows using an accelerometer-based activity monitoring system", *Animal Biotelemetry*, Volume-3, Issue-15, Page No.: 1 to 14, DOI 10.1186/s40317-015-0045-8, 2015.

CDCO-OFDM for Indoor Optical Wireless Communication

Jayasudha Koti

Dept. Electronics and Telecommunication
Thakur College of Engineering and Technology
Mumbai, India

Email: jayasudhakoti@sfitengg.org

Mishra B K

Dept. Electronics and Telecommunication
Thakur College of Engineering and Technology
Mumbai, India

Email: drbk.mishra@thakureducation.org

Abstract— Optical wireless communication (OWC) is an alternative technology to meet the demands of exponentially growing high data rate applications by broadband users. Though the implementation of single carrier modulation techniques in OWC is an age old technology, but for the last few years research is focused towards the multicarrier modulation techniques in OWC. In OWC information is carried out using intensity modulation and retrieved using direct detection. To perform intensity modulation the baseband signal should be unipolar signal. To obtain unipolar signal various techniques such as DC-biased orthogonal frequency division multiplexing (DCO-OFDM), Asymmetrically clipped orthogonal frequency division multiplexing (ACO-OFDM), Flip orthogonal frequency division multiplexing (Flip-OFDM) and Unipolar orthogonal frequency division multiplexing (U-OFDM) techniques have been reported in the literature. Though the DCO-OFDM is spectrally efficient compared to other techniques it requires more power to achieve the targeted BER. In this paper convolutional encoder and hard-decision Viterbi decoder at the receiver are considered. It has been observed that CDCO-OFDM requires less than transmitted power than DCO-OFDM to attain the targeted BER. Performance of DCO-OFDM and CDCO-OFDM is evaluated for 4-QAM and 7dB bias in the presence of additive white Gaussian noise (AWGN) channel. It is observed that CDCO requires 6dB less power to transmit than DCO-OFDM for the BER 10^{-4} .

Keywords— CDCO-OFDM, multicarrier modulation, error control coding, hermitian, unipolar signal

I. INTRODUCTION

Rapid utilization of RF spectrum may lead to congestion of the spectrum to meet the demands of the exponentially growing users. This laid a path to use the infrared (IR) region of electromagnetic spectrum where optical radiation is used as a mode to communicate. This focused research towards optical wireless communication (OWC). In OWC information is sent wirelessly in the form of optical radiations using IR region as a medium. Light emitting diodes (LED's) and photo diodes are used as optical transmitters and detectors for indoor applications. In OWC intensity modulation (IM) and direct detection (DD) is used. Initially single carrier modulation (SCM) is used in OWC where entire bandwidth is used to transmit one symbol. Time taken to transmit one symbol is $\frac{1}{B}$ seconds. SCM is ideal for low data rate applications and

it results in inter symbol interference when used for high data rate applications. Concept of dividing entire bandwidth in to different sub bands and transmitting different data streams parallel over different subcarriers made OFDM a well known broadband wireless technology. Resilience to ISI and its ability to tune the transmitted signal to channel frequency made it as a radical broad band wireless technology. Concept of Fast Fourier algorithms made the implementation of OFDM modulators and demodulators easy by replacing bank of modulators and demodulators. This technology forms a basis for 4G technologies like LTE, WiMAX and supports high data rate greater than 100Mbps. This made possible of utilization of high data rate applications like HDTV, online gaming, mobile videophones and soon[1-4].

OFDM was widely used in RF domain for the last few decades. But OFDM in OWC is a state of art technology. In conventional systems OFDM generates a bipolar signal. For IM and DD we require a unipolar signal. Unipolar signal should be real and positive. These signals are generated by various unipolar techniques and they differ in the subcarrier assignment and conversion of bipolar real signal to positive real signal. Various techniques like DC-biased orthogonal frequency division multiplexing, Asymmetrically clipped orthogonal frequency division multiplexing, Flip orthogonal frequency division multiplexing and Unipolar orthogonal frequency division multiplexing have been described in the literature. Among these techniques DCO is spectrally efficient but it requires more power to transmit. The average transmitted power governs the eye safety as well as the electrical power consumption by the transmitter. Thus, power efficiency is not only important for eye safety but also to enhance life of battery operated handheld devices. One way to improve the performance without increasing the transmit power along with power efficient and ISI resilient modulation signal formats is the introduction of channel coding techniques[5]. This Coded DCO (CDCO) has been implemented for 4-QAM, 7dB bias for AWGN channel. It is noticed that transmitted power for CDCO is 6dB less than a DCO-OFDM

In this paper we the authors present a novel technique CDCO-OFDM and compare it with the DCO-OFDM. Section II describes the DCO-OFDM. Implementation of CDCO is presented in Section III.

Simulation results are shown in section IV. Conclusions

are drawn in Section V.

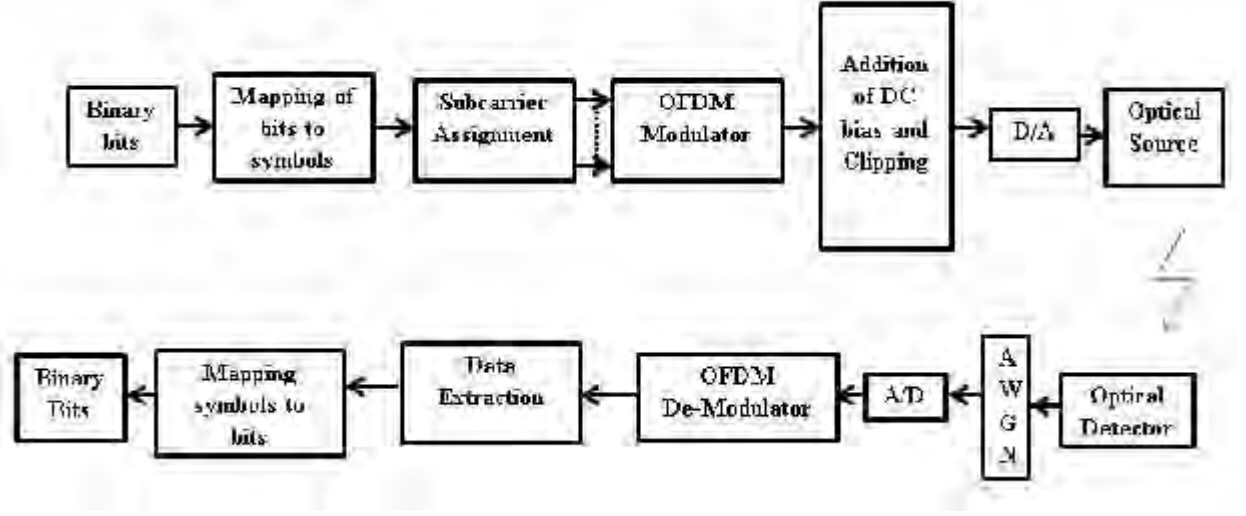


Fig. 1 DCO-OFDM for Indoor Optical Wireless Communication

II. DCO-OFDM

A stream of randomly generated bits $x\{k\}$ is mapped in to symbols by higher order modulation techniques. $a\{k\}$ represents the mapped symbols whose values depends on the modulation. $x, y, x_1, y_1, \dots$ of $a(k)$ represents the amplitude levels and depends on the M-ary constellation. QAM is considered for analysis. Higher the order of the modulation more the number of bits will be transmitted per symbol

$$x(k) = \{0, 1, 1, 0, \dots\}$$

$$a(k) = \{x + jy, x_1 - jy_1, \dots\}$$

A_{ki} denotes the complex QAM symbol transmitted in k_{th} OFDM subcarrier of i_{th} OFDM symbol, where k is subcarrier index. If Signal A_{ki} is given as an input to the IFFT modulator then the output signal is bipolar. For OWC systems information is modulated using intensity modulation, therefore transmitted base band modulating signal should be real and positive (Unipolar). So conventional OFDM systems should be modified to be used in optical OFDM systems. To obtain a unipolar signal Hermitian symmetry has to be imposed

$$A_{k,i} = A_{N-k,i}^*, \quad \text{where } k = 1, 2, \dots, \frac{N}{2} - 1 \quad (1)$$

In (1) $*$ denotes complex conjugation, N denotes the number of subcarriers. Also, the $N = 0$ and $N/2$ subcarriers are assigned null value to avoid the residual complex time domain signal component as shown in (2)

$$A_{0,i} = A_{\frac{N}{2},i} = 0 \quad (2)$$

Once the Hermitian symmetry is imposed on the QAM symbols the IFFT operation is performed by the OFDM modulator and time domain samples is given in (3)

$$a_{n,i} = \frac{1}{N} \sum_{k=0}^{N-1} A_{k,i} \exp\left(\frac{j2\pi kn}{N}\right) \quad (3)$$

for $n = 0, 1, 2, \dots, N-1$, N indicates IFFT size. $a_{n,i}$ is a real signal with positive and negative time domain samples as shown in Fig. 2.

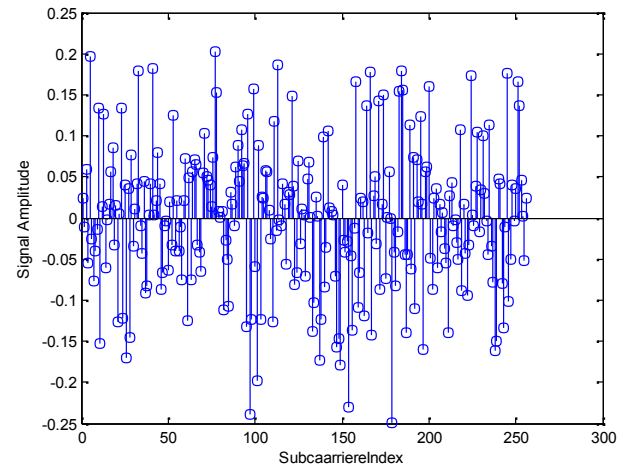


Fig. 2 Real Time Domain Signal before biasing

A real positive signal is obtained by DCO-OFDM by adding DC bias to $a_{n,i}$. In general DC bias should be absolute value of the maximum negative amplitude of the bipolar OFDM signal. Since bipolar OFDM signal suffers from high peak to average power ratio (PAPR). Therefore high DC bias is required to eliminate

all the negative peaks of time domain signal. If large DC bias is used, the optical energy-per-bit to single sided noise spectral density, $E_{b(\text{dB})}/N_0$ becomes large. Therefore, a moderate DC bias is introduced and the residual negative peaks are hard clipped to zero to ensure unipolarity of time domain signal at the optical transmitter input [6-7].

In general for large values of N i.e. $N \geq 64$ the amplitude of signal $a(t)$ can be approximated by Gaussian distribution with zero mean and variance, $s^2 = E\{a^2(t)\}$. Therefore, in order to avoid large DC bias and reduce the required optical power, a moderate DC bias approach is used wherein DC bias denoted by β_D is proportional to root mean square (RMS) of $a(t)$ i.e. σ

$$\beta_D = \mu \quad (4)$$

Where μ is proportionality constant and

$$s = \sqrt{E\{a^2(t)\}}$$

The resultant DC-bias time domain signal, $x_D(t)$ is given by,

$$a_{DCO}(t) = a(t) + b_{DC} \quad (5)$$

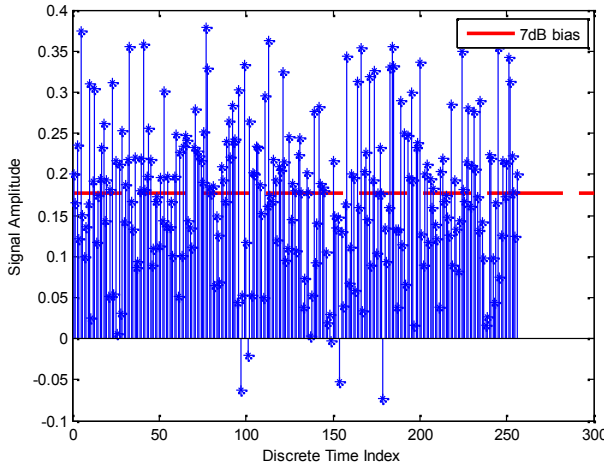


Fig. 3 Real Time Domain Signal after biasing

Any value below this is hard clipped to zero to ensure unipolarity of transmitted signal. The real and unipolar DCO-OFDM signal after clipping is given by

$$a_D(t) = x(t) + \beta_D + n_c(\beta_D) \quad (6)$$

where $n_c(\beta_D)$ is the clipping noise component. This Signal acts as an input to optical modulator where it is used to modulate the intensity of optical carrier. The resultant signal is then transmitted over flat channel. This signal is usually affected by shot noise which is modeled as AWGN noise, $N(t)$ and it is introduced in the electrical domain.

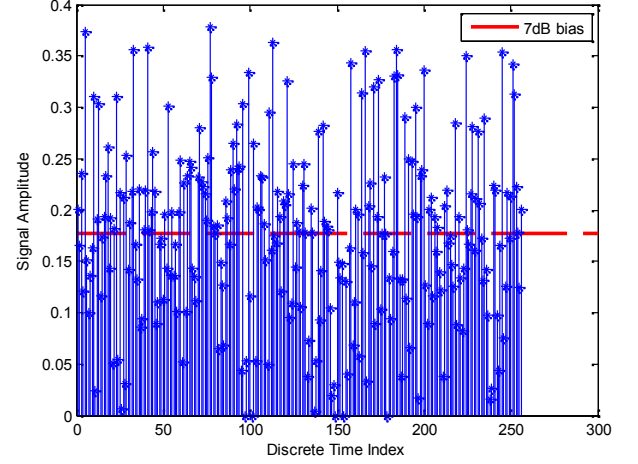


Fig. 4 Real Time Domain Signal after clipping

At the receiver, the received optical signal is first converted to electrical signal using a photodetector and the DC bias is subtracted before samples are fed to FFT. Further data extraction and conversion of symbols to bits are performed.

The performance of DCO-OFDM is strongly influenced by the introduction of DC bias. So value of β_D is optimized depending upon the application. Usually a DC bias of 7dB is used to obtain unipolar DCO-OFDM signal. If the DC bias is large optical energy-per-bit to single sided noise spectral density, $E_{b(\text{dB})}/N_0$ becomes very high making DCO-OFDM inefficient in terms of optical power. On the other hand, if the added DC bias cannot exceed maximum amplitude of the negative peak then hard clipping is performed which introduces clipping noise affecting all the information carrying subcarriers. Thus larger the bias smaller the clipping noise. But larger bias means higher transmission power i.e. larger E_b/N_0 to achieve acceptable BER. So there is tradeoff between lower DC bias and BER performance. Therefore CDCO-OFDM is proposed to decrease the transmission power at the same BER

III. CDCO-OFDM

Channel coding is one way to improve the performance by maintaining the same BER at the lower transmit power. Error control coding techniques are introduced in CDCO-OFDM. The principle of channel coding involves introduction of controlled amount of redundant bits for detection and correction of transmission errors introduced by the channel. There are different types of channel coding or forward error correction (FEC) techniques. In CDCO-OFDM convolutional encoder for data protection before baseband modulation and hard-decision Viterbi decoder at the receiver is considered. Convolutional encoder maps the input stream of information bits in to a encoded bits. Convolutional codes are specified by the three parameters (n, k, m) , where 'n' represents the number of output bits, 'k' represents the number of input bits and 'm' is the number of memory registers



Fig. 5 CDCO-OFDM for Indoor Optical Wireless Communication

Efficiency of the code depends on the code rate and it is given as k/n . Range of k and n parameters range from 1 to 8, m from 2 to 10 and the code rate from $1/8$ to $7/8$. Constraint length represents the number of bits in the encoder memory and is given by $L = k(m-1)$. The convolutional encoder takes a block of k information denoted by $u = (u_0, u_1, \dots) = (u_0^{(1)} u_0^{(2)} \dots u_0^{(m)}, u_1^{(1)} u_1^{(2)} \dots u_1^{(m)} \dots)$ and introduces controlled amount of redundant bits to generate encoded sequence (code word) block of length n symbols given by $v = (v_0, v_1, \dots, v_n) = (v_0^{(1)} v_0^{(2)} \dots v_0^{(m)}, v_1^{(1)} v_1^{(2)} \dots v_1^{(m)} \dots)$. This results in a convolutional encoder of rate $R = (k/n)$. The encoded block of symbols is obtained by convolving the input k -bit message sequence with the encoder impulse responses. The encoding equation for all is given by,

$$v^{(j)} = \sum_{i=0}^m u_i * g_i^{(j)} \quad (7)$$

Where $j = 1, 2, 3, \dots, m$

Where g is impulse response or encoder generator sequence. Generator polynomials can also be determined from the encoder circuit. Convolutional encoder depicted in Fig. 6 has three shift registers with constraint length of three and input is given to s_0 . Codes C_0 and C_1 are generated by performing EX-OR operation as shown in (8).

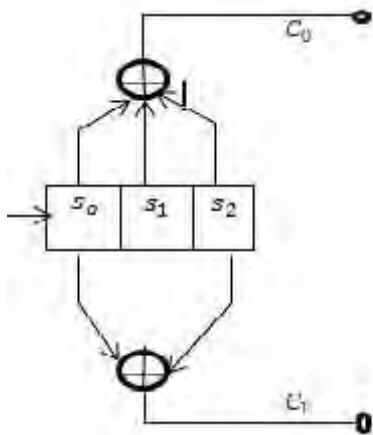


Fig. 6 Convolutional Encoder

$$C_0 = S_0 \oplus S_1 \oplus S_2 \text{ and } C_1 = S_0 \oplus S_2 \quad (8)$$

Therefore for one bit of information two bits are generated.

In CDCO randomly generated bits are encoded using convolutional encoder of constraint length of seven and coding rate of $1/2$. Output of encoder is given to DCO-OFDM transmitter. Real time OFDM signal obtained after applying DC bias of 7dB is shown in Fig. 7

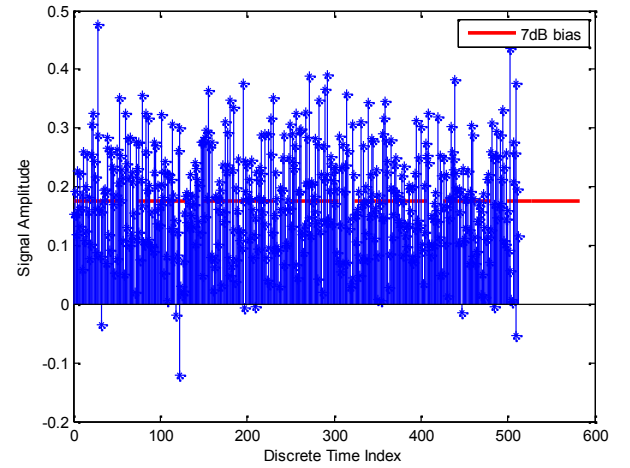


Fig. 7 Real Time Domain Signal in CDCO-OFDM

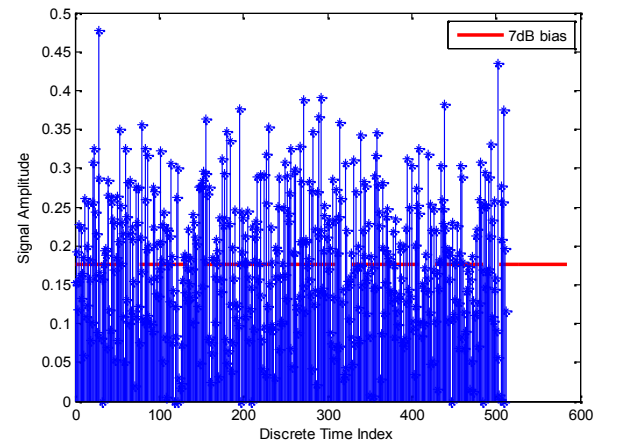


Fig. 8 Real Time Domain Signal in CDCO-OFDM after Clipping

Signal obtained in Fig. 7 consists of negative real components and since for IM we require real and positive signal, the negative components are clipped to zero as shown in Fig. 8. Signal obtained in Fig. 8 is used to modulate the optical carrier intensity. The performance of an indoor optical wireless link is affected by ambient illumination sources such as natural sunlight, fluorescent lighting and incandescent lighting that are not used for actual data transmission. All these undesirable indoor lighting other than the source generates shot noise of high-intensity at the receiver front end. The shot noise is modeled as zero mean AWGN i.e. additive white Gaussian noise, which is unrelated to the original message signal. This Gaussian and signal-independent noise is indicated by $N(t)$. Thus, the indoor optical wireless channel suffers from signal degradation due to AWGN. So AWGN noise is added for the analysis. Convolutional encoder for data protection before baseband modulation and hard-decision Viterbi decoder at the receiver are considered.

At receiving end the received signal r is decoded by incorporating hard-decision Viterbi decoder to obtain estimate $\hat{u}$ of the original message.

IV. SIMULATION RESULTS

DCO-OFDM and CDCO-OFDM has been simulated for parameters shown in Table. 1

Table 1. Simulation parameters

Parameters	Values
OFDM symbols	400
Subcarriers	256
Modulation	4 QAM
DC Bias	7dB

The electrical domain BER performance of DCO-OFDM and CDCO-OFDM is simulated for the 4-QAM and 7dB bias. It has been observed that CDCO-OFDM requires 6dB less SNR to achieve a BER of 10^{-4} .

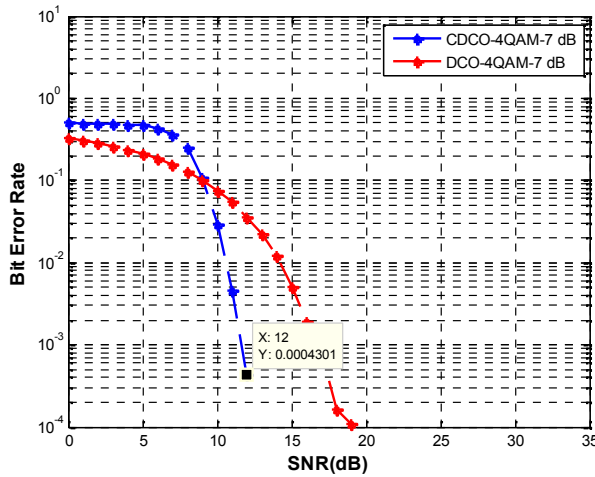


Fig. 9 BER Performance of CDCO-OFDM and DCO-OFDM

Therefore CDCO-OFDM requires lower optical transmit power to transmit OFDM signal for the same BERs for

indoor optical wireless channel with AWGN characteristics. Thus the proposed CDCO-OFDM is more efficient in terms of optical power compared to conventional uncoded DCO-OFDM.

The error probability of received signal measured in terms of BER depends upon on the noise level introduction which is stated by Signal-to-Noise ratio i.e. SNR. Difference between the transmitted and received signal results in an error, defined by BER. If the BER is below the acceptable margin of any communication system it is necessary to increase the SNR which requires an increase in the system transmit power. However, this contradicts against the power constraint regulation for an indoor optical wireless communication system. The average transmitted power governs the eye safety as well as the electrical power consumption by the transmitter. Thus, power efficiency is not only important for eye safety but also to enhance life of battery operated handheld devices. Hence the most important evaluation criterion for any modulation technique incorporated in IM/DD communication system is the amount of average transmitted power required to achieve desired BER. Additionally, in IM/DD systems the SNR is directly proportional to square of average transmitted power. Concept of introducing error control coding resulted in achieving the desired BER at the lower value of SNR.

V. CONCLUSION

Unipolar Communication techniques are used to perform IM in indoor optical wireless communication. These techniques vary in assignment of subcarriers and the approach to convert bipolar real signal to unipolar real signal. Though conventional DCO-OFDM is spectrally efficient technique it requires greater value of SNR to achieve a targeted BER. One way to improve the performance without increasing the transmit power along with power efficient and ISI resilient modulation signal formats is the introduction of channel coding techniques. Therefore an attempt is made to introduce error control coding techniques to the conventional DCO-OFDM. Convolutional encoding before the baseband modulation and hard-decision Viterbi decoder at the receiver are incorporated to achieve a power efficient system. Code rate of $1/2$ and constraint length of seven are considered for coding. Simulations are performed for 4-QAM and 7 dB bias to compare the performance of DCO-OFDM and CDCO-OFDM techniques. It has been observed that CDCO-OFDM requires 6dB less SNR as compared to DCO-OFDM to achieve a targeted BER of 10^{-4} . CDCO-OFDM is power efficient as compared to DCO-OFDM.

REFERENCES

- [1] Weinstein, S.B., Ebert, P.M., "Data Transmission by Frequency-Division Multiplexing Using the Discrete Fourier Transform," *IEEE Transactions on Communication Technology*, vol. COM- 19, no. 5, pp. 628-634, Oct. 1971
- [2] J. Armstrong, "OFDM for optical communications," *Journal of Lightwave Technology*, vol. 27, no. 3, pp. 189-204, February 2009
- [3] J. Kahn and J. Barry, "Wireless Infrared Communications," *IEEE Proc.*, vol. 85, no. 2, pp. 265-298, Feb.1997
- [4] H. Elgala, R. Meshleh and H. Haas, "Indoor optical wireless communication: potential and state-of-the art," *IEEE Communication magazine*, vol. 49, no. 9, pp. 56–62, September 2011
- [5] Andrew J. Viterbi, "Convolutional codes and their performance in communication systems," *IEEE Transactions on Commun.*, vol. 19, no. 5, pp. 751-772, Oct. 1971.
- [6] S. D. Dissanayake and J. Armstrong, "Comparison of ACO-OFDM, DCO-OFDM and ADO-OFDM in IM/DD Systems," *Journal of Lightwave Technology*, vol. 31, no. 7, pp. 1063–1073, April 2013.
- [7] Mingxuan Zhang and Zaichen Zhang , " An Optimum DC-Biasing for DCO-OFDM System ," *IEEE Communication letters*, vol. 18, no. 8, pp. 1351-1354, August 2014

AN ENHANCED ALGORITHM FOR DENSITY BASED TRAFFIC LIGHT CONTROL SYSTEM

Shikha Jayprakash Mishra
EXTC Department,
Thakur College Of
Engineering And Technology
Mumbai, India
Shikhamishra.403@gmail.Com

Satyam Ramesh Bhikhadiya
EXTC Department,
Thakur College Of
Engineering And Technology
Mumbai, India
Satyam.Bhikhadiya@Gmail.Com

Mayank Dharmendra Mishra
EXTC Department,
Thakur College Of
Engineering And Technology
Mumbai, India
Mayankmishra9833@Gmail.Com

Abstract— As the number of road users are increasing on the daily basis, the vehicle population on the roads increased to an extreme level. Thus, leading to traffic problems which cause major time delay and more issues. Therefore, there is a need to find an optimal solution for traffic control. There are several types of traffic problems; so, to overcome these problems, the project focuses on optimization of traffic light controller in the cities using image processing, Machine Learning and Artificial Neural Network (ANN), in which a Pi camera and a Raspberry PI 3 model B+ microcontroller is used in order to process the images and measure the traffic density at any traffic junction. The traffic controller changes the signal timing dynamically depending upon the density at the traffic signal. Artificial Neural Network is used to distinguish the vehicles such as cars, trucks, ambulances, etc. and the priority to the vehicle is set accordingly by Decision making Machine Learning Algorithm. The number of vehicles moving on the roads is counted by the microcontrollers and depending upon the various vehicle counts, the microcontrollers controls the timing of the signal at the traffic junction respectively.

Keywords— raspberry pi 3 model b+, machinelearning, microcontroller, artificial neural network.

I. INTRODUCTION

[5] Basically, a traffic light control system is an approach towards solving traffic issues in a defined area. Traffic at every junction in our country is a major complication that India is facing today. The standing traffic leads to surplus wreckage of time in everyone's life. In exigency circumstances, where medical help is required, possibility of an ambulance arriving at the right time becomes a great challenge. It becomes impossible to such an extent that, it costs a

person's life. As noticed in the current time, the traffic light system is broadly classified into two types. They are: -

1). Time Based Traffic Light Control System

(Static): This is an old and conventional form of signal controlling system using Electro-Mechanical signal controllers. On the contrary, to the computerized signal controllers these are build up using moving parts such as cams, dials and shafts. Additionally, the controls system is wired to them and it works accordingly. Apart from the electronic components, dial timers and electrical relays are used. Cycle lengths of signalized intersections are recognized and evaluated by the small gears that are located inside the dial timers which range from 35 seconds to 120 seconds. If there is any failure in the cycle gear of dial timer, it can get replaced with another cycle that would be more feasible. Dial timer are designed in order to control phases at the signalized intersection in only one way. Many old signalized intersections till date use this type of signals. However, this fails whenever there is a dynamic change in the flow of the traffic.

2). Density/Adaptive Traffic Light Control System

(Dynamic): As compared to the system mentioned above, this works on the images captured by the camera at traffic signals, in order to calculate the density of the traffic. Based on the processing done at the junction by the microcontroller, signal times are adjusted accordingly. This is an advance version, wherein real time data is accepted and accordingly priorities are assigned to make it dynamic. Advance communication is used by the system, which uses sensors and RFID tags to acquire data and provide information to the system based on the current situation on the roads. The smart system then processes this information and makes decisions; that is, it automatically recognizes the duration of each traffic light signal based on previous traffic situation on the road. Such type of system includes fuzzy

experts' systems (FES), artificial neural networks (ANN) and wireless sensor networks (WSN).

II. PROBLEM DEFINATION

Traffic is the major issue which almost every country faces because of the increasing number of vehicles, particularly in large urban areas. As the problem of urban traffic congestion spreads & occurrence of road accidents increases. There is an immediate need for the introduction of advanced technology and techniques to improve the traffic control algorithms to better satisfy this increasing demand. The ideal way for controlling a traffic light is using timer for accordingly. Through this project a system is proposed for controlling the traffic light by Artificial Neural Network (ANN) and Decision-making Machine Learning algorithm. Detection of the vehicles will be done by image processing, taking images as inputs. A camera will be installed beside the traffic light. It will capture image in required order. The image sequence will then be analyzed and evaluated using digital image processing and according to traffic conditions on the road, traffic light can be controlled. Each phase. Alternative way is to use electronic sensors in order to detect vehicles and produce signal that cycles.

III. POPOSED WORK

As the number of road users is increasing on the daily basis, the vehicle population on the road is increased to an extreme level. Thus, leading to traffic problems which cause major time delay and more issues. Therefore, there is a need to find an optimal solution for traffic control. There are several types of traffic problems; so, to overcome these problems, the project focuses on optimization of traffic light controller in the cities using image processing, Machine Learning and Artificial Neural Network (ANN), in which a Pi

camera and a Raspberry PI 3 model B+ microcontroller is used in order to process the images and measure the traffic density at any traffic junction. The traffic controller changes the signal timing dynamically depending upon the density at the traffic signal. Artificial Neural Network is used to distinguish the vehicles such as cars, trucks, ambulances, etc. and the priority to the vehicle is set accordingly by Decision making Machine Learning Algorithm. The number of vehicles moving on the roads is counted by the microcontrollers and depending upon the various vehicle counts, the microcontrollers control the timing of the signal at the traffic junction respectively.

IV. METHODOLOGY

Machine Learning

The machine learning based content classifiers are a sort of managed machine learning worldview, where the classifier should be prepared on some named preparing information before it tends to be connected to real arrangement undertaking. The preparation information is normally an extricated bit of the first information hand named physically. After appropriate preparing they can be utilized on the genuine test information.

Artificial Neural Network (ANN)

Artificial Neural Network (ANN) is a system that is inspired by biological neurons that resides in an animal brain. The neural network in itself is not an algorithm, but a framework for many such machine learning algorithms to do the job together and process many complex data inputs. Learning is the main key point in ANN. An ANN is basically a collection of connected units or also called as nodes known as artificial neurons, where each connection can transmit a signal from one artificial neuron to another. Then the received signal can be processed by the artificial neuron and then signal additional neurons adjoining the previous one. The original goal of ANN was to solve the problems that a human brain cannot.

V. TECHNOLOGY

Python

Python is a broadly utilized abnormal state, universally useful, deciphered, powerful programming dialect. Its outline reasoning underlines code clarity, and its grammar enables developers to express ideas in less lines of code than conceivable in dialects, for example, C or Java. The dialect gives builds expected to empower composing clear projects on both a little and huge scale.

Tensrflow

Across a range of tasks, Tensor flow is an open-source library for dataflow programming. It is nothing but a symbolic math library, and is also used in machine learning applications such as neural networks. It is used at Google for both research and production, often replacing its closed source predecessor, DistBelief. It was developed by Google Brain team

Google's internal use but was the released by Apache 2.0 open source license on Nov 9, 2.15.

VI. CONCLUSION

The project will help in reducing stagnant traffic at the junctions along with the reduced transportation cost and fuel consumption. Time for an individual person is saved and a path will be provided for the emergent vehicles in order to reach their destination on time, to help the needful. As Raspberry Pi is used in the project there's a scope of implementation of Internet of Things (IOT) in the future along with RFID. With the help of Artificial Neural Network and Machine Learning Algorithms interfaced with the Raspberry Pi, a real time analysis of the traffic will be achieved and accordingly the timing for the traffic signals will be controlled and priority for the emergency vehicle will be provided.

VII. ACKNOWLEDGMENT

We sincerely thank our guide Ms. Megha Gupta for her guidance and constant support and also for the stick to our backs. We also thank the project coordinators for arranging the necessary facilities to carry out project work. We thank the HOD, Dr. Vinit Kumar Dongre, Dean Academic, Dr. R.R Sedamkar, Vice Principal, Dr. Deven Shah, The Principal, and Dr. B. K. Mishra and the college management for their support.

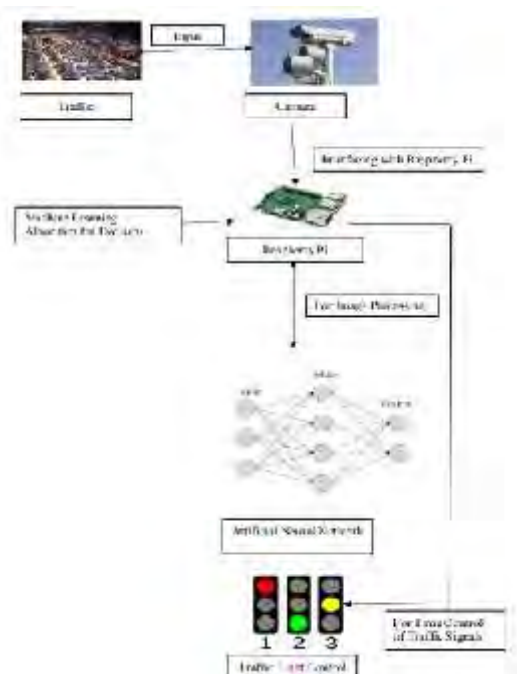


Fig.1. Block diagram of density based traffic light Controlsystem

REFERENCES

- [1]"Multi-Objective Traffic Light Control System based on Bayesian Probability Interpretation" Mohamed A. Khamis, Walid Gomaa, Hisham El-Shishiny Conference Paper in Conference Record - IEEE Conference on Intelligent Transportation Systems · September 2012
- [2]"Techniques for Smart Traffic Control: An In-depth Review" Roxanne Hawi, George Okeyo, Michael Kimwele International Journal of Computer Applications Technology and Research Volume 4- Issue 7, 566 - 573, 2015, ISSN: 2319-8656 26 March 2018
- [3]"Smart Traffic Light Control System" Ghazal, Khaled ElKhatib, Khaled Chahine, Mohamad Kherfan Conference Paper ISBN: 978-1-4673-6941-1 ©2016 IEEE 06 October 2017
- [4]"An Integrated Traffic light Control System Using RFID Technology and Fuzzy logic" Javed Alam and Prof. (Dr.) M. K. Pandey International Journal on Emerging Technologies (Special Issue NCETST-2017) 8(1): 420- 430(2017) (Published by Research Trend 04 May 2017
- [5]"Autonomous Vehicle Density-based Traffic Control System" Benjamin Kommey, Seth Djanie Kotey, Andrew Selasi Agbemenu International Journal on Emerging Technologies (Special Issue NCETST-2015) 8(1): 423- 431(2015) (Published by Research Trend 25 May 2015
- [6]"Bounded Model Checking of Traffic Light Control System" Bin Yu, Zhenhua Duan, Cong Tian Electronic Notes in Theoretical Computer Science 309 (2014) 63–74 2014
- [7]"A Review of Computer Vision Techniques for the Analysis of Urban Traffic" Chao Han ,Su Song IEEE Transactions on intelligent transportation systems, vol. 12, no. 3, September 2011
- [8]"Soft Computing Approaches in Traffic Control Systems: A Review" Shailendra Tahilyani, Manuj Darbari, and Praveen Kumar Shukla 2212-6716 © 2013 The Authors. Published by Elsevier B.V. Selection and/or peer review under responsibility of American Applied Science Research Institute doi: 10.1016/j.aasri.2013.10.032
- [9]"A Review of the Self-Adaptive Traffic Signal Control System Based on Future Traffic Environment" Yizhe Wang, Xiaoguang Yang, Hailun Liang, Yangdong Liu Hindawi Journal of Advanced Transportation Volume 2018, Article ID 1096123, 12 pages <https://doi.org/10.1155/2018/1096123>
- [10]"Surface Street Traffic Estimation" Jungkeun Yoon, Brian Noble, Mingyan Lijkyoon, bnoble, mingyan @eecs.umich.edu Ann Arbor, MI 48109-2122 2016

This page is kept blank intentionally

Testing and troubleshooting of Intel Celeron j series J1800 on Linux System

Sunilkumar Gupta
Electronic Engineering
Thakur college of engineering and
technology
Mumbai, India
sunilpgupta1995@gmail.com

Shubham singh
Electronic Engineering
Thakur college of engineering and
technology
Mumbai, India
Shubhamsingh1228@gmail.com

Anand Shukla
Electronics Engineering
Thakur college of engineering and
technology
Mumbai, India
anandshukla021@gmail.com

Abstract—With the widespread use of computers in each and every field and with the technological advancement in semiconductor processing industries, it is required to evaluate the performance of the computer in a profound manner. This requires the thorough knowledge of personal computers. Motherboard is heart of any computer system. In a computer system in different parts, different faults may arise. In this paper details of motherboard is discussed. In the first part of this paper series different VRM circuit of motherboard is discussed in detail. Also, technical guide is suggested for troubleshooting of VRM circuit faults and its remedies.

Keywords— Computer, Motherboard, CPU, VRM Circuit, SMPS.

I. INTRODUCTION

Today, with tremendous advances in Information technologies, the use of information systems turned out to be explicitly. Computer system typically include a combination of hardware components and software, application programs, system programs, processors, buses, memory, input/output devices etc. Today, more sophisticated computer software has evolved to take advantage of the higher performance of the hardware, resulting in computer systems that are much more powerful than just a few years ago. Fault diagnosis in the Electronics field has received a lot of attention in research literature over the last years. Several theoretical and practical fault troubleshooting techniques have been developed and experimented to automate the diagnostic process of electronic devices

II. RELATED WORK AND DESIGN GOALS

A. DETAILS OF MOTHERBOARD

The synonymous words used for motherboard are Main board, System board. The motherboard is considered to be mother of the personal computer (PC) or controller/holder/common connecting point of all other devices required to run a PCT. The motherboard is the main Printed Circuit Board (PCB) in a Personal Computer that is used to integrate and control all other components and devices in a complete computer system. It contains various components like CPU, memory, BIOS and basic controllers that are required to operate the system. Different types of motherboards are available which are built and designed with a limited range of specific components that can be used in them,

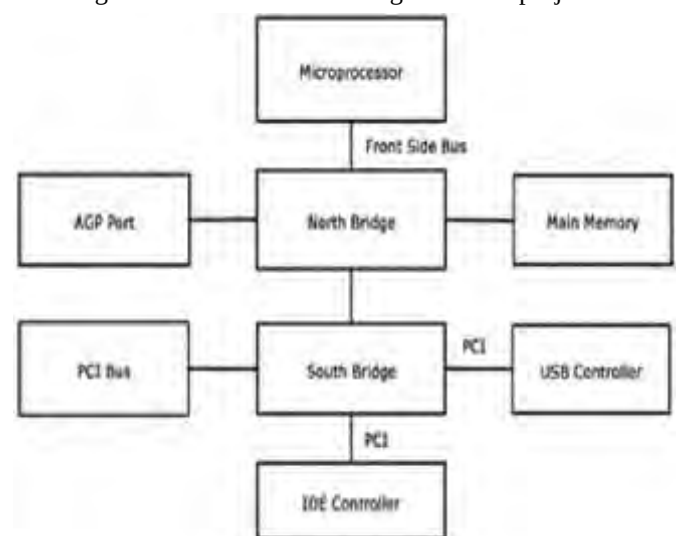
which are dependent upon the manufacturers design. An important thing to understand that all motherboards are not same. They may integrate some of the same technologies. But the way those technologies work together may be completely different in nature. Some can appear to be very similar, yet have hidden differences. Their appearance can vary in circuit board size, shape, design, capabilities and configuration possibilities..

B. Scope

The focus of the study is to analyze, design, develop, test and implement an online interactive web for computer hardware repair. The system also help to gain more knowledge in repairing hardware part of the computer system like display adapter, motherboard, hard drive, power supply, CPUs, mouse as well as system error and failure.

C. System Architecture And Design Rules

The designing of the block diagram plays a very important role as it visually describes the system as a whole displaying the significant elements of the system. The diagram below is the block diagram of the project.



1. NORTH BRIDGE CHIPSET (GMCH): North chipset is used to control high speed devices like CPU, RAM and Video Card. This chip set controls the Bus speed and Switches controlled data ensuring that data

between the components is smooth and continuous. Also, it controls the speed of CPU and RAM.

2. SOUTH BRIDGE CHIPSET : (ICH - INPUT/OUTPUT CONTROLLER HUB) : The function of the south bridge chipset is similar to the driver components like – Sound Card, Network Card, Hard Drive, CD-ROM drive, USB Port, BIOS IC and S I/O.

3. IDE PORT: This is controlled by SOUTH Chipset used to connect IDE drive like-HDD, CDROM, DVD etc

III. APPLICATIONS

1. Determine the domain of the problem and exonerate the network.
2. Conduct an Application flow analysis.
3. Fix the problem.
4. Validate the problem.
5. Document the fix.

IV. SCENARIO

- We have started working on the motherboard
- 25 to 50% work is done
- VGA and we have studied about some chipsets, ports and various types RAMs
- We have learned about some processors too.
- We have also studied about some motherboards (Intel)

•We currently are focusing on various types of OS such as kali Linux, Ubuntu etc.

V. ACKNOWLEDGEMENT

This project cannot be entirely created by an individual. The timely completion of the project ‘Testing and troubleshooting of Intel Celeron j series J1800 on Linux System’ has been possible because of our teacher and project guide Ms. Leena chakraborty who provided us with guidance and motivation throughout its making. We thank her for giving us an opportunity to create this project. We are also thankful to Dr. Sandhya Save (Electronics Department, HOD) for her guidance and to our parents for providing all possible resources to gain the best possible knowledge.

Finally we would thank our college ‘Thakur College of Engineering and Technology’ for providing us with a platform and the necessary facilities to make this project.

REFERENCES

- [1] Stephen J. Bigelow, Bigelow's PC Troubleshooting & Repair, Dr. eamtech Publishers, New Delhi.
- [2] B. Govinraju, IBM PC and Clones-Hardware, troubleshooting & maintenance -Tata McGraw Hill Publishing
- [3] Compagny Limited
- [4] Robert C. Brenner, IBM PC advanced troubleshooting & Repair-Prentice Hall of India Pvt. Ltd, New Delhi
- [5] ASUS Motherboard troubleshooting Guide – First Edition 2006
- [6] Bryan Betts, Diagnosing & Fixing Motherboard Problems, PC Support Advisor PP,3-6 '1997
- [7] Youssef Bassil, "Expert PC Troubleshooter with Fuzzy-logic and self-learning support", International Journal of Artificial Intelligence &
- [8] Applications (IJAI) Vol 3, No.2, PP.11-16 March 2012
- [9] Sourav Mandal, Sumanta Chatterjee, Biswarup Neogi, "Diagnosis and troubleshooting of computer faults based on expert system and

Design of VHF Yagi Uda antenna for Durdrishti Ground Station

Kiran R. Rathod¹

Research Scholar & Assitant Professor
EXTC Department, University of Mumbai
KJSIEIT, Mumbai, India
¹kiran.rathod@somaiya.edu

Vijay S. Rasal², Sandesh S. Sawant³, Vighnesh R. Mane⁴

Under Graduate Students
EXTC Department, University of Mumbai
KJSIEIT, Mumbai, India
²v.rasal@somaiya.edu, ³sandesh19@somaiya.edu,
⁴vighnesh.m@somaiya.edu

Abstract—This paper presents a design and simulation of VHF Yagi-Uda array antenna to be used for reception of HAM Radio Signals as well as Weather Satellite signals. The antenna is simulated and optimized at 146 MHz. The simulation is done using High Frequency Structuring Software (HFSS). It has impedance bandwidth of 10 MHz (6.84%) which satisfies the requirement of VHF HAM Band and weather prediction satellites.

Keywords—VHF, Yagi Uda, Return loss, Gain, Bandwidth

I. INTRODUCTION

In the last few years the wireless communication industry has evolved and it will be no surprise if it keeps on evolving more in the coming years. An antenna is a very important device in wireless communication which converts a guided electromagnetic wave on a transmission line to a plane wave propagating in free space^[1]. There are wide variety of antennas which have been developed for different applications, such as wire antennas which include dipoles, monopoles, Yagi-Uda arrays and related structures. Aperture antennas consisting of open-ended waveguides, rectangular or circular horn, reflectors and lenses. Printed antennas like printed slots, printed dipoles and microstrip patch antennas. Antenna plays a very vital role in any ground station system. They are the most essential link between free space and transmitter or receiver and determine the characteristics of the complete system. Antenna and its working environment decide the effectiveness of the ground station.

Our objective is to design an antenna for ISS (International Space Station) APT(Automatic Picture Transmission) signal reception via K.J. Somaiya's Durdrishti ground station which will automatically track the NOAA and Meteor weather satellites through the feeded data of their passes over the location of ground station. The antennas are designed by selecting particular Ham band frequency range. Three types of antennas i.e. V-Dipole, Quadrafilair Helix and Yagi Uda are designed to operate on Ham band frequency range of 144MHz to 146MHz for Reception. V-Dipole antenna is the simplest antenna configuration, although the presence of three different parameters, viz. the two arm lengths and the included angle makes it even more difficult. The design procedures available for

symmetrical V-Dipole mainly depend on maximizing the directivity with respect to the included angle only. Quadrafilair Helix being directional, consisting of one or more conducting wires, wound in the form of helix, is an excellent antenna for transmission and reception purpose. Being directional, signal is captured easily along with noise too.

The three element Yagi Uda is used to optimize its directivity and match it to the 50-ohm impedance cable. As frequency is 145 MHz corresponding wavelength for this frequency will be 2.0689 meters. We implemented antennas such that the size will be reduced to such an extent that it can be assembled and disassembled at site. The material used is robust in nature in order to survive the extreme weather conditions. In half wave dipole, input resistance and reactance increase along with length of dipole. We preferred dipole antenna over folded dipole, even though we get better results in folded dipole antenna & cross Yagi antenna (50 Ohm). The major reasons for using Yagi Uda over other types of antennas are as follows:

1. The performance of simple Yagi-Uda Antenna is similar to Cross Yagi but with less complex design.
2. We can achieve higher gain and range in cost effective affordable designs which are far less subject to interference.

II. CONSTRUCTION & DESIGN METHODOLOGY

Yagi-Uda antenna consists of mainly three elements i.e. directors, reflectors and dipole where directors and reflectors are parasitic element. Yagi-Uda antenna dimensions are as follows

Dipole= 0.48λ
Director= 0.45λ
Reflector= 0.55λ

The basic design is as shown in Fig. 1.

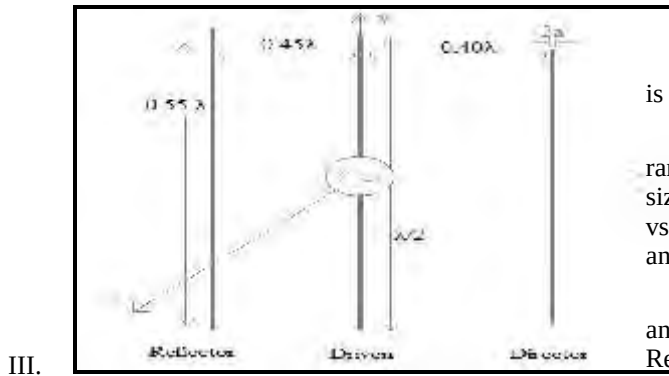


Fig. 1 Yagi-Uda basic design

This antenna is designed to operate at 144 MHz-146 MHz which is HAM RADIO Wireless Communication Band. For this frequency, wavelength is 2.0689 meters. For this VHF band frequency which is, Yagi-Uda is the best fitted antenna to be used [2].

The director is made to be smaller than the driven element. The director is placed in front of the driven element that is in the direction of maximum sensitivity. Typically director will add around 1 dB of gain in the forward direction. A director acts as a capacitive element. The director can be made capacitive by tuning it above the resonant frequency. The second alternative is more commonly used. Feed box is connected with driven element to feed the signal from cable RG-58 (50 Ohm). This cable is connected using SMA female connector. Feed box is isolated from environmental resistance.

This is behind the main driven element that is the side away from the direction of maximum sensitivity. Reflector reflects the EM waves. This helps in achieving unidirectional propagation.

IV. RESULTS AND DISCUSSION

Simulation is the connecting medium between design idea and hardware manufacturing. After receiving signals from antennas which were made from general designs available, we found that some of the parameters need to be improved in order to receive the weather signals more accurately. Hence we have simulated this linear polarization Yagi-Uda antenna using HFSS software.

In order to provide an efficient result, the parametric analysis of various components is considered. Different parameters were toggled with to find the optimum value. The parameters which were used for the same and the results of the same are as mentioned below.

A. Return Loss and Bandwidth

Return loss signifies the degree to which the antenna is matched with the transmission line. It indicates how much of the incident power is reflected back because of a mismatch in impedance. Generally, the impedance of the transmission line is considered to be 50Ω, although the values can sometimes differ. Return loss is calculated as follows:

$$R_L(\text{dB}) = 10 \log_{10} (p_i/p_r) \quad (1)$$

In the above equation, p_i is the incident power and p_r is the reflected power.

The simulated results are carried over a frequency range of 100 MHz to 200 MHz with a frequency step size of 20MHz. The fig. 2 shows the graph of frequency vs. Return loss parameter of the simulated Yagi-Uda antenna.

As shown in the fig. 2, this simulated Yagi-Uda antenna resonates around 146 MHz and exhibits a -20dB Return Loss bandwidth of around 30 MHz from 130 MHz to 160MHz.

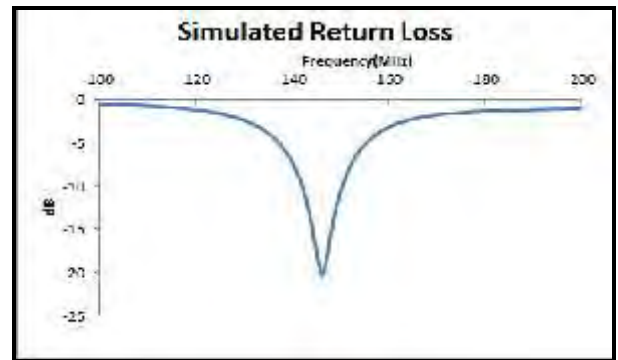


Fig. 2 Simulated Return Loss of the proposed antenna

B. Gain

Gain indicates the radiation in selected direction in comparison to an isotropic antenna. Gain provides us with a value to how efficiently an antenna converts input power into electromagnetic waves. Fig. 3 shows the gain plot of the simulated antenna.

Further studies are required to improve the gain. Techniques such as introduction of parasitic elements and further parametric analysis are considered for the same.

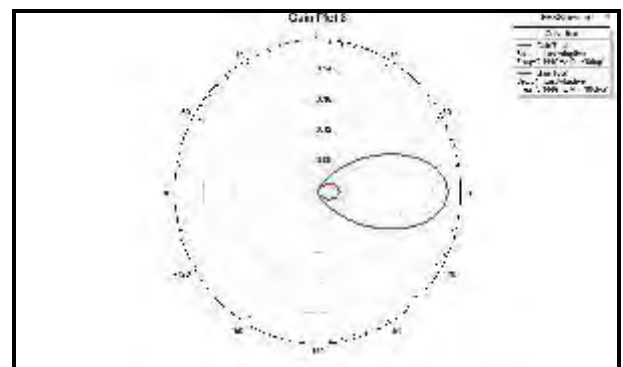


Fig. 3 Gain Plot of Simulated Antenna

C. Radiation Pattern

Radiation pattern is graphical representation of the intensity of the antenna plotted against the angle from perpendicular axis.

The only effort required is the reading and following of values along the circles. Fig. 4 shows the impedance matching of the simulated antenna.

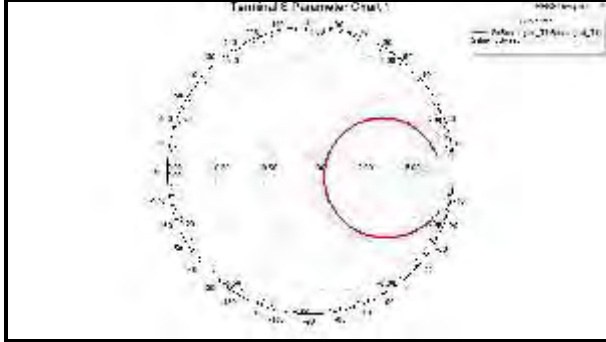


Fig. 4 Impedance Matching of Simulated antenna

Fig. 5 shows the top view of radiation pattern and Fig. 6 shows the front view of radiation pattern.

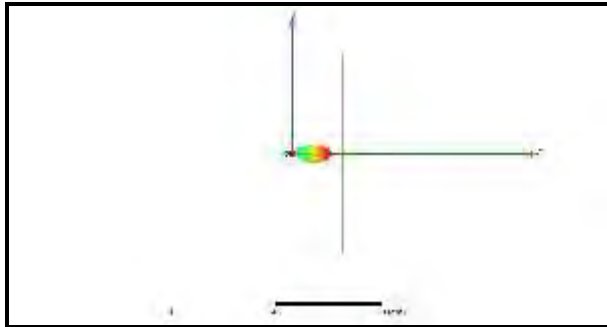


Fig. 5 Top View of Radiation Pattern in HFSS

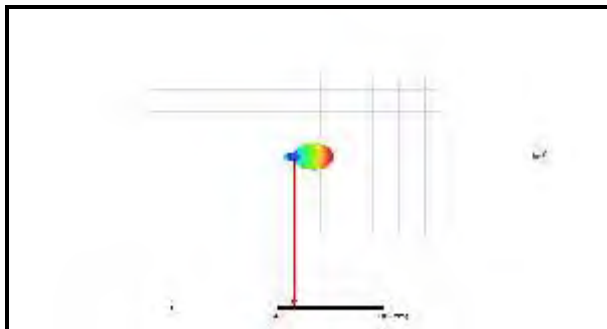


Fig. 6 Front View of Radiation Pattern in HFSS

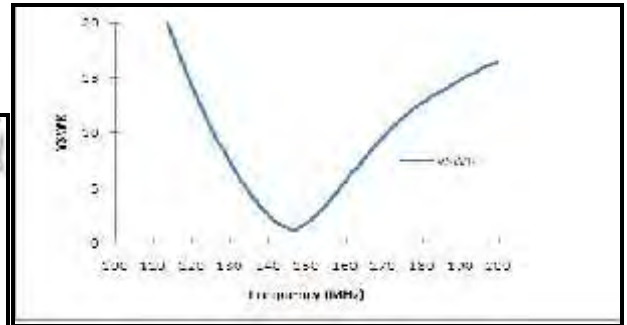
D. Voltage Standing Wave Ratio (VSWR)

Standing Wave Ratio (SWR) is a measurement of how efficiently the antenna will radiate the power available from the radio. In simple terms, the radio would like to radiate all of its power, but can only do so if the other components co-operate. Bad co-axial cables and mounts, or insufficient antenna and ground plane can cause system bottlenecks.

$$VSWR = V_{MAX} / V_{MIN}$$

Fig.7 Simulated VSWR of the proposed antenna

The simulated graph of VSWR vs. Frequency is shown in fig.7.



IV. CONCLUSION

In this paper, 3 element Yagi-Uda antenna for VHF weather satellite reception is designed and simulated using HFSS. Yagi-Uda antenna is simulated and optimized at 146MHz. The antenna operates around the 146 MHz VHF band with its resonating frequency at 146 MHz and impedance bandwidth of 10MHz. The antenna is suitable for reception of weather satellite signals. Further studies are required to improve the gain of the antenna to improve its working efficiency.

V. ACKNOWLEDGMENT

We thank Dr. Suresh Ukarande, Principal, KJSIEIT, for giving us the opportunity to carry out this research work. Our professor Mr. Kiran Rathod guided us with various antenna design techniques and shared his expertise in antenna design with us. The authors would also like to thank the Radio Frequency Laboratory of KJSIEIT, Sion for providing licensed version of HFSS for design and development purpose.

REFERENCES

- [1] David M. Pozar, Microwave Engineering, 3rd edition, John Wiley & Sons (Asia) Pte Ltd., 2012.
- [2] Sagar shinde, Iqar patel, Kishor kumbhar, Nikhil sarode, P.E.S.MCOE, Pune, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 3, Issue 10, "Design of High Gain Yagi-Uda Antenna in VHF Band" pp.1, October 2014
- [3] C. A. Balanis, Antenna Theory Analysis and Design, 3rd edition, John Wiley & Son, Inc., 2010.
- [4] Hamid Mubarak Mustafa Makkawi Khartoum, Sudan, International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE) "Design, Simulation and Performance Analysis of Yagi Antenna Array For VHF Radar" pp. 1,4-5, 2018.
- [5] Ansoft HFSS. ver. 19, Ansoft Corporation, Canonsburg, PA, 2018

This page is kept blank intentionally

Quad-Band Annular Ring Antenna with Defective Ground Structure for Calling Tablet

Mahesh Munde
EXTC Department
St. Xavier's Technical Institute
Mumbai, India
mmunde@xaviertech.com

Anil Nandgaonkar
EXTC Department
Dr. BATU
Lonere, India
abnandgaonkar@dbatu.ac.in

Shankar Deosarkar
EXTC Department
Dr. BATU
Lonere, India
sbdeosarkar@dbatu.ac.in

Abstract—Quad-band circular annular ring antenna with two inputs is proposed in this article, which is a suitable choice for calling tablets and wi-fi devices. It covers 850 MHz/900 MHz, 1800/1900 MHz, 2.4 GHz and 3.5 GHz bands. Circular annular ring with circular DGS is used to achieve multiband operation. FR4 lossy substrate having dielectric constant (ϵ_r) of 4.3, thickness 1.53 mm and loss tangent (δ) 0.025 is used to fabricate the antenna whose gain is reasonable and varies for different bands from 2.61 dB to 7.25 dB. Specific absorption rates obtained at resonant frequencies for 900 MHz, 1.8 GHz, 2.4 GHz and 3.5 GHz are 0.939 W/kg, 0.694 W/kg, 1.08 W/kg, 0.84 W/kg in 1 gram of tissue respectively.

Keywords—Annular ring, Defective Ground Structure (DGS), Quad-band, Specific Absorption Rate (SAR)

I. INTRODUCTION

Antenna is major device in wireless communication and designing of antenna has many challenges due to rapid technology changes. Calling Tablet uses multiband multisystem antennas. Multiband antennas can replace demand for multisystem requirement. Fourth generation wireless standard operate from 400 MHz to 4 GHz [1]. Higher frequencies from the band are allocated for Asia and Europe so as to provide larger bandwidths [2]. In Circular annular ring antennas TM_{nm} are used as there is no field variations and Bessel's and Neuman's functions of order n [3]. TM_{11} is dominant in these antennas, so as to achieve multiband resonance higher modes must be excited and the frequency of resonance of annular ring is given by equation 1 [4-5].

$$F_{11} = Xn \cdot \frac{c}{2\pi \sqrt{\epsilon_r}}$$

Defect in ground plane gives multiband operation and suppresses backward radiation also it reduces cross-polarization levels [6]. Various methods to enhance bandwidth and improve system capacity are proposed by using various symmetrical and asymmetrical defects in ground plane are proposed [7]. Microstrip patch antennas with single or multiple slots is employed to reduce mutual coupling and to suppress higher order harmonics [8]. In this article annular ring antenna is fed with two microstrip line feeds to enhance gain, 250 milli watts input power is supplied while carrying out simulations.

II. METHODOLOGY

A. Design of Circular Annular ring antenna

The designed antenna is for calling tablet and fabricated using low cost FR4 lossy substrate with dielectric constant (ϵ_r) 4.3, thickness 1.53 mm and loss tangent (δ) 0.025. A circular concentric ring is designed with full ground and parametric study on defect in ground is done and optimized using CST MSW. Antenna dimensions are (120 × 110 × 1.6) and all dimensions are in mm and are shown in top view and the defect in ground is shown in bottom view in Fig. 1. The single antenna element with two microstrip line feed to match 50 Ω impedance on both sides is used to enhance the gain as shown in Fig. 1. Circular slot in ground is made to enhance the performance of the antenna and is optimized from 10 mm to 41.3 mm. It is observed that as circular slot size in ground reaches and coincides with outer ring diameter of antenna. Antenna performance is enhanced in terms of gain and bandwidth along with suitable SAR. Fig. 2. shows photograph of fabricated antenna.

For evaluating SAR, antenna must be placed near the head phantom at a distance ranging from 3mm to 1 cm.

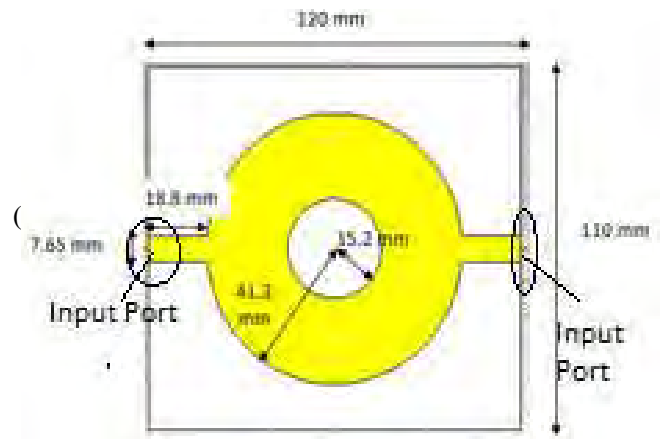


Fig. 1. (a) View of annular ring antenna.

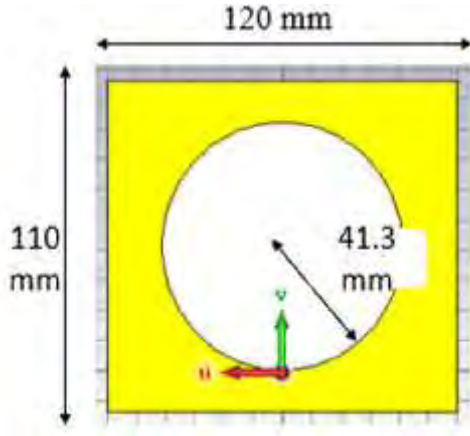


Fig. 1. (b) View of DGS.

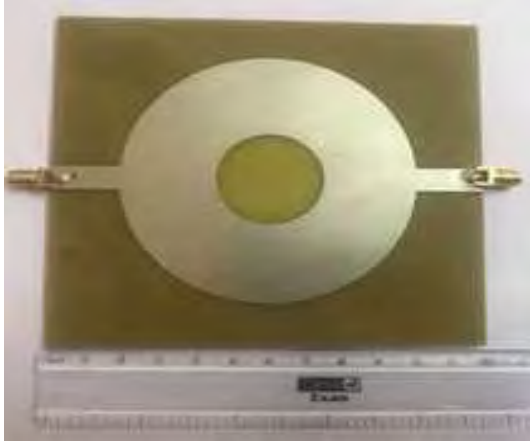


Fig. 2. (a) View of fabricated annular ring antenna.

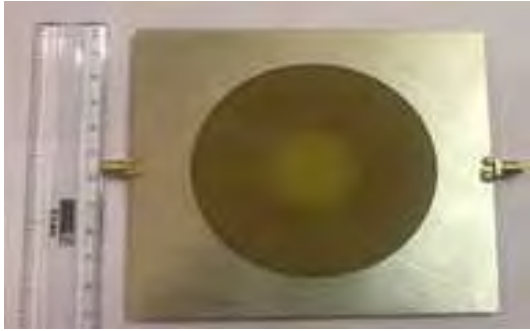


Fig. 2. (b) Bottom view of fabricated DGS.

III. RESULTS AND DISCUSSION

Return loss characteristics are presented in Fig. 3. for annular ring antenna Quad-bands operation at four resonant frequencies.

From the results it is evident that, for first band (850/900 MHz) return loss measured is -28.88 dB at resonant frequency of 852 MHz and bandwidth obtained is 413 MHz (0.587-1 GHz). Second band (1800/1900) gives return loss of -20.30 dB at 1.857 GHz frequency of resonance and bandwidth is 470 MHz (1.630-2.100 GHz), third band 2.4 GHz return loss measured is -16.63 dB at resonance frequency of 2.38 GHz and bandwidth is 439 MHz (2.171-2.610 GHz), fourth band return loss is -16.10 dB at resonant frequency of 3.45 GHz and bandwidth is 261 MHz (3.357-3.618 GHz).

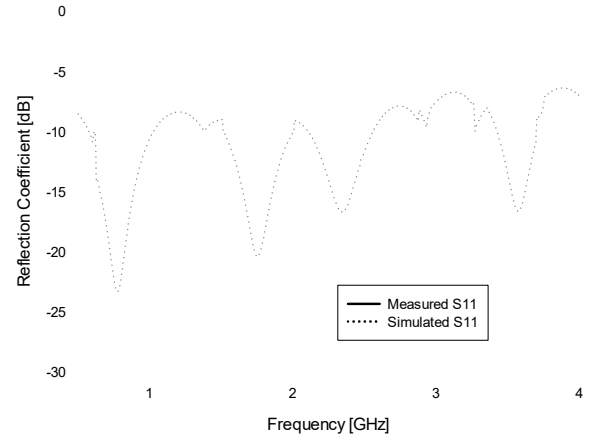
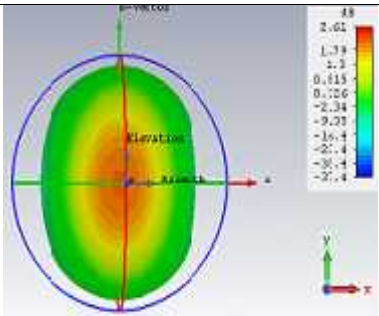
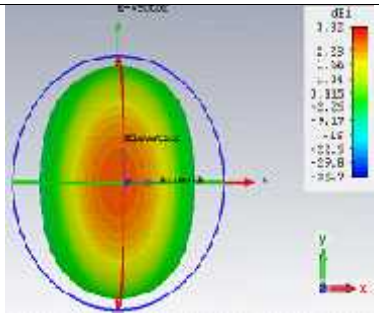
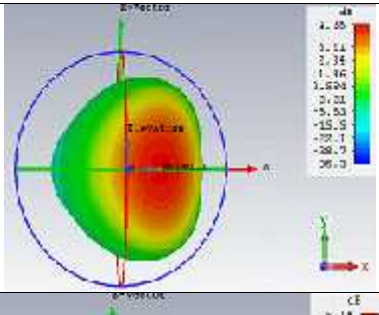
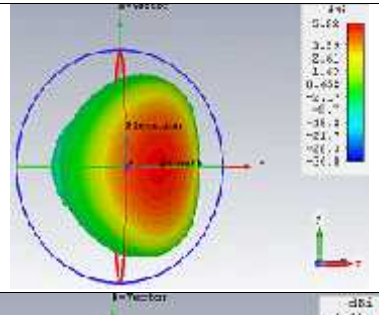
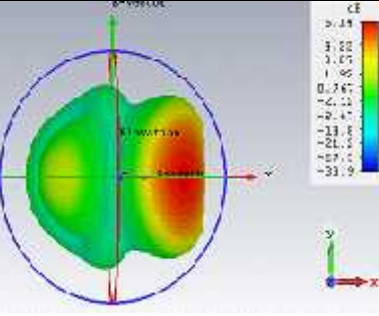
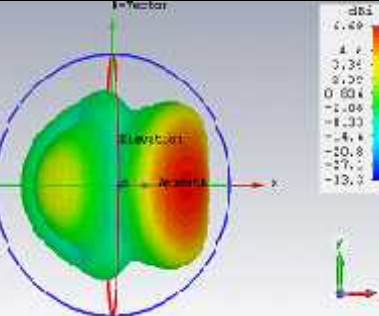
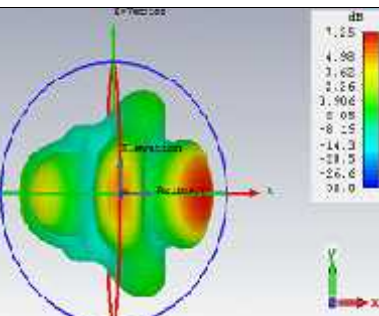
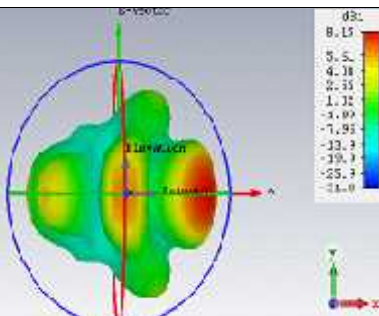
Fig. 3. S_{11} vs Frequency of annular ring antenna.

Table 1 demonstrates simulated maximum gain and directivity of annular ring antenna for all four bands. From Table 1 it is evident that as frequency is increasing, gain and directivity is increased but at 3.5 GHz the directivity is slightly reduced as compared to the rising trend due to increase in sidelobe level at 90 and 180 degrees and is observed in radiation patterns.

TABLE I.

GAIN AND DIRECTIVITY OF ANNULAR RING ANTENNA

Frequency in GHz	Gain in dB	Directivity in dB	Radiation Efficiency in %
0.9			78.61
1.8			89.65
2.4			91.77
3.5			88.95

Below Fig. 4. shows simulated values of vswr which should range between 1 and 2 and for all the bands range obtained is between 1.2 to 1.4.

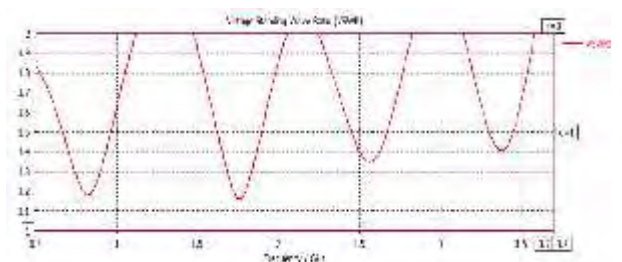


Fig. 4. VSWR vs Frequency.

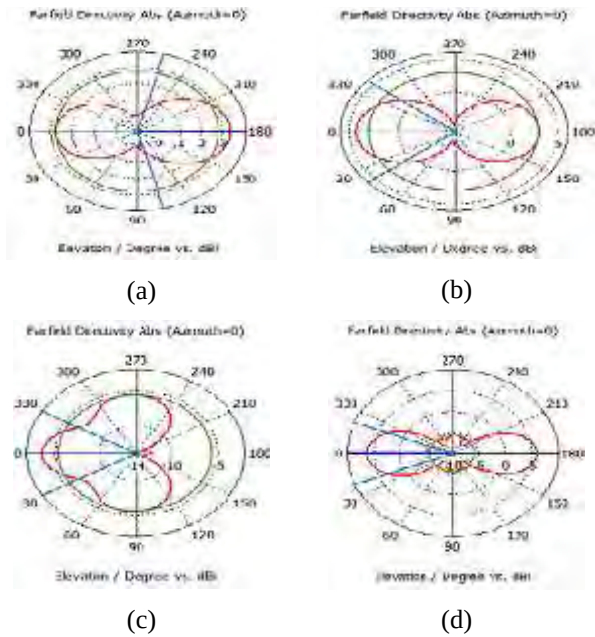


Fig. 5. Radiation patterns along HPBW at a) 0.9 GHz b) 1.8 GHz c) 2.4 GHz and d) 3.5 GHz

Fig. 5. shows radiation patterns at all desired resonant frequencies in azimuth and elevation plane. It is observed that HPBW is getting narrower as frequency is increased. Radiation pattern figure look like numeral 8 at all frequencies except 2.4 GHz. Sidelobes at 2.4 GHz are more but still backward radiation is less which reduces SAR.

TABLE II. SAR AT RESONANT FREQUENCIES OF PROPOSED ANTENNA

Frequency in GHz	SAR at 1gram
0.9	

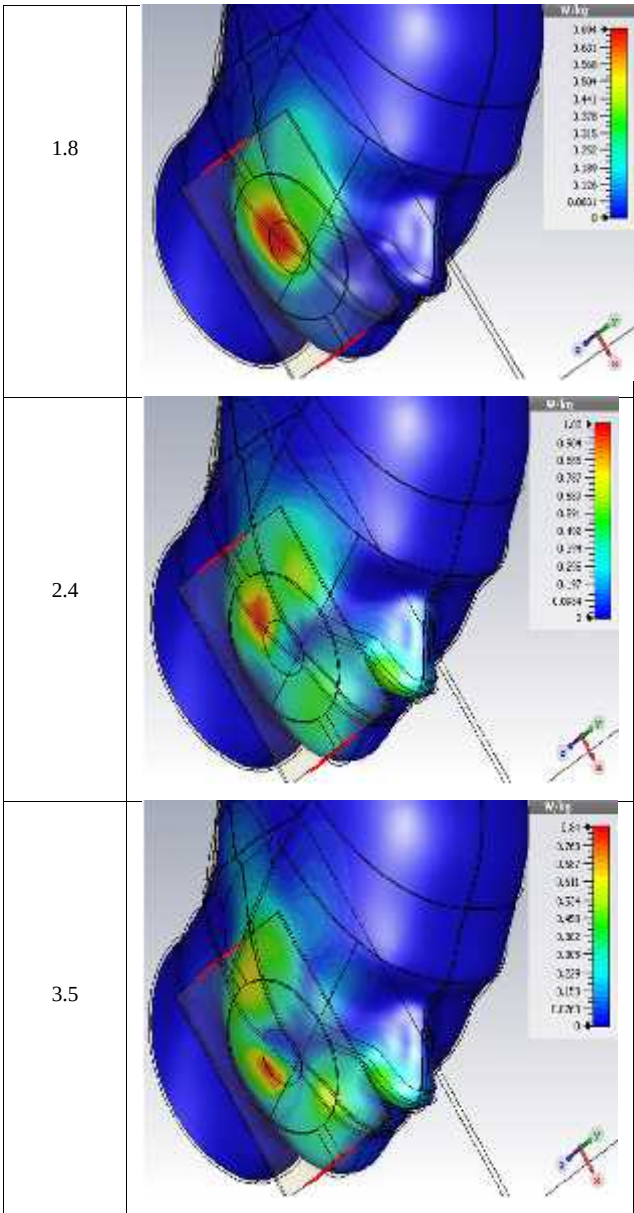


Table 2 shows values of SAR obtained at all resonant frequencies for 1 gram of tissue.

IV. CONCLUSION

Quad-band annular ring antenna is proposed in this article for calling tablets, it covers 850 and 900 MHz, 1800 and 1900 MHz, 2300 MHz as well as Wi-Fi (2.4 GHz) and Wi-Max (3.5 GHz).

A single antenna can be implemented to serve multiple purposes so that cost arising from multiple antennas can be reduced. The gain and directivity provided by the antenna at 900 MHz is 2.61 dB and 3.32 dB and at 1.8 GHz is 4.68 dB and 5.22 dB during calling session which is satisfactory and at 2.4 GHz is 6.14 dB and 6.69 dB and at 3.5 GHz is 7.25 and 8.15 dB respectively which can be used for Wi-Fi and Wi-Max. Maximum SAR achieved is 1.08 W/kg in 1g tissue mass of head phantom at 2.4 GHz and is much below as per the guidelines stated by FCC and IEEE.

REFERENCES

- [1] D. Campbell, C. J. Reddy, "Antenna design considerations for LTE enabled tablets", 2015 IEEE International Symposium on Antennas and Propagation & USNC/URSI National Radio Science Meeting, Vancouver, pp. 1140-1141, 2015.
- [2] G. Gampala, C. J. Reddy, O. Stabler, T. Hager, "Compact Antenna for MIMO LTE Mobile Phone Applications," *Microwave Journal*, vol. 55 (3), 2012.
- [3] S. E El-khamy, R. M. El-Awadi, E. A. El-Sharawy, "Simple analysis and design of annular ring microstrip antennas," in *IEE Proceedings H - Microwaves, Antennas and Propagation*. vol. 133(3), pp. 198-202, 1986.
- [4] S. Chakraborty, S. Srivastava, "High Gain Annular Ring Antenna," 2011 International Conference on Devices and Communications (ICDeCom), Mesra, pp. 1-5, 2011.
- [5] Ramesh Garg, *Microstrip antenna design handbook*, Boston: Artech House, 2001.
- [6] D. Guha, M. Biswas, M. Yahia, M. Antar, "Microstrip Patch Antenna with Defected Ground Structure for Cross Polarization Suppression," *IEEE Antennas and Wireless Propagation Letters* (4), pp. 455-458, 2005.
- [7] K. Wong, "4G/Multiband handheld device ground antennas," 2013 Asia-Pacific Microwave Conference Proceedings (APMC), Seoul, pp. 134-136, 2013.
- [8] M. Khandelwal, B. Kanaujia, S. Kumar, "Defected Ground Structure: Fundamentals, Analysis, and Applications in Modern Wireless Trends," *International Journal of Antennas and Propagation*, pp. 1-22, 2017.

This page is kept blank intentionally

Implementation of Faculty Management System In ERP

Niket Amoda,
Assistant professor, Dept of EXTC,
Thakur College of Engg. & Technology,
Mumbai, India,
niket.amoda@thakureducation.org

Deepak Kumar Sinha,
Assistant professor, Dept of EXTC,
Thakur College of Engg. & Technology,
Mumbai, India,
deepaksinha.extc@gmail.com

Abstract – We are living in the era of information technology. Enterprise Resource and Planning has brought revolutionary changes in the in technical world whether it is business, education filed, governance, medical system. Vision and mission of ERP system is to integrate the information from all the departments of the organization. These system implement business process within the organization to achieve synergy in operation across various business unit. ERP provides support for all variation of business practices, enables implementation for these practices with a view towards enhancing productivity, foster the image of the enterprise products and services. In every organization top management is handled by ERP system, and human resource plays main role in it. Generally in tenant management human resource and ERP system plays key role of development of project.

Keywords— *ERP; Faculty Management System (FMS); Organization; Biometric and Leaves; Time Table; Account; Salary*

I. INTRODUCTION

Faculty is the backbone of an Educational institute therefore their management plays a major role in deciding the success of an organization [1]. Faculty Management Software makes it easy for the employer to keep track of all records. This software allows the administrator to edit faculty, add new faculty, transfer/promote/terminate faculty. Each faculty in the database is associated with a position can be added and edited when need arises. Faculty can be transferred between positions easily without having to retype back their information in the database. You can check to see if there are duplicate positions/faculties in the database. Most of all, the employer can assign tasks to faculties and assess their progress in order to keep track of faculty's performance.

A flexible and easy to use Faculty Management System for small and medium sized Educational Institutes provides modules for personnel information management thereby organization and companies are able to manage the crucial organization asset people [2]. The combination of these modules into one

application assures the perfect platform for re-engineering and aligning Human Resource processes along with the institute goals. This system brings about an easy way of maintaining the details of faculties working in any organization.

It is simple to understand and can be used by anyone who is not even familiar with simple faculty system. It is user friendly and just asks the user to follow step by step operations by giving easy to follow options. It is fast and can perform many operations for a company. The goal of this project is to design and develop an faculty management system to fill existing gaps in the electronic management of employees. Scope of FMS will be limited to the following:

1. *Faculty profiles*: Faculties will have access to their personal profiles and will be able to edit their details.
2. *Electronic leave application*: Complete elimination of paperwork in leave management by enabling a faculty apply for leave as well as check their leave status through the system. This will also enable the HOD & Principal to accept/reject leave application through the system.
3. *Syllabus Management*: Assign lecture and practical to faculties, assign a lesson plan and keep track of the progress.
4. *Report generation*: The Head of the Department will be able to generate timely reports in order to monitor faculties and this can be used for performance appraisals. The reports will be have all the information of an faculties from educational background, trainings attended, projects done as well as technical skills.
5. *Recruitment Process*: The admin will add a faculty and a default password and faculty id will be generated and given to the new employee. Admin will then have the ability to add an employee's information to the database.

II. LITERATURE SURVEY

FMS refers to the systems and processes at the intersection between human resource management (HRM) and information technology. It merges HRM

as a discipline and in particular it's basic HR activities and processes with the information technology field whereas the programming of data processing systems evolved into standardized routines and packages of enterprise resource planning (ERP) software. [3] An organization or company with a very large number of employees manages a greater volume of data. This activity can be daunting without a more sophisticated tool to store and retrieve data. The various levels of sophistication can be examined by looking at the evolutionary aspects of HR technology..

These aspects can be characterized into four stages of development: Paper-based systems, early personal computer (PC) technology, electronic databases, and Web-based technology. [4] The benefits of automation are becoming widely known to HR and other areas of the business. The focus has shifted to automating as many transactions as possible to achieve effectiveness and efficiencies. The technology of the future will be about speedy access to accurate current information, and reliability to access this information via multiple systems will give organizations a strategic edge. HR is expected to relinquish its role as sole owner of HR information, so that managers and employees can use this information to solve their own problems using Web-based systems. This new system will not necessarily mean reduction in HR staff. The new system will enable HR professionals to focus on transforming information into knowledge that can be used by the organization for decision making; it will be about HR and IT working together to leverage this technology.

A recent study by the Hackett Group, a business process advisory firm found that high-performing organizations spend 25 percent less than their peers on HR because they use technology effectively. [5] The two most popular Web-based HR applications used today are self-service for employees and self-service for managers. These applications have enabled companies to shift responsibility for viewing and updating records onto individual employees and have fundamentally changed the manner in which employees acquire information and relate to their HR departments. [6]

III. SYSTEM DESIGN

1. Authentication:

Login- The user can login to the FMS system with his/her username and password.

Logout- The user can log out from the FMS system.
Login failure- If the user does not exist in the

database or the user has not yet being authorized by the FMS admin.

2. Authorization:

User role check- After logging in, the user role will be checked from the database and the user interface will be displayed according to their role.

3. Process Data:

Display- User with defined roles can display the content of the database. Being more specific, faculty can only view his/her personal information. HOD can not only see his/her personal information but also faculties' information who are under his/her department or school. Admin can display their personal information and all faculty.

Edit- A user with faculty role can edit his/her specific personal information. Dean or HOD can only edit faculty's personal information that is under his/her coverage except user role type. Admin can edit all information related to all faculties including their user role type.

Search- User with Dean/HOD role can search the content of database for the faculties who are under his/her coverage. Admin can search all the faculties' information in the database. Search feature works on specific keywords showing faculty qualification, skills and certification etc. For example, HOD wants to find employees' who are well trained in "Java Programming Language". He/she will write the specific keyword in the search bar and press the available search button. Afterwards, he/she will find a list of all the employees' who know "Java Programming".

Update authentication- This feature can be used only by admin role type. Admin can update the role type of a specific user. For example, a faculty got promotion and his role type will be changed from employee Asst. Professor to Associate Professor or Professor. Admin will be able to update this authentication mechanism.

4. Leave Application/Approval

Leave application- The user can be able to fill in leave application form in the appropriate fields.

Leave approval- The HOD and Principal can be able to approve leave applications based on the reasons stated, length of leave. Leave days accrued- The user shall be able to check the number of leave days accrued.

5. Recruitment

Add new employee- Admin will be able to add a new employee to the database. The new faculty will have all the required personal information related to him/her. The new created faculty will have an id. Admin will assign a new role such as faculty, Dean, HOD, HR, and admin to the new created user.

6. Report generation

Report generation- Admin shall be able to generate a report in pdf format for each employee based on the information in the database.

7. Project Management

Create project team: The HOD of department or project manager shall be able to create a project and come up with a project team.

Work Breakdown Structure (WBS): The HOD or project manager shall be able to assign tasks to the project team as well as monitor their progress.

8. Trainings and Task Management

Trainings: The HOD shall create trainings and assign faculties that are required to attend the trainings as well.

Tasks: HOD shall assign tasks to faculties in his/her department.

9. Hardware requirements

FMS should be able to work on a computer with the following minimum hardware specifications:

OS: Windows 7/8/10 and Linux

CPU: Intel i5 and above

RAM: 8 GB and above

Storage: 1TB of hard drive

Others: Network interface card, mouse, keyboard, and monitor.

10. Software requirements

Since FMS application is a web-based application, internet connection must be established. The FMS software personal database model will support Oracle11g environment as DBMS.

IV. IMPLEMENTATION

All users are presented with the same login interface. User must login the system by means of valid username/password combination. After access is granted to the system, the admin can add a new user to the system by entering the basic information which are the full names and email address. The admin also assigns the new user a role which will

determine the access level. During the process of user registration, the all users are issued with a unique username and password combination. Seeing that the system holds private employee information, the admin has the ability to monitor all activity logs into the system by date and time.

The newly added user logs into the system with a default password which can later be changed to a more secure password. All employees can edit basic information such as newly acquired technical skills and emergency contacts. Employees can apply for leave by filling in a form as well as submitting an attachment to support their leave request. The HOD has the ability to view all employees under his/her department, assign a task and trainings. The HOD can also create a project, add members to the project and create a work breakdown structure. Being an employee, the HOD can apply for leave as well as check leave days accrued. Upon logging in to the system, the HR manager gets notifications on the leave applications submitted and has the ability to approve or reject leave requests as they are submitted.



Fig. 1: Main Login Window of FMS

The Admin carries out all employee tasks which include the ability to view and edit basic details, view pending tasks, projects and trainings. The HR also has to the ability to generate employee reports in PDF format.

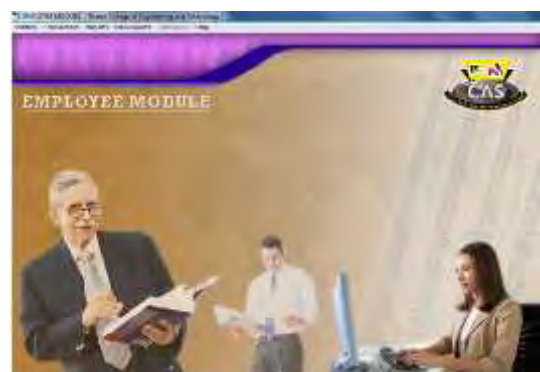


Fig. 2: User interface of FMS

1. Implementation of Oracle 11g Triggers

In Oracle 11g, a trigger is a set of SQL statements that is invoked automatically when a change is made

to the data on the associated table. A trigger can be defined to be invoked either before or after the data is changed by INSERT, UPDATE or DELETE statements. MySQL allows you to define maximum six trig BEFORE INSERT: Activated before data is inserted into the table.

AFTER INSERT: Activated after data is inserted into the table.

BEFORE UPDATE: Activated before data in the table is updated.

AFTER UPDATE: Activated after data in the table is updated.

BEFORE DELETE: Activated before data is removed from the table.

AFTER DELETE: Activated after data is removed from the table.

Here we are adding the titles and setting them to an applicable to whom.

When you use a statement that makes change to the table but does not use INSERT, DELETE or UPDATE statement, the trigger is not invoked. For example, the TRUNCATE statement removes the whole data of a table but does not invoke the trigger associated with that table. There are some statements that use the INSERT statement behind the scenes such as REPLACE statement and LOAD DATA statement.

V. RESULTS

All the manual work is replaced through this system which will result into faster processing of data and reduction of clerical mistakes. Ultimately employees and students will be benefitted and there will be win-win situation for all. The records of student can be accessed by the Admin, HOD and Senior Leadership. Here we are adding the titles and setting them to a applicable to whom.



Fig. 3: Adding new faculty in FMS

Adding the grade of the employee.

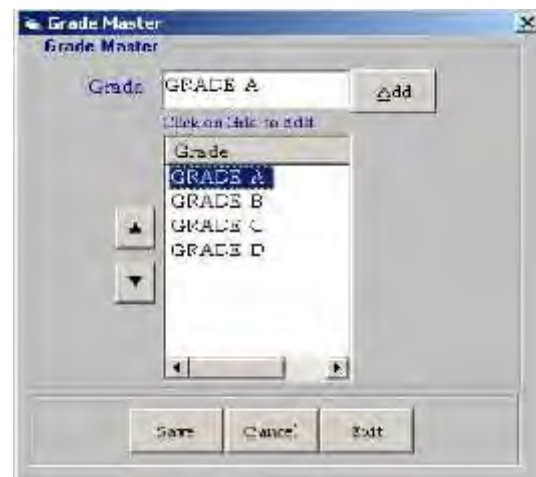


Fig. 4: Grade of the faculty

Experience can be added



Fig. 5: Experience type of the faculty

Creating the pay Commission of the faculty

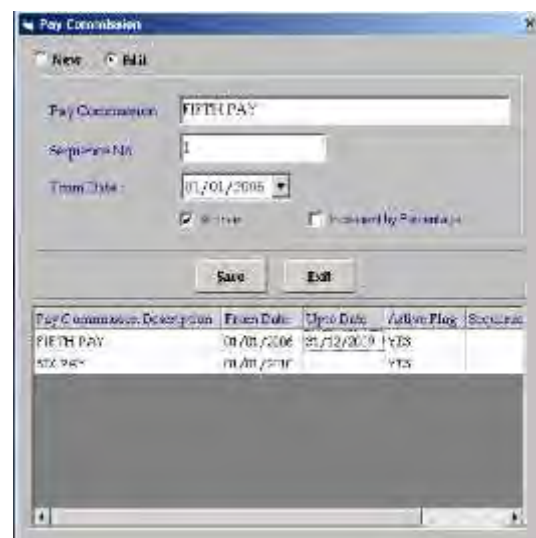


Fig. 6: Pay commission for the faculty

Adding the Sanction post of the particular designation

Fig. 7: Designation of the faculty

VI. CONCLUSION

The software product produced was fairly good, it achieved most of the user requirements, the user interface is good and is very easy to navigate, and even novice users can find their way around the web application easily. The client side validation is excellent. The lack of integration with a payroll system is the major drawback and the system was also unable to generate structured reports i.e. reports based on specific information the Human Resource is interested in.

REFERENCES

- [1]Xia Hu, Min Zhou,"The Three-dimensional Teaching Mode of ERP Course in Colleges and Universities", IEEE-2011.
- [2]Chongjun Fan, Peng Zhang, Qin Liu, Jianzheng Yang," Research on ERP Teaching Model Reform for Application-oriented Talents Education" International Education Studies Vol. 4, No. 2; May 2011.
- [3]Wenjie Yang, Haoxue Liu, Jie Shi," The Design of Printing Enterprise Resources Planning (ERP) Software" IEEE-2010.
- [4]Pranab Garg, Dr.Himanshu Aggarwal "Comparative Analysis OfErp Institute Vs Non Erp Institute; Teacher Perspective, IJMBS-2011.
- [5]Sun, A., A. Yazdani and Overend, J (2005). "Achievement assessment for enterprise resource planning (ERP) system implementations based on critical success factors." Int. J. Production Economics 98: 189-203.
- [6]D. Habhouba, S. Cherkaoui, and A. Desrochers" Decision-Making Assistance in Engineering-Change Management Process"IEEE-2010, 344-349.
- [7]Nielsen, J. (2002). Critical success factors for implementing an ERP system in a university environment: A case study from the Australian International Journal of Human and Social Sciences 5:6 2010 398, HES. Faculty of Engineering and Information Technology. Brisbane,Griffith University. Bachelor: 189.
- [8]G. R. Faulhaber, "Design of service systems with priority reservation," in Conf. Rec. 1995 IJREAM Int. Conf. Communications, pp. 3-8.
- [9]W. D. Doyle, "Magnetization reversal in films with biaxial anisotropy," in 1987 Proc. INTERMAG Conf., pp. 2.2-1-2.2-6.
- [10]G. W. Juette and L. E. Zeffanella, "Radio noise currents n short sections on bundle conductors (Presented Conference Paper style)," presented at the IJREAM Summer power Meeting, Dallas, TX, Jun. 22-27, 1990, Paper 90 SM 690-0 PWRS.
- [11]] J. G. Kreifeldt, "An analysis of surface-detected EMG as an amplitude-modulated noise," presented at the 1989 Int. Conf. Medicine and Biological Engineering, Chicago, IL.
- [12] J. Williams, "Narrow-band analyzer (Thesis or Dissertation style)," Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993.

This page is kept blank intentionally

Research on Suspicious Activity Detection Critical Review

Shital S. Mali
Dept. Of Electronics & Telecommunication
St. Francis Institute of Technology Borivali,
Mumbai, India
email id-shitalmali165@gmail.com

Prof. Dr. Uday Pandit Khot
Dept. Of Electronics & Telecommunication
St. Francis Institute of Technology Borivali,
Mumbai, India
email id- udaypandit@rediffmail.com

Abstract— As on date, public premises authorities are capturing videos using CCTV camera in terms of image frames. This is to observe the behaviour of human action. Public premise authorities are collecting real time image frames to check real time situation. If there is any suspicious activity happening in these places, then targeted person is going to get in touch with premise security authority for review the video stream. Then, they will review the past video stream manually. It might take few hours. In this time slot, the concern person who has done abnormal activity will go out of current premises easily as they are having manual control. It will be good if these abnormal activity detection and analysis activity is automated in real time. So that, it will be easy for premises security authority to maintain appropriate securities. This paper is a result of near investigation of concentrates drawn from writing survey, completed to comprehend the suspicious action recognition procedures utilized for identifying strange human conduct, following deserted item, or unattended things and so on., which prompted a broad examination between different proposed techniques. The result of the audit is displayed in type of different discoveries, which incorporates procedures and techniques used to tackle specific research issue, the extension for the future work in the zone. his electronic document is a “live” template and already

Keywords—Video Surveillance, Suspicious Activity, Image

I. INTRODUCTION

In day to day life, human beings are carrying their regular daily routine. They used to visit public places such as airport, railway stations, bus stations and government offices. There are so many people are moving from source to destination or vice versa. Some people are going from one station to another and some are coming from other station to source station. There can be rush present in public places. In such cases, there might be chances of abnormal or suspicious activities such as unattended baggage detection, person running very fast by doing some activity and terrorist attack happening to these mentioned public places., Abnormal activity detection and immediate action taken against it are vital steps in such scenarios at public places. To achieve objective of abnormal activity detection, human action recognition is first step. This is

defined as examination of real time ongoing performance from video captured by CCTV camera. This has gained a lot of consideration during the earlier few decades. From photographic investigation to human computer interaction systems, understanding what the people are doing is a necessary thread Recently, there are many algorithms for activity recognition is available into the market. Literature survey approaches for action recognition in video sequences are summarized in Table I. and some of which are quiet successful.

Model-based methods usually explained based on human body following or pose decision to model the changing aspects of person body parts for activity recognition. On the other hand, appearance-based methods are mainly relies on presence based features for action recognition.

Both given approached are focused on the classification work where activities of models are typically made from shapes of low-level features and directly attached with activities such as walking, bending, standing, waving and boxing etc. Developer can also give detailed information of those activities in terms of certain high-level semantic concepts like following, nearby etc. For instance, the activity of clapping can be categorized as “arm motion only” and/or “steady body with arm moving”. Other activities can be “raise arms or put it down”, standing, fast walking, running and cyclic motion. The mixture of these high level semantic concepts can be used to demonstrate human activity analysis. Then the same conclusions can be used comparison purpose and categorize human activities. Along with activity identification and analysis, the next task is to track the activity. These tracking phenomena are quite useful in visual surveillance systems for abnormal activity detection. Human tracking is achieved to trace a individual along the video frame sequence throughout the video. Then, resulting routes of people are further processed by expert investigation systems for examining human actions and identifying possible abnormal situations.

These days, there are various types of systems present to detect human activity but these systems have their own constraint and also not real time. In an investigation environment, the programmed detection of abnormal activities can be used to real time alert to related premises authority of potential abnormal behavior such as automatic reporting of a person with a bag loitering at an airport or station, person running in indoor environment and person touching few things from rack which are supposed to be. Similarly, in entertaining backgrounds, the activity recognition can recover the human computer interaction (HCI), such as the programmed recognition of various player's activity during a cricket/tennis game. So that, this can be used to create an avatar of player in the machine to play cricket/tennis. The activity recognition module can be used in recognizing healing of patient health in health care system or robot can be used to perform the tedious activities.

Today's technology contains various types of algorithms but each method has its own limitation which has been highlighted into literature survey section. Most methods are working on common human poses such as walking from left to right and right to left. Some are recognizing activity such as playing sports, doing different types of exercises. But while detecting abnormal activity in crowded area, these algorithms are not working that much efficient. Because the existing algorithms are not robust enough to work in real time i.e. is not able to process frames with frame rate of 30 fps.

II. MOTIVATION

Looking at the existing situation in real day to day life, every premise is covered with CCTV camera and storing huge chunk of data in storage area. But, abnormal activity happened then need to follow tedious way to rectify the issue which is real time activity

So considering the current threat, current market inspired to work on security so that the real time threats are reduced and security can be increased. The methods reported are using background subtraction, gaussian mixture model [1], optical flow, deep learning networks [2],[3],[4],[5] but these algorithms were unable to give appropriate results in past because unavailability of huge real time data and high end processors to process the data were unavailable. Now, its better to create the algorithms which can utilize current huge data for training and current high end processors for processing. This is to get real time output. Stage.

III. CHALLENGES

- Different scales - Individuals may show up at disparate scales in various recordings, however can do a similar activity.

- Development of the camera - The camera may be steady or moving.
- Movement with the camera - The individual playing out an activity as can be seen in Fig.1.1(i.e., skating) moving with the camera at a comparable speed
- Occlusions - Action may not be completely unmistakable as can be seen in Fig.1.2 e.g. crowded people.
- Background "clutter"- Different items/people present in the video outline with incompletely impeded
- Human variation - People are of various sizes/shapes.
- Activity Variety-Different individuals perform distinctive activities in various ways.



Fig. 1 Camera moving with person



Fig.1.2 Crowded Scenario Discussion

Various solution approaches were used to detect suspicious activities which majorly included unattended or abandoned baggage, intrusion detection. Loitering individuals etc. Semantic based study of suspicious behavior stood out as robust technology to conclude such experiments. Vision based Cellular Model could fetch up to 98 % results in object detection, but outputs varied as per experimentation. No solution could provide 100% accuracy results in event detection, which lays down the scope for further research. Semantic analysis along with vision based system though fetched 95% results, but this solution could reduce occlusion issues in overlapping objects cases, to considerable extent.

IV. CONCLUSION

Suspicious Activity Detection included activities like loitering individuals, unattended baggage, intrusion detection, moving object detection etc. used numerous technologies for detection of target. The solution approaches based on employing timeliness background differencing, and level motion masking, and Vision based semantic analysis boasted of

resolving occlusion problem with 95% accuracy results. Usage of Si-Factor (Similarity Factor) could detect intruders in high level noisy data. This review reflects the significance of applications of Intelligent Video surveillance, esp. in Human fall detection as it directly connects to the wellbeing of society, taking care of unattended elder people at home in life styles of major working population. Suspicious activity detection also emerged out to be of interest as by single system. Many applications can be derived to serve security applications for benefit of society. By a straight principle of moving object detection, intrusion detection, loitering individuals, unidentified objects etc. can be designed and implemented. The exhaustive review could finally lead to important and comparative findings in the area of image recognition.

REFERENCES

- [1] Linqin Cal, Xiolin Liu, Hin Ding and Fuli Chen, "Human Action Recognition Using Improved Sparse Gaussian Process Latent Variable Model and Hidden Conditional Random Filed", IEEE transaction and content mining, Vol 6, pp. 20047-57, Mar 2018.
- [2] Van Minh Khong and ThanhHai Tran, "Improving Human Action Recognition with Two-Stream 3D Convolutional Neural Network", 2018 1st International Conference on Multimedia Analysis and Pattern Recognition (MAPR), 5-6 Apr 2018
- [3] SaritaChaudhary, MohdAamir Khan and CharulBhatnagar, "Multiple Anomalous Activity Detection in Videos", 6th international conference on Smart Computing and Communications ICSCC 2017
- [4] Chan-Su Lee, "Human Action Recognition using Tensor DynamicalSystem Modeling", 2017 IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), 21-26 Jul 2017
- [5] FarhadKhezeli and FarbodRazzazi, "Real-time Human Action Recognition with Extreme Learning Machine", 2017 10th Iranian Conference on Machine Vision and Image Processing (MVIP), 22-23 Nov 2017
- [6] DishaniLahiri, ChhaviDhiman and Dinesh Kumar Vishwakarma, "Abnormal Human Action Recognition Using Average Energy Images", 2017 Conference on Information and Communication Technology (CICT), 3-5 Nov 2017.
- [7] Shanshan Zhang, Rodrigo Benenson, Mohamed Omran, Jan Hosang and BerntSchiele, "How Far are We from Solving Pedestrian Detection?", International Conference on Computer Vision and Image Processing 2016 (CVIP 2016), 21 Jun 2016.
- [8] Nitya Shree R, Rajeshwari Sah and Shreyank N Gowde, "Surveillance Video Based Robust Detection and Notification of Real Time Suspicious Activities in Indoor Scenarios", Computer Science and Information Technology, May 2016.
- [9] YonglongTian, Ping Luo, Xiaogang Wang and Xiaoou Tang, "Pedestrian Detection aided by Deep Learning Semantic Tasks", Computer Vision and Pattern Recognition (CVPR 2015), pp. 201-210, 29 Nov 2014.
- [10] Rodrigo Benenson, Mohamed Omran, Jan Hosang and BerntSchiele, "Ten Years of Pedestrian Detection, What Have We Learned?", ECCV 2014, CVRSUAD workshop, 16 Nov 2014.
- [11] Piotr Doll, Christian Wojek, BerntSchieleand PietroPerona, "Pedestrian Detection: An Evaluation of the State of the Art", IEEE Transaction paper on Pattern analysis and Machine Intelligence, Vol34, No 4, April 2012
- [12] Markus Enzweiler, and Dariu M. Gavrila, "Monocular Pedestrian Detection:Survey and Experiments", IEEE Transaction on Pattern analysis And Machine Intelligence, Vol 31, No. 12, Dec 2009
- [13] YanKe, RahulSukthankar and Martial Hebert, "Spatio-temporal Shapeand Flow Correlation for Action Recognition," 2007 IEEEConference on Computer Vision and Pattern Recognition(CVPR 2007), pp. 1-8, USA, 2007.
- [14] Du Tran and Alexander Sorokin, "Human Activity Recognitionwith Metric Learning," 10th European Conference on Computer Vision: Part I, pp. 548-561, Springer, Amsterdam, The Netherlands, 2008
- [15] Jianpeng Zhou and Jack Hoang, "Real Time Robust Human Detectionand Tracking System", 2005 IEEE Computer Society Conference onComputer Vision and Pattern Recognition (CVPR2005), 21-23 Sep 2005.
- [16] A. Veeraraghavan, A. R. Chowdhury, and R. Chellappa, "Roleof Shape and Kinematics in Human Movement Analysis," Proceedings of the 2004 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR 2004), 27 Jun-02 Jul 2004.

TABLE I. DIFFERENT METHODOLOGIES FOR SUSPICIOUS ACTIVITY DETECTION

Sr No.	Author / Journal	Problem Handled	Methodology	Results / Advantages	Limitations / Gaps
1.	Linqin Cal, Xiolin Liu, Hin Ding and Fuli Chen, IEEE, 2017.	Attributable to the delicate to outer condition, current human movement acknowledgment is as yet difficult in the region of PC vision. Specifically, the acknowledgment of unpretentious	$-y = \frac{f(x, W)}{n} + \epsilon$ $n \dots \dots \dots n \times d$ Where W belongs to R is a matrix of mapping parameter - HCRF -Gaussian Process Latent Variable Model (GPLVM).	-High recognition accuracy and computational efficiency - Valuable data covered up under time successive activity information can be adequately used utilizing	They considered only walking & jumping actions.
2.	Van Minh Khong and ThanhHai Tran, IEEE, 2018.	Each stream has design of a current 3D convolutional neural system (C3D) which has been appeared to be minimized.	-RGB -Optical flow algorithm - C3D	- C3D achieved better performance - This outcome demonstrates the favorable position when joining stream with rgb stream. The execution of early combination strategy is higher than the late combination	This method mainly focused on general gesture of human being. They haven't consider special movements.
3.	Sarita Chaudhary, Mohd Aamir Khan and Charul Bhatnagar, IEEE, 2017.	Due to exponential increase in crime rate, surveillance systems are being put up in malls, stations, schools, airports etc. With the videos being captured 24x7 from these cameras, it is difficult to manually monitor them to detect suspicious activities	- Feature extraction process key features - Problem domain knowledge rules - Anomaly Detection	- Detects multiple anomalous activities in videos -Detecting multiple anomalous activities successfully with detection accuracy upto 90%.	Suspicious movement & multiple object overlapping is missing.
4.	Chan-Su Lee, IEEE, 2017	Multidimensional tensor subspace analysis can learn more compact and useful representations than conventional linear subspace learning.	-Tensor dynamics system modeling -Iterative expectation maximization algorithm	- Action recognition experiment shows potential advantage of tensor dynamical systems - Model applicable for other applications such as motion capture data analysis, texture analysis, and bio-informatics data analysis.	Scope for improvement of different activities of human motion sequence.

5.	FarhadKhezeli and FarbodRazzazi, IEEE, 2017.	Focusing on some very common activity such as two hand front clap, bowling, front boxing, walking etc. It's difficult to handle complex situation which is rarely happening	-RGB video - depth data -Extreme Learning Machines (ELM) -Decision-fusion	- SON-HOF is extracted from RGB video - PDV and TDV are extracted from the skeletal model - ELMs provide higher accuracy - It is reliable and useable	They are focusing on some very common activity such as two hand front clap, bowling, front boxing, walking etc. It's difficult to handle complex situation which is rarely happening. This is limitation of existing.
6.	DishaniLahiri, ChhaviDhiman and Dinesh Kumar Vishwakarma, IEEE, 2017	Introduced a new dataset, AbHA dataset that includes three new abnormal activities – chest pain, fainting, and headache.	-Histogram of Oriented Gradients (HOG) -Principle Component Analysis (PCA).	- Average Energy Image based feature descriptor is calculated. - To encode all the body difference for one activity in one frame.	This method has some limitations such as single person present in one frame.
7.	Nitya Shree R, RajeshwariSah and Shreyank N Gowde, Conference Paper, 2016	- To detect other harmful activities, - Expanding the dataset, - Introducing machine learning techniques.	- Background subtraction - filtering - Edge detection - Pattern matching (triangular shape and possession)	- Capable of detecting and notifying danger - An observer or the guard is relieved from the burden of continuous monitoring - Cost effectiveness, simple installation, scalability to	The accuracy can be improve by varying false positive and true negative parameter.
8.	Shanshan Zhang, Rodrigo Benenson, Mohamed Omran, Jan Hosang and BerntSchiele, IEEE, 2016	- To report localization errors, - Calculating the influence of raining annotation noise	- State-of-the-art methods - Perfect single frame detector	- Strong results in image classification and general object detection. - Can improve even with a small portion of sanitised training data.	To have limitations when producing well localised detection scores around small objects, improvement on the raw classification power of the neural n/w
9.	YonglongTian, Ping Luo, Xiaogang Wang and Xiaoou Tang, IEEE, 2016	- Object detection accuracy, - Models were different in cropping images at different Locations, - Improving the detection results.	-Object detection -RCNN -Deep ID-Net - State-of-the-art	- Model averaging performances are the best - Great flexibility to incorporate various deformation handling approaches and deep architectures - More suitable for the object detection task and with good generalization capability	The work can be exploring by adding more attribute configuration.

10.	Piotr Doll, Christian Wojek, BerntSchiele and PietroPerona, IEEE, 2009	Challenging images of low resolution and frequently occluded people, Fail to predict performance on full images, research addressing detection at smaller scales and of partially occluded pedestrians is crucial.	- State-of-the art Algorithm - Histogram of Oriented Gradients (HOG)	-Under more realistic and challenging conditions, performance degrades rapidly. -Pedestrians in the medium/far scales represent more than 80% of the data. - Improve performance at low resolutions and under occlusion.	- Performance degrades rapidly under even mild occlusion. - At low resolutions, motion is very informative for human perception; thus effective motion features for this setting are needed.
-----	--	---	--	---	--

Power Consumption and Delay in Wireless Sensor Networks Using N-Policy M/M/1 Queuing Model

Sanjeev Ghosh
Associate Professor,
Dept. of Electronics & Telecommunication Engineering
Thakur College of Engineering & Technology
Mumbai, India.
sanjeevghosh@gmail.com

Dr. Srijia Unnikrishnan
Professor,
Dept. of Electronics Engineering Fr. Conceicao Rodrigues
College of Engineering
Mumbai, India
srija@fragnel.edu.in

Abstract—Technological advancements in low power integrated circuits and wireless communications have made it possible to use efficient, low cost, low power small devices in remote sensing applications. This has led to the feasibility of using a network of sensors to be used for the collection, processing, analysis and distribution of important information, collected in a wide variety of environments. Sensor nodes in a wireless sensor network transmit data in single or multi-hop to a central node called the base station. A very important issue in wireless sensor networks is the scarcity of power and hence optimal use of available power is of prime importance. It is seen that in any sensor node, switching from idle to busy state and vice versa takes up a major portion of the power. We study and analyze a technique that aims to reduce the number of these in order to reduce the consumption of power. In this technique the radio of the sensor node is switched on only when the number of packets in a queue exceed a certain threshold as opposed to the general tendency of transmitting a packet as soon as it is available for transmission. This however introduces delay in the processing of the packets. We analyze the performance of this system with respect to the power consumption and mean waiting time. The simulations performed show that the simulation results are close to the theoretical results thus indicating the validity of the technique studied.

Keywords—Wireless Sensor Network; Queuing Theory;

I. INTRODUCTION

A WSN comprises of a large number of sensor nodes that are typically distributed over a wide area. The WSN also comprises of a node that acts as an information collector and is referred to as the sink node. These sensor nodes usually consist of a sensing unit, a battery and a radio. In typical deployment scenarios, the sensor nodes may be deployed in remote, unattended, and hostile environment in large numbers. In some applications, the physical size of a sensor node is kept as small as possible for stealthy missions and cost cutting. In most cases, sensor nodes in WSN are fitted with non-rechargeable batteries and have a limited lifetime. It may be difficult to recharge or replace their batteries due to their remote or hostile locations. This fact gives rise to major design issues for WSN, which is to reduce power consumption

and to increase the lifetime of sensor nodes as much as possible [1][2].

Data packets usually originate at the sensor nodes as a result of its sensing activities. Moreover the sensor also behaves as a router to route the packets that arrive from other nodes. The data that are generated at the sensor nodes as well

as the ones routed by the nodes must all reach a sink node in sensor network. The traffic in a wireless sensor network usually has a many-to-one pattern, where nodes that are located nearer to the sink bear a heavy burden of the traffic. As a result, it is seen that the nodes around the sink would consume their energy much faster, leading to the eventual death of the node. This problem is known as the energy-hole problem [3]. If an energy hole appears, then packets cannot be delivered to the sink anymore. The longevity of a WSN entirely depends on the life of sensor nodes that are closer to the sink of the WSN. As described in [4], there are four main sources of power consumption: collision, overhearing, control packet overhead, and idle listening.

Overhearing and idle listening use power by keeping the radio receiver in an ON state without actually getting any useful information. However, compared with the other three types of power consumption for a generic node, packet collisions lead to energy waste which is much more. Medium contention in a contention-based protocol is one of the main reasons of packet collisions among sensor nodes. Shih et al [5] have demonstrated that power consumption is very high in case of the radio transmitter switching from one mode to another. Here, we study an approach to alleviate total average times of both medium contention and mode switching of radio receiver [3]. The approach discussed here is based on N-policy M/M/1 queuing model.

The nodes located near the sink of the WSN use more energy than other nodes because of the larger forwarding burden. This would lead to a faster depletion of the battery and eventually to the

failure of the WSN. From the angle of queuing theory, the larger forwarding burden implies that the average arrival rate of packets at the nodes closer to the sink is higher than that of nodes farther away from the sink. To alleviate this problem, an optimal N criterion is adopted for a queue based scheme. A queue threshold, N , is specified which would imply that the node will wake up only after the node's buffer has at least N packets and the node switches back to idle state when there are no packets to be transmitted, in other words, the buffer becomes empty. In this scheme, when the node buffer is filled with N packets, the sensor node triggers its transmitter and starts transmitting the packets in the buffer in a burst. The optimal threshold value (N^*) of N at which the sensor nodes use the least power is also determined.

In this paper, we present the mathematical expressions for the queue based approach and also data simulations with MATLAB tool are conducted on optimal queued values for mitigating power consumption. We also have conducted simulation of the queue based approach using MATLAB and the results are presented here that confirm the power saving achieved by the queue based scheme.

The rest of the paper is organized as follows: In section II, we present the system model. In section III, we discuss the mathematical preliminaries and provide numerical expressions for the average power consumption of a sensor node and the optimum value of N . We provide the values of various parameters used for evaluating the power consumption and also discuss the simulation of the system model in section III. We discuss the results of evaluation and simulation in Section IV. In section V, we provide the conclusion of our work.

II. SYSTEM MODEL

Here the operation of radio server in an N -policy $M/M/1$ queuing process under steady-state conditions is studied. The sensor node turns the transmission of radio on at a packet's arrival and off at service completion epochs. We have made an assumption that packets arrive at a node following a Poisson process with mean arrival rate λ . The radio service times follow an exponential distribution and has a mean $1/\mu$. A scheme is studied in which a sensor node switches to busy state i.e. starts its radio transmitter when the node's buffer is filled at least with number of packets equal to the threshold (N) and the node switches to the idle state when there are no packets to be transmitted remaining in the buffer. Such switching actions between idle state and busy state and vice versa are referred to as transitions. Since the main aim is to minimize the power consumption of individual sensor nodes by

reducing the number of transitions, we study the behavior of a single sensor node when this scheme is implemented.

Let's first have a look at the mathematical preliminaries for the N -policy Markovian queuing system [6]. The analytic steady state results are presented for a single sensor node. For our analytical model, the following notations are used.

n	Number of packets in the sensor node's buffer
N	Threshold number of packets
λ	Mean arrival rate per node
$1/\mu$	Mean service time
$PI(n)$	Probability that the sensor is in idle state when there are ' n ' packets
$PB(n)$	Probability that the sensor is in busy state when there are ' n ' packets
PI	Steady state probability that the sensor is in idle state
PB	Steady state probability that the sensor is in busy state
L	Mean number of packets in the sensor node's buffer

The state-transition-rate diagram for the N -policy $M/M/1$ queuing system is shown in Fig.1. In Fig.1, there are two chains of horizontal circles associated with the state of the radio server. The upper and lower chains represent the idle state and the busy state of the radio server, respectively. Each circle with number in it denotes that the number of data packets queued in the sensor node for that state.

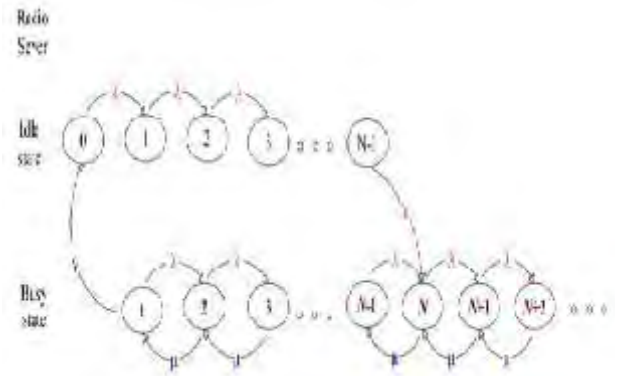


Fig. 1. State-transition diagrams for the N -policy $M/M/1$ queuing [3]

The value λ is the mean arrival rate of data packets into the sensor node, and the value μ is the mean service rate of radio server. The steady-state equations for $PI(n)$ and $PB(n)$ are as follows:

The probability generating function (PGF) may be used to obtain analytic solution $PI(0)$ since solving

(1) – (6) using a recursive method is difficult. The solution of $PI(0)$ is [3]

The expressions for PI and PB are given by [1]

For N policy M/M/1 queuing model, the steady-state probability that the radio server is busy is equal to ρ which is termed as “traffic intensity” or “utilization” of the system in a generic sensor node.

The expected number of data packets in a one-node system under N-policy is denoted by LN. The expression for LN are given by [3]

Depending on the threshold value, the sensor node switches from idle to busy state and from busy state to idle state in a single busy cycle and hence a busy cycle constitutes two transitions. The sensor node, during its scheduled period of active time undergoes many such cycles. The expected length of the idle period, the busy period and the busy cycle, are denoted by $E[IN]$, $E[BN]$, and $E[TN]$, respectively. Since the busy cycle is the sum of the idle period and the busy period, we obtain $E[TN] = E[IN] + E[BN]$. The mathematical expressions of $E[BN]$, and $E[TN]$ are as follows [3]

To determine the average power consumption of a sensor node, we consider the following parameters responsible for power consumption in a sensor node:

CB = Power consumption during busy cycle in watts
CT = Power consumption during transitions/cycle in watts

CH = holding power for each data packet present in the system

Cid = power consumption for keeping the server in idle period

$P(N)$ = Average power consumption/unit time in watts/sec

The average power consumption is given as [3]

The optimal threshold value (N^*) of N based on equation (13) is determined by differentiating equation (13) with respect to N and equating it to 0. The value of N for which the sensor node consumes minimum power and it is given by [3]

The mean waiting time of the packets in the queue (W_q) is given by

The simulation has been run for 10 simulation hours. Simulations results are obtained by varying the threshold number of packets to determine average power consumption per node in a network.

III. ANALYSIS AND SIMULATION

50

A. Analysis

To show the effectiveness of the approach shown above, the expressions in equation (13) and (15) were evaluated. The Power Consumption expression in (13) has been evaluated by assuming different values mean arrival rate (λ) and the radio service times ($1/\mu$). All data simulations have been carried out with MATLAB 7.12.0 (R2011a) on Intel Core i3-4030U CPU (1.9 GHz, 4GB RAM). We have written MATLAB scripts to evaluate the discussed power-saving scheme. These evaluations are compared with ordinary M/M/1 queuing case with the queuing threshold value set to 1, i.e. $N = 1$. We have assumed the following parameters for the evaluation of the Power consumption in equation (13) [3].

Mean arrival rate (mar) of packets: λ (range from 1.0 to 5.0) Mean service rate: $\mu=10$

Power consumption elements: CT =20, CH =2, CB = 20, Cid = 4

B. Simulation

We perform the simulation for a WSN using the parameters as in [7][8][9]. Here we have simulated the power consumption for a single node of a WSN by assuming that the packets arrive with mean arrival rate (λ) and the radio service times follow an exponential distribution with mean $1/\mu$. We have assumed that the node has a buffer that can hold up to 50 packets which is more than sufficient for a maximum threshold value of 20. The packets that arrive at the node are held in the buffer and are not transmitted immediately, instead they are stored in the buffer. When the number of packets in the buffer reach the threshold N, the radio is turned on to transmit all the packets in the queue in burst mode. This simulation is performed for different values of the queue threshold N. The following values of simulation parameters have been considered.

Mean arrival rate (mar) of packets: λ (range from 1.0 to 5.0) Mean service time: $\mu=10$

Threshold number of packets N: 1 to 20

Power Consumption in transmit mode: 81 mW Power Consumption in Receive/Idle mode: 30 mW Power Consumption in Sleep mode: 0.003 mW

The simulation has been run for 10 simulation hours. Simulations results are obtained by varying the threshold number of packets to determine average power consumption per node in a network.

IV. RESULTS

In this section, we present the analysis and simulation results. In the first part, the expressions in equation (13) and (15) were evaluated. The Power Consumption expression in (13) has been evaluated by assuming different values mean arrival rate (λ) and

the radio service times ($1/\mu$). We study the effect of varying the mean arrival rate (from 1.0 to 5.0) and obtain the corresponding power consumption while keeping other parameters the same. The results are shown in figure 2 with $\text{mar}(\lambda)$ set from 1.0 to 5.0.

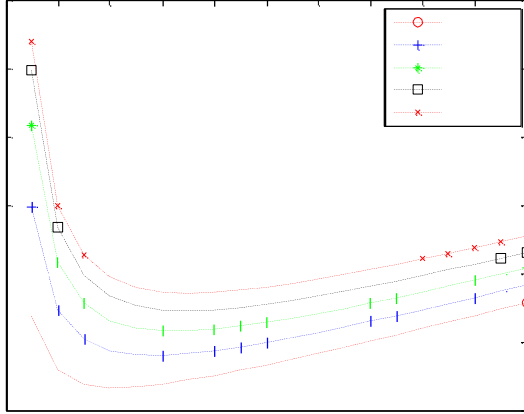


Fig. 2. Power Consumption (λ : 1-5)

The location of optimal N value (i.e., the bottom point of each curve) which corresponds to the lowest power consumption, shifts right accordingly as the mean arrival rate (mar) is increased gradually. For mean arrival rates $\lambda = [1.0, 2.0, 3.0, 4.0, 5.0]$, the optimal values of N are $[4, 6, 6, 7, 7]$ respectively.

The mean waiting time (delay) of the packets waiting in the buffer is also calculated using equation (15) by varying the values of mean arrival rates (λ) and the queue threshold (N) using equation (15). Fig. 3 shows the mean waiting time plotted against the mean arrival rate (λ) of the packets by considering different values of queue threshold (N). The results are shown in figure 3 with $\text{mar}(\lambda)$ set from 1.0 to 5.0.

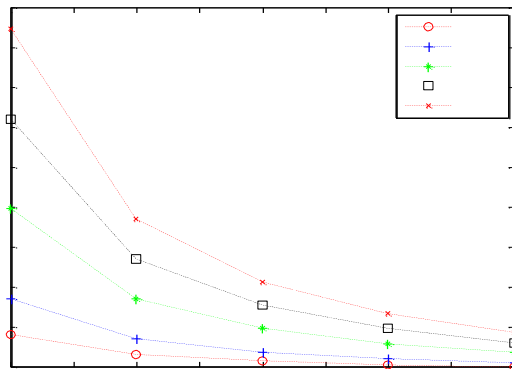


Fig. 3. Mean arrival rate / node vs Average delay (sec)

Since the mean delay of the system is directly proportional

3. The mean delay decreases as the mean arrival rate increases. This is due to the fact that the increase in the arrival rate leads to the faster filling of the queue buffer and hence leading to shorter waiting times. From Fig. 2 and Fig. 3, it is also observed that there exists a trade-off between the data delay and the average power consumption with respect to the value of N .

In this section, we present the results of simulation. We have computed the power consumption for a single node of a WSN by assuming that the packets arrive with mean arrival rate (λ) and the radio service times follow an exponential distribution with mean $1/\mu$. The simulation has been run for 10 simulation hours. Simulations results are obtained by varying the threshold number of packets to determine average power consumption per node in a network. The results are shown in Fig. 4 with $\text{mar}(\lambda)$ set from 1.0 to 5.0.

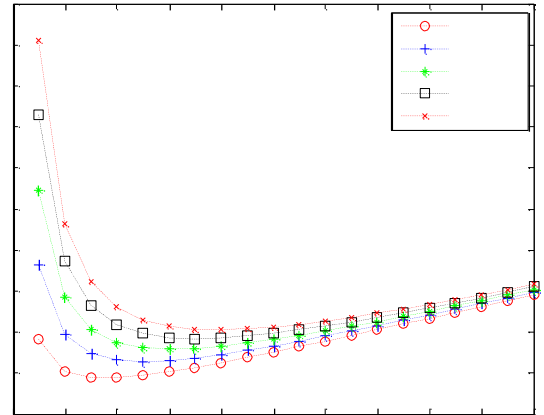


Fig. 4. Average Power Consumption (λ : 1-5)

It can be seen that the power consumption pattern obtained as a result of the simulation is similar to the one illustrated in Fig. 2. It is also seen that the optimal N value (i.e., the bottom point of each curve) which corresponds to the lowest power consumption, shifts right accordingly as the mean arrival rate (mar) is increased gradually. For mean arrival rates $\lambda = [1.0, 2.0, 3.0, 4.0, 5.0]$, the optimal values of N are $[4, 5, 6, 7, 8]$ respectively.

The mean waiting time (delay) of the packets waiting in the buffer is also simulated by varying the values of mean arrival rates (λ) and the queue threshold (N). Fig. 4 shows the mean waiting time plotted against the mean arrival rate (λ) of the packets by considering different values of queue threshold (N). The results are shown in figure 5.4 with $\text{mar}(\lambda)$ set from 1.0 to 5.0.

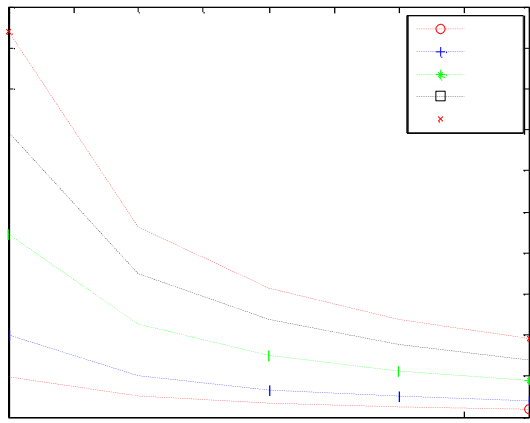


Fig. 5. Mean arrival rate / node vs Average delay (sec)

V. CONCLUSION

In this work, we have analyzed a scheme by which the power consumption of a single node in the WSN is reduced by setting a threshold for the number of packets in the buffer before the node can transmit all the packets in the buffer in a burst. This leads to a reduction in the number of transitions of the sensor node during its scheduled period of active time. Since the mean delay of the system is directly proportional to N , the delay increases as N increases. The mean delay decreases as the mean arrival rate increases. This is due to the fact that the increase in the arrival rate leads to the faster filling of the queue buffer and hence leading to shorter waiting times. We have also simulated a model of a wireless sensor network

and evaluated the system performance in terms of power consumption and determined the power consumption improvement with the implementation of the N -policy. We have also indicated the optimal value of N by both analysis and simulation. The results show that the average power consumption can be reduced to a large extent by selecting an optimum threshold value (N). The simulation of mean delay experienced at a node is comparable to the theoretical results. The simulation results compare with the analytical results to a great extent under different scenarios in which we have varied the mean arrival rate (λ) of the packets thus indicating that the scheme studied is effective and can be implemented in a practical scenario.

REFERENCES

- [1] C. E. Jones, K. M. Sivalingam, P. Agrawal, and J. C. Chen, "A Survey of Energy Efficient Network Protocols for Wireless Networks," *Wirel. Netw.*, vol. 7, no. 4, pp. 343–358, 2001.
- [2] M. Liu, J. Cao, Y. Zheng, H. Gong, and X. Wang, "An energy-efficient protocol for data gathering and aggregation in wireless sensor networks," *J. Supercomput.*, vol. 43, no. 2, pp. 107–125, 2008.

[3] F. C. Jiang, D. C. Huang, C. T. Yang, and F. Y. Leu, "Lifetime elongation for wireless sensor network using queue-based approaches," *J. Supercomput.*, vol. 59, no. 3, pp. 1312–1335, 2012.

[4] W. Ye, H. Heidmann, and D. Estrin, "Medium access control with co-ordinated adaptive sleeping for wireless sensor networks," *Ieee/Acm Trans. Netw.*, vol. 12(3), no. January, pp. 493–506, 2004.

[5] E. Shih, S. Cho, F. S. Lee, B. H. Calhoun, and A. Chandrakasan, "Design Considerations for Energy-Efficient Radios in Wireless Microsensor Networks," *J. VLSI Signal Process. Syst. Signal Image. Video Technol.*, vol. 37, no. 1, pp. 77–94, 2004.

[6] D. Gross, J. Shortle, J. Thompson, and C. Harris, *Fundamentals of Queueing Theory, Fourth*. Hoboken, New Jersey: John Wiley & Sons, Inc., 2008.

[7] F.-C. Jiang, D.-C. Huang, C.-T. Yang, C.-H. Lin, and K.-H. Wang, "Design strategy for optimizing power consumption of sensor node with Min(N , T) policy M/G/1 queuing models," *Int. J. Commun. Syst.*, vol. 25, no. 5, pp. 652–671, May 2012.

[8] R. Maheswar, "Power Control Algorithm for Wireless Sensor Networks using N-Policy M / M / 1 Queueing Model," *Int. J. Comput. Sci. Eng.*, vol. 2, no. 7, pp. 2378–2382, 2010.

[9] S. Ghosh and S. Unnikrishnan, "Reduced power consumption in wireless sensor networks using queue based approach," 2017 International Conference on Advances in Computing, Communication and Control (ICAC3), Mumbai, 2017, pp. 1-5. doi: 10.1109/ICAC3.2017.8318794

This page is kept blank intentionally

STBC Based OFDM for M-Ary QAM Modulation Technique

Chandrashekhar K. Beral,
Dwarkadas J.Sanghvi College of Engineering,
Mumbai

V. Venkataramanan
Dwarkadas J.Sanghvi College of Engineering,
Mumbai

Abstract: The STBC based OFDM is used to identify the BER for different Quadrature Amplitude modulation based on space time block coded Orthogonal Frequency Division multiplexing over an AWGN and Rayleigh multipath fading channel. The comparison done with different modulation technique 4QAM,16QAM,64QAM and 128 QAM. The simulation result shown in fig 3,4,5 and 6.

Keyword : OFDM, STBC and QAM different modulation technique.

I. Introduction

The main aim of wireless communication technique is high data rate with high speed and simple decoding and low complexity at receiver. STBC OFDM combine the features of simple linear decoding and less complexity at receiver. Most communication systems employ it. The STBC OFDM system used Alamouti Codeword transmitted through adjacent OFDM symbols over the same OFDM subcarrier so that data is coded through the space and time to improve the data rate and reliability of transmission.

The main aim of this article is to assess the behavior of the STBC-OFDM system under the effect of AWGN and multipath Rayleigh fading channel utilizing different modulation techniques like 4-QAM, 16-QAM, and 64-QAM and 128-QAM. The STBC-OFDM system is accomplished by applying Alamouti's algorithm with (2x2) multiple input multiple output antennas.

Space time block code (STBC)

The very first and well-known STBC is the Alamouti code, which is a complex orthogonal space-time code specialized for the case of two transmit antennas. In this section, we first consider the Alamouti space-time coding technique and then, we go to STBC based OFDM coding.

Alamouti space-time code

A complex orthogonal space-time block code for two transmit antennas was developed by Alamouti. In the Alamouti encoder, two consecutive symbols x_1 and x_2 are encoded with the following space-time codeword matrix:

$$X = \begin{bmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{bmatrix}$$

Alamouti encoded signal is transmitted from the two transmit antennas over two symbol periods. During the first symbol period, two symbols x_1 and x_2 are simultaneously transmitted from the two transmit antennas. During the second symbol period, these symbols are transmitted again, where $-x_2^*$ is transmitted from the first transmit antenna and x_1^* is transmitted from the second transmit antenna. Simultaneously transmitted from the two transmit antennas. During the second symbol period, these symbols are transmitted again, where $-x_2^*$ is transmitted from the first transmit antenna and x_1^* is transmitted from the second transmit antenna.



Fig. 1 - Alamouti encoder

II. STBC-OFDM SYSTEM MODEL

The block diagram of the STBC-OFDM system with (2x2) multiple input multiple output antennas is depicted in Fig. At the transmitter side, the input binary information will be divided into several lower rate sequences via Serial-to-Parallel (S/P) converter. These lower rate sequences are mapped using M-QAM modulation technique. After that, the Alamouti space-time block encoder takes two sequential OFDM symbols, which are in this case X_1 and X_2 , and creates an encoding matrix X where the symbols X_1 and X_2 are planned to be transmitted over two transmit antennas in two sequential transmit time slots. The Alamouti encoding matrix is as follows:

The equation can be explained as follows: At a given symbol period (t), the X_1 is transmitted from the first antenna (Tx_1) and the X_2 is transmitted from the second antenna (Tx_2). During the next symbol period ($t+T$), $-X_2^*$ is transmitted from Tx_1 , and X_1^* is transmitted from antenna Tx_2 . * denotes to complex conjugate process.

After that, the N_f -point of Inverse Fast Fourier Transform (IFFT) is provided to the signals to achieve

the orthogonality between subcarriers. In order to reduce the interference between the adjacent carriers's, several zeros will be inserted in the IFT bins. Finally, the parallel data are passed through Parallel-to- Serial (P/S) converter and transmit to the receiver side over the wireless fading channel. The envelope of the fading channel is assumed to be steady over the two consecutive time slots.

$$\begin{aligned} Y_{11} &= h_{11}x_1 + h_{12}x_2 + z_{11} \\ Y_{12} &= -h_{11}x_2^* + h_{12}x_1^* + z_{12} \\ Y_{21} &= h_{21}x_1 + h_{22}x_2 + z_{21} \\ Y_{22} &= -h_{21}x_2^* + h_{22}x_1^* + z_{22} \end{aligned}$$

In the above equations, Y_{11} and Y_{12} are the received signals at time t and $t+T$, respectively. x_1 and x_2 are the transmitted signals, h_{11} , h_{12} , h_{21} and h_{22} represent the channel impulse responses for Tx_1 and Tx_2 , respectively, while z_{11} , z_{12} , z_{21} and z_{22} are the AWGN at times t and $t+T$, respectively.

At the receiver side the reverse steps of the transmitter processes are employed, an S/P conversion is established and N_f -point FT is performed to achieve the multicarrier demodulation. After that, the output signals of the FT, are passed to the combiner as we gate X_{r1} and X_{r2} where H_1 and H_2 are the estimated channel frequency response. To find the best likely transmitted symbols, the Maximum Likelihood Detector (MLD) will be applied as shown in

$$\text{dis}(X_r, X_i) \leq (X_r, X_j)$$

In the above equation, the $\text{dis}(A, B)$ represents to the Euclidean distance between A and B , using Euclidean distance we calculate the Bit error rate for different modulation technique. M-QAM de-mapping technique is performed to recover the original data, which are converted to the serial form via P/S convertor. Then the BER evaluated for various values of energy per bit to noise power spectral density ratio (E_b / N_o).

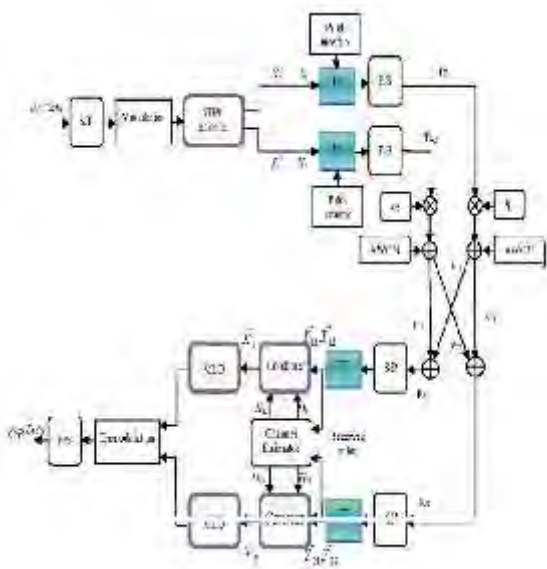


Fig 2. STBC-OFDM System with(2 x2) multiple input multiple output antennas

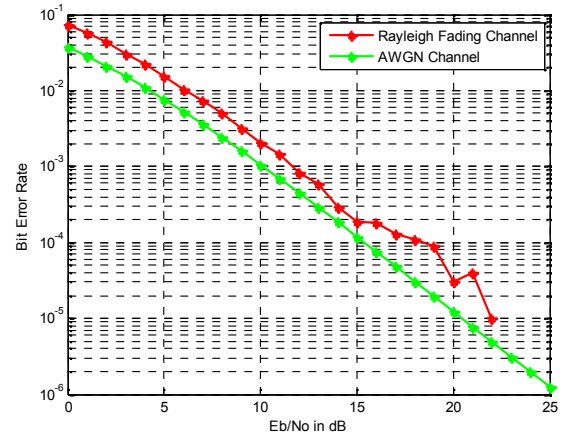


Fig 3 STBC-OFDM System with(2 x2) multiple input multiple output antennas for 128QAM

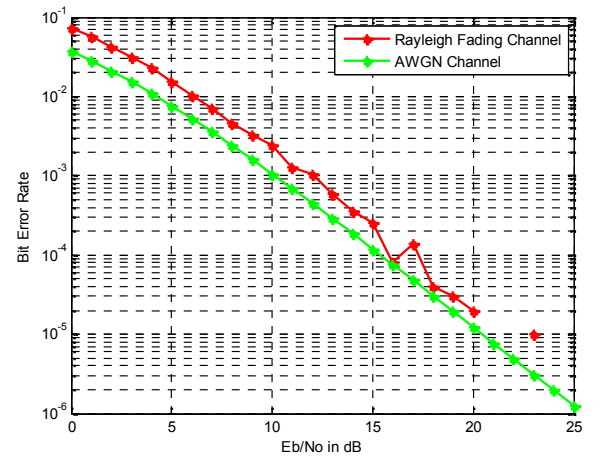


Fig 4 STBC-OFDM System with(2 x2) multiple input multiple output antennas for 64QAM

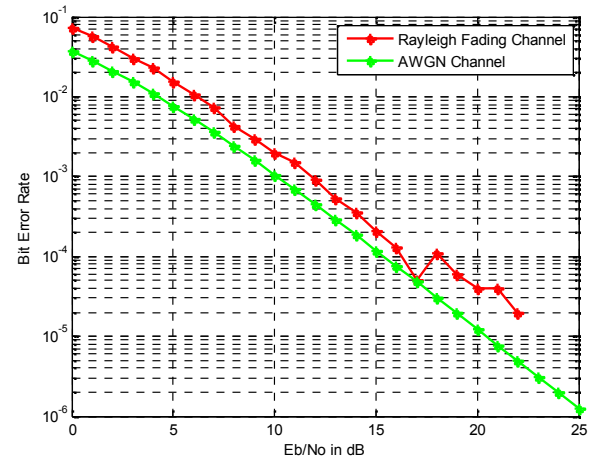


Fig 5 STBC-OFDM System with(2 x2) multiple input multiple output antennas for 16QAM

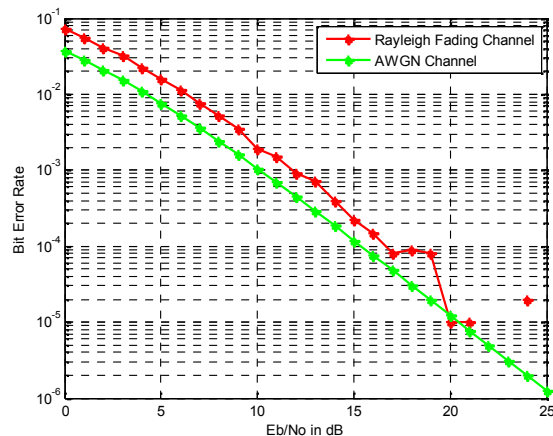


Fig 6. STBC-OFDM System with(2 x2) multiple input multiple output antennas for 4QAM

III. SIMULATION RESULTS

This section compare the performance of different modulation technique and find the BER for different modulation technique .the result shown in graph is for M ary QASK (M=4,16,64,128) under different channel models AWGN and multipath Rayleigh fading .Figs. (3, 4, 5 and 6) depict the BER performance of STBC OFDM system using M-QAM of 4, 16, 64 and 128 constellation points respectively, under AWGN channel and multipath Rayleigh fading [11].

IV. CONCLUSION

In this paper, the performance comparison of STBC-OFDM system using M-QAM modulation techniques with various numbers of constellation points was investigated. The performance of system was simulated and compared under AWDN and multipath rayleigh fading channel.

REFERENCES

- [1] J. Wang, O. Y. Wen, S. Li, and R. S.-K. Cheng, "Capacity of alamouti coded OFDM systems in time-varying multipath rayleigh fading channels," in Vehicular Technology Conference, 2006. VTC 2006-Spring. IEEE 63rd, 2006, pp. 1923-1927.
- [2] G. Manik, A. Kalra, and S. Kalra, "Performance Analysis of STBCOFDM System Under Multipath Fading Channel," International Journal of Soft Computing and Engineering, vol. 1, pp. 87-90, 2012.
- [3] S. M. Alamouti, "A simple transmit diversity technique for wireless communications," Selected Areas in Communications, IEEE Journal on, vol. 16, pp. 1451-1458, 1998.
- [4] N. Kaur and E. N. Gupta, "OFDM-STBC Based Transceiver for WiMAX 802.16e International Journal of Innovative Research in Computer and

Communication Engineering, vol.3, pp. 4284-4289 Issue 5, 2015

- [5] L. Yazhen and G. Jing, "Space-time block coded for the OFDM system," in 2012 2nd International Conference on Consumer Electronics, Communications and Networks (CECNet), 2012.
- [6] K. S. Dhore and Prof.S.G.Hate, "Performance Enhancement of MIMO OFDM Using STBC," SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE) ,Vol. 2, pp. 64-68, Issue 6– June 2015.
- [7] G. Manasra, O. Najajri, H. A. Arram, and S. Rabah, "Multicarrier QAM Modulation Based on Discrete Wavelet Transform Using Wireless MIMO System," in Information and Communication Technology (PICICT), 2013 Palestinian International Conference on, 2013, pp. 77- 82.
- [8] S.R. Chaudhary and K. R. Jadhav, "PERFORMANCE ANALYSIS OF STBC-MIMO OFDM SYSTEM WITH DWT & FFT," International Journal of Technical Research and Applications (IJTRA), Vol. 3, Issue 5 (September-October, 2015), PP. 227-232.
- [9] S. Sharma and S. Kumar, "BER Performance Evaluation of FFT-OFDM and DWT-OFDM," International Journal of Network and Mobile Technologies, vol. 2, pp. 110-116, 2011.
- [10] A. A. Alansari, "MIMO-OFDM System Performance Analysis Based on DWT," International Journal of Advanced Science and Engineering Technology On line ISSN. 2225-9686, vol. 3, pp. 214-220, 2013.
- [11] "Mimo-Ofdm Wireless Communications With Matlab ", IEEE Press - Yong Soo Cho Chung-Ang University, Jaekwon Kim Yonsei University, Won Young Yang, Chung-Ang University, Chung G. Kang, Korea University, Republic of Korea.

This page is kept blank intentionally

Design And Deployment Of Ethernet Master And Performance Evaluation

Chinmay Kargutkar
Dwarkanadas J. Sanghvi
College of Engineering,
Mumbai 56

Meet Gopani
Dwarkanadas J. Sanghvi
College of Engineering,
Mumbai 56

Pavan Borra
Dwarkanadas J. Sanghvi
College of Engineering,
Mumbai 56

Chandrashekhar K. Beral
Dwarkanadas J. Sanghvi
College of Engineering,
Mumbai 56

Abstract- Ethernet for Control Automation Technology (EtherCAT) - is an open source, relatively high-speed Fieldbus system based on Ethernet basics. The motivation for EtherCAT development was to improve Ethernet capabilities so that it can be applied to automation applications which require real-time operations and low component costs. This paper presents the performance analysis in light of its performance time and timing jitter of a PC-based real-time EtherCAT Master using the fully pre-emptive RT Linux kernel and also a proposed solution for implementation of a standalone EtherCAT Slave Module.

Keywords – EtherCAT, Fieldbus, realtime bus, automation.

I Introduction

Nowadays, the popularity of Ethernet based field bus system as the standard for communication in the fields of automation and control technology is radically increasing worldwide[1], [2]. Ethernet has already established itself as a command-level technology for both factory networking and inter-control communication. After adaptation of the Field bus standard Ethernet-based network simplifies, thoroughly reduces wires, and makes maintenance and debugging of the overall system as convenient as possible[1], [2]. Moreover, the move towards Ethernet as the basic communication platform is also based on the excellent price over performance relationship of the technology. However, Ethernet is not optimized to send relatively short messages and also requires microprocessors/microcontrollers at every node that entirely slows down the whole system. In comparison with other field buses, it could not achieve typical automation requirements regarding performance and being deterministic at higher data-rates. Some applications require real-time performance that is vital in controlling intelligent and dynamic systems. Real-time Ethernet protocols have been developed to ensure determinism over standard Ethernet such as EtherNet/IP, PROFINET, and EtherCAT. EtherCAT (Ethernet for Control Automation) is a RT (Real Time) Ethernet protocol that is gaining popularity in factory automation and

process control systems [3], [4]. It offers various appealing features such as higher performance usage of the Ethernet bandwidth for data transfers, more flexible topology and lower costs compared to the other Ethernet Field bus technologies. At present, the most generic EtherCAT system uses a structured environment that provides top quality, high performance, and technical support on high-end hardware system [1]. In addition to this, another important factor is the cost of acquisition and maintenance where a single unit can be considered expensive, bulky, and not fully optimized for its purpose.

II. BASIC PRINCIPLE OF ETHERCAT

EtherCAT is a highly flexible Ethernet network protocol that is developing rapidly and growing at an even faster clip. A unique principle called “processing on the fly” specific to EtherCAT gives it a handful of advantages [1]. Because EtherCAT messages are passed before being processed in each node, EtherCAT operates at a high speed and efficiency. The process also creates flexibility in topology and provides incredible synchronization. Outside of the advantages gained from “processing on the fly,” EtherCAT benefits from its simple infrastructure. EtherCAT includes, among other things, a safety protocol and multiple device profiles. EtherCAT also benefits from a strong users group. The combination of such benefits means that EtherCAT is poised for continues growth. The fundamental principle of EtherCAT is pass-through reading. Pass-through reading means that messages are not dedicated for a single node and consumed by that node[1]. Instead, the messages are transmitted to the following node in a string format as they are processed. Input data to a node is read as the message is processed and output data is inserted in the message to the next node. A single message is issued by the EtherCAT Master with data for all nodes. As the message is transmitted around the ring and back towards the Master, each node reads its inputs and concatenates its outputs to the message frame. When the messages arrive back at the EtherCAT Master

every node in the network has received a new input data from the Master and returned a new output data to the Master. Without the deficiency of small payloads or messages targeted to specific nodes, an EtherCAT network can achieve maximum bandwidth utilization. An EtherCAT network can be compared to a railway where each station can off-load and re-load packages at every station while the train moves through the station. EtherCAT uses the standard IEEE 802.3 physical layer [2]. No special hardware is required to implement an EtherCAT network. External switches are not used in an EtherCAT network. Instead, each EtherCAT device embeds a switch. Each device has two RJ45 ports. One RJ45 is connected to the previous node in the network, which acts as the input and one is connected to the next node, which acts as the output [1], [2]. Somewhat unique trait to EtherCAT is the concept of self-terminating networks. Any node that does not detect the next node in the channel automatically terminates the network at that point. Terminating nodes copy messages from the Master's transmit path to the Masters receive path, that is they simply echo it across its input-output port [1], [3]. EtherCAT networks can be wired in a ring if the Master has two Ethernet ports. Networks wired in a ring provide a measure of redundancy. If the Cable breaks anywhere in the ring are closed by the ports upstream and downstream of the break. The Master can detect the break and send messages out to both of the new sub-segments.

III. IMPLEMENTATION OF ETHERCAT MASTER

The EtherCAT Master minimal systems requires an embedded platform for deployment of the EtherCAT software on a supported OS [5]. Fig. 1 shows the specification of the PC system used for implementation of the EtherCAT Master.

List	Specification
CPU	Intel® Pentium(R) N3540 @2.16GHz x4
RAM	4.00 GB
HDD	100 GB
OS	Debian GNU/Linux 9(Stretch) 64-bit
Kernel	4.9.0-8-RT AMD64

Fig. 1. Hardware Specification of Master System

The EtherCAT Master requires Real-Time computing for clock synchronization so the RT 4.9.0 patch was used with the Linux OS [5], [6]. Open Source kernel module, EtherLAB was used to make all the systems work in harmony. EtherLAB works as a Real Time kernel module attached to the open source operating system Linux communicating with peripheral devices

by a special Ethernet technology, known as EtherCAT [6]. Using the IgH Master, the Linux PC can act as the EtherCAT master [6], [7], [8]. The next question which arises is why integrate the EtherCAT master into a Linux Kernel. This question can be answered based on the two answers as stated below: - Kernel code has significantly better real-time characteristics, i.e. less latency than user-space code. Cyclic work is usually triggered by timer interrupts inside the kernel. The execution delay of a function that processes timer interrupts is less when it resides in kernel-space because there is no need for time-consuming context switches to a user-space process. The master code has to directly communicate with the Ethernet hardware. This has to be done in the kernel through network device drivers, which is one more reason for the master code being in kernel-space. Fig. 2. gives a general overview of the master architecture.

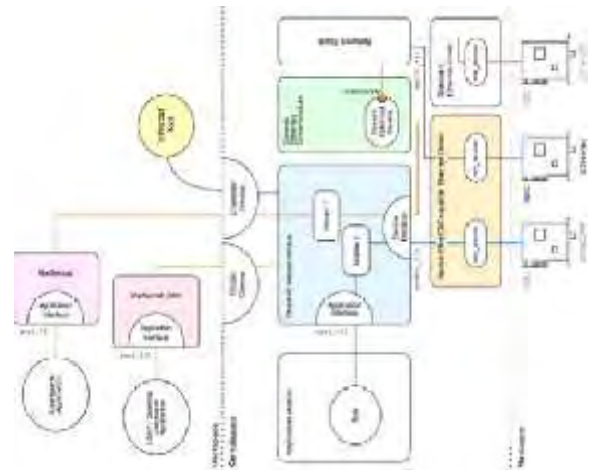


Fig. 2. Overview of Master Architecture

The master environment comprises of three basic components: "Master Module", the "Device Interface" and the "Application Interface"[6]. Master Modules-- Kernel module containing one or more EtherCAT master instances. Device Modules-- EtherCATcapable Ethernet device driver modules that offer their devices to the EtherCAT master via the device interface. These modified network drivers are capable of handling network devices used for EtherCAT operation and normal Ethernet devices in parallel. A master can then authenticate a certain device and then is able to send and receive EtherCAT frames. Application-- A program that uses the EtherCAT master (usually for the cyclic exchange of process data with EtherCAT slaves). These programs are not part of the EtherCAT master code but have to be generated or written by the user. An application can request a master through the application interface. If this succeeds, it has control over the master: It can

provide a bus configuration and also exchange process data.

A. Master Phases

Every EtherCAT master provided by the master module runs through several phases namely "Orphaned Phase", "Idle Phase" and "Operation Phase". Orphaned phase- This mode takes effect when the master still waits for its Ethernet device(s) to connect. No bus communication is possible until then. Idle phase- This mode takes effect when the master has accepted all required Ethernet devices but is not requested by any application yet. The master runs its state machine that automatically scans the bus for any slave devices and executes pending operations from the user-space interface if any. The command-line tool can be used to access the bus, but there is no process data exchange because of the missing bus configuration. Operation phase- The master is requested by an application that can provide a bus configuration and exchange process data.

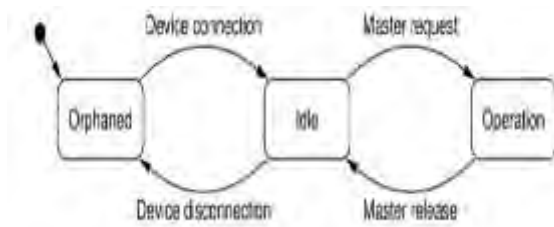


Fig. 4. Master Phases and Transitions

B. Master Configuration

The bus configuration is supplied via the application interface. Fig. 3 gives an overview of the objects that can be configured by the application.

C. Slave Configuration

The application has to tell the master about the expected bus topology. This can be done by creating a "slave configurations" file. A slave configuration can be seen as an expected slave. When a slave configuration is created, the application provides the bus position, vendor id, and product code. When the bus configuration is applied, the master checks, if there is a slave with the given vendor id and product code at the given position. If this condition is satisfied, the slave configuration is "attached" to the real slave on the bus and the slave is configured according to the settings provided by the application. The state of a slave configuration can be queried by either using the application interface or via the command line tool.

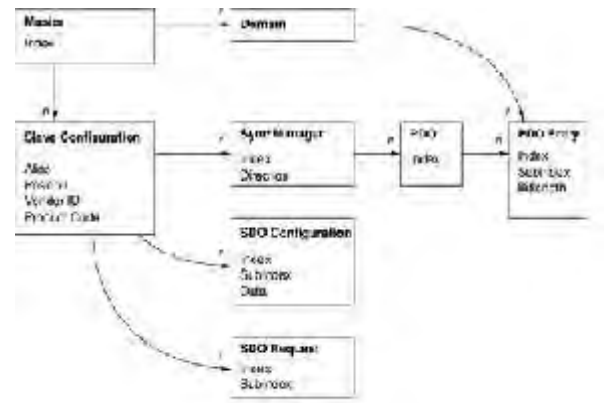


Fig. 3. Master Configuration

D. Cyclic Operation

To enter the cyclic operation mode, the master has to be "activated" to calculate the process data image and apply the bus configuration for the first time. After activation, the application is in charge to send and receive frames. The configuration cannot be changed after activation. Shown below in Fig.4 is the pseudo-code for the cyclic task function for the experiment to be conducted.

```

Create Cyclic Task(set period of the task)
while(1)
    read start time;
    collect data from slave;
    process data and initialize commands;
    send commands back to slave;
    sleep for remaining period;
    read end time;
    calculate jitter;
end
  
```

Fig. 4. Pseudo-code of Master Cyclic task

IV. IMPLEMENTATION OF THE ETHERCAT SLAVE MODULE

The ESM (EtherCAT Slave Module) hardware design can be divided into three parts: physical layer interfaces, data link layer ESC (EtherCAT Slave Controller) circuit and the application layer microprocessor control circuit [10]. The physical layer hardware includes the MII (RJ-45) interface. The data link layer hardware design includes EEPROM circuit, clock source circuit and LAN9252 (ESC) [10],[11]. The application layer hardware design includes STM32F103 microcontroller minimum system, input/output circuit, ESD (Electrostatic Discharge) protection, and clock/timing

circuit [10], [12]. The overall hardware structure of the ESM module is as below in Fig.5.

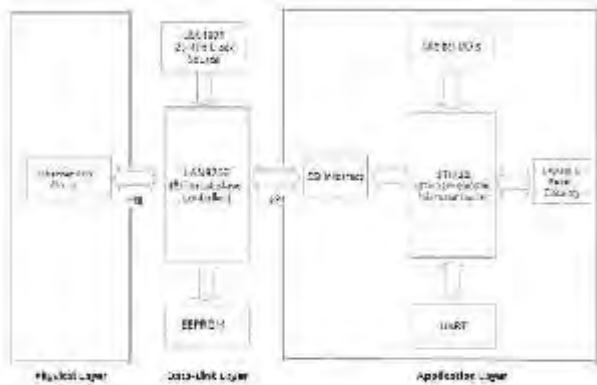


Fig. 5. Hardware Structure of the EtherCAT Slave Module

Software designs for communication and application of the ESM consist of two parts. They are XML (Extensible Markup Language) configuration files, which describes the ESM slave module and drive program files for the ESM slave module [10]. There are two problems which are seen when configuring an ESM device. The first one is the design of XML file. In order to identify ESM module hardware that connected to the master station, it is necessary to describe the system hardware and configure the corresponding register. The device description file of the EtherCAT system is generated by the XML file format. It is generated analytically by the configuration tool offline, and then, online loaded by EtherCAT master. Configuration tool converts device description file into a binary file and updates to EEPROM of the slave. -Another difficulty is the design of the application layer program. It is to edit the program downloaded to Microcontroller, which is for network process data reading and writing in the data link layer, slave controller managing, state machine processing, and the distribution clock.

V. EXPERIMENT AND RESULTS

For this study, we constructed an EtherCAT system with the controller based on the embedded EtherCAT Master discussed in the previous section, a slave operated using the CANopen protocol. The complexities associated with the XML configuration file and its setup made us look for an alternative [10]. A similar ESM hardware developed for Arduino by AB&T Technologies was used. The EasyCAT shield which allows an Arduino board to be used as an ESM is shown in Fig.6[13]. The EasyCAT Shield uses the 3x2 SPI(Serial Peripheral Interface) connector to communicate with the microcontroller. This connector is standard on all the Arduino boards. The Shield EasyCAT allows exchanging on the bus EtherCAT 32 byte in input and 32 bytes in output, configurable up to 128 bytes. The

communication is totally managed in Hardware and the exchange of data with the sketch Arduino is made through a library furnished with the EasyCAT together with the file XML EtherCAT Configuration File (ESI-EtherCAT Slave Information)



Fig 6. EasyCAT Shield + Arduino UNO

The Master was configured on the hardware setup as specified in Fig.1, to establish a link connection with a single Slave and on successful target identification, the Master was suspended to perform its cyclic task wherein an RT-Thread was allocated to the Master which used to cyclically transfer data. The Master thread was also allotted an isolated core for optimum performance. Also, the task thread was given the highest priority along with the core affinity set to the isolated core.



Fig. 7.a. Histogram for a cyclic task of 10ms

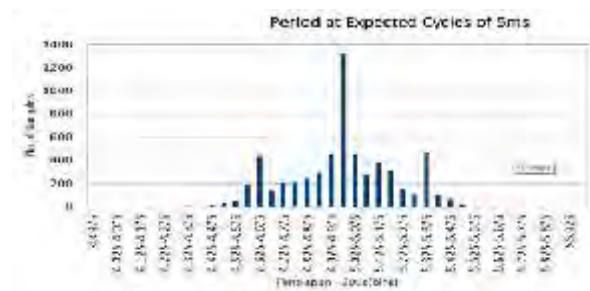


Fig. 7.b. Histogram for a cyclic task of 5ms

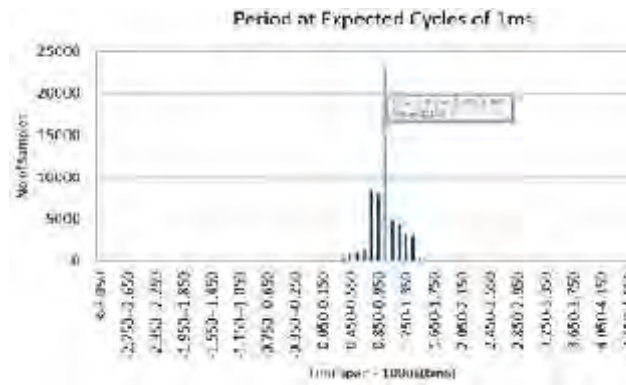


Fig. 7.c. Histogram for a cyclic task of 1ms

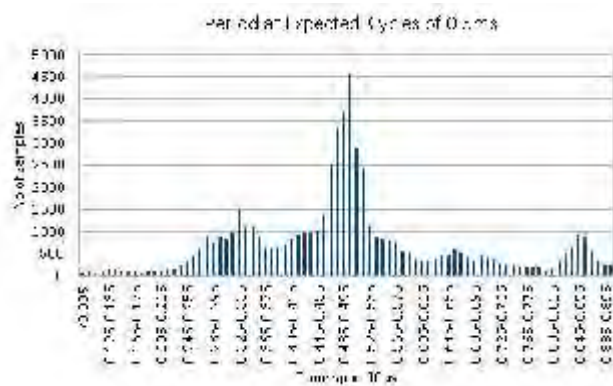


Fig. 7.d. Histogram for a cyclic task of 500us

The experiment is performed for varying expected cycle periods of cyclic task as shown by the distribution plot in Fig7. For each task with an expected cycle time of 10 ms, 5 ms, 1ms, and 0.5 ms respectively, test metrics for jitter in the cyclic tasks were collected. Each set of experiment was performed for one minute each and the samples were stored in bins of different spans and histograms for the set was plotted. As seen by the experiment results, the average actual period in all expected cycle time was able to meet the corresponding target. The highest average jitter is found in the task running at 0.5 ms expected cycle. Based on the results the most optimized period for EtherCAT cyclic task on the existing hardware is 1ms. Moreover, the experiment was operated using the generic driver that comes with the IgH EtherCAT Master in user space. The lesser end-to-end delay could be accomplished if a native driver is implemented.

VI. CONCLUSION

In this paper, an EtherCAT Master was implemented on a PC based upon a Pentium 4-core processor. Performance analysis was conducted on the system in terms of periodicity and jitter. The open-source EtherCAT Master, IgH Master was used in the Linux environment with a Pre-Emptive RT stack loaded on the kernel. Using the developed master, experiments

were conducted in various expected cycle time to test its performance with a single slave. For the existing Master hardware best performance at higher speeds was seen at 1ms period which had less jitter, also the master hardware had several drawbacks which required for us to isolate certain cores for a single task. System Priorities on such devices add up to the total latency in the system thereby decreasing the performance. In our future research, we will extend our analysis by developing hardware specifically designed to implement the master device. The hardware will be developed around an embedded board which supports embedded Linux.

VII. REFERENCES

- [1] EtherCAT- The Ethernet field Bus https://www.ethercat.org/pdf/english/ETG_Brochure_EN.pdf
- [2] Yongming Chen, Hua Chen, Mingzhong Zhang, "The Relevant Research of CoE Protocol in EtherCAT Industrial Ethernet" Xiamen University, Xiamen, P.R. China. DOI: 10.1109/ICICISYS.2010.5658844
- [3] EtherCAT Technology Group <https://www.ethercat.org>
- [4] CANopen DS301 Technical Documentation <http://download.gongkong.com/file/company/1>
- [5] EtherCAT Development guide for Linux <http://www.ericl.wilkinson.com/blog/2015/5/31/ethercat-development-guide-for-linux>
- [6] EtherLAB introduction <http://www.etherlab.org/en/ethercat/>
- [7] IgH Master <https://www.etherlab.org/download/ethercat/igh-ethercat-master-1.1.pdf>
- [8] Linux Repository IgH Master <https://github.com/sittner/ec-debianize>
- [9] EtherCAT Master Documentation <http://www.etherlab.org/download/ethercat/ethercat-1.5.2.pdf> [10] EtherCAT Slave Implementation Guide https://www.ethercat.org/en/downloads/downloads_7BA2567EB9F443219AD0014448F674F2.htm
- [11] LAN9252 EtherCAT Slave Controller <https://www.microchip.com/wwwproducts/en/LAN9252>

12] STM32f1038tc Datasheet

<https://www.st.com/en/microcontrollers/stm32f103c8.html>

[13]EasyCAT Shield

<https://www.bausano.net/en/hardware/ethercat-e-arduino/easycat.html>

Python- A language for an Embedded System

Mrs. Leena Chakraborty
Thakur College of
Engineering &
Technology, Mumbai,
India.
leena.chakraborty@thakure
ducation.org

Ms. Jalpaben Pandya
Thakur College of
Engineering &
Technology, Mumbai,
India.
pandyajalpa7@gmail.com

Mrs. Roohi Mehta
Thakur College of
Engineering &
Technology, Mumbai,
India.
riteshroohi@gmail.com

Abstract - Embedded system is an electronic system which is designed to perform one or limited set of functions using hardware and software. embedded systems are present everywhere right from mobile phones, smart cards to biometric systems. Embedded C is the programming language currently being used for embedded systems. Python has emerged as the new programming language for embedded systems due to its advantages such as writability, error reduction, and readability. All Python releases are open source and freely usable and distributable, even for commercial projects. In this paper we have designed a embedded system with Python.

Keywords –Embedded System, Python, Raspberry Pi

I. INTRODUCTION

An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, store and also control the data in various electronics-based systems. In a simplest and most general form, an embedded system consists of a processor, sensors, actuators and memory. The idea is that any application should be able to provide solution to a real-world problem, for which some data is definitely to be read in. For this, sensors are needed. This data is processed by the processor and the result of it is given to actuators which perform appropriate actions. Frequently, an embedded system is a component within some larger system. For example, modern cars and trucks contain many embedded systems.

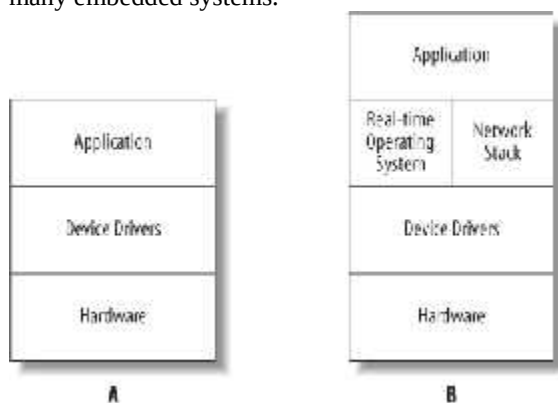


Fig. 1. (A) Basic embedded software diagram and (B) a more complex embedded software diagram

Programming Languages for Embedded Systems:

- C/C++ According to a 2016 survey by IEEE Spectrum, C and C++ took the top two spots for being the most popular and used programming languages in embedded systems. ...
- Rust. Just as C++ is to C, Rust is to C++. ...
- Python. ...
- VHDL and Verilog. ...
- Online Resources.

One of the few constants across most embedded systems is the use of the C programming language. More than any other, C has become the language of embedded programmers. This has not always been the case, and it will not continue to be so forever. However, at this time, C is the closest thing there is to a standard in the embedded world. The C programming language has plenty of advantages. It is small and fairly simple to learn, compilers are available for almost every processor in use today, and there is a very large body of experienced C programmers. In addition, C has the benefit of processor-independence. Of course, C is not the only language used by embedded programmers. Where as Python is a general purpose, multi-programming paradigm language which focuses on readability and writability, eliminating as much unnecessary writing as possible for straightforward code.

Out of the box, Python might not be as useful for embedded programming as C or C++, but with numerous libraries available, it's easy to implement features that make it just as useful. It is excellent for automating testing, and collecting and analyzing data [1].

Python might be at its strongest when used as a communication middleman between the user and the embedded system they're working with. Python can also be used to receive embedded system data that can be stored for analysis. Programmers can then use Python to develop parameters and other methods of analyzing that data.

We have designed embedded system –smart mirror using Python as a programming language.

II. PROPOSED SYSTEM



Fig. 2 Proposed system

The proposed system is to design an interactive futuristic smart mirror with artificial intelligence using Raspberry Pi. In the proposed system, the ability of the system to recognize face and provide details of the same, incorporates the theory of artificial intelligence. Interactive computing, with wirelessly connected embedded devices that are being used in various day-to-day activities. Based on this technology, many devices/products are now emerging and with this intelligence it is providing comfortable, secure and convenient personal services everywhere. The project aims at creating a smart system for users where it detects face using Python. The mirror will recognize user's face and it will be processed using Raspberry Pi and display user's feeds. User's image will be stored in database.

III. COMPONENTS REQUIRED

The Smart Mirror makes use of hardware components and software applications to display information: Hardware Components.

1. Raspberry Pi: A Raspberry Pi is a credit card-sized computer originally designed for education, inspired by the 1981 BBC Micro. Creator Eben Upton's goal was to create a low-cost device that would improve programming skills and hardware understanding at the pre-university level[2]. But thanks to its small size and accessible price, it was quickly adopted by tinkerers, makers, and electronics enthusiasts for projects that require more than a basic microcontroller[3].



Fig. 3 Raspberry Pi

2. Mirror: A special mirror known as a two way mirror or observation mirror is used in this project. A two mirror is special as compared to an ordinary household mirror. Unlike a household mirror, the two way mirror is not painted with an opaque color on the back, instead its left untouched. This gives the property of the mirror being reflective one side and transparent/translucent from the other. Hence the two way mirror acts as mirror as long as there is no light send from the back of mirror.

Software and Tools

1. Raspbian OS Raspbian is a free operating system optimized for the Raspberry Pi hardware. Raspbian comes with over 35,000 packages, pre-defined functions which helps in easy installation on a Raspberry Pi computer.

2. Python Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python's elegant syntax makes it an ideal language for scripting and rapid application development in many areas on most platforms.

IV. IMPLEMENTATION

The Smart Mirror interface is designed and implemented such that only when an authorized user appears in front of the mirror only then his/her customized data is displayed after proper authentication. The load cell integrated stool plays a major role in authenticating the smart mirror. Only when the weight sensed by the load cell is same as the weight stored in the health database the updates are retrieved from the internet and displayed[4].

Initially the mirror will be in sleep mode acting like a normal mirror reflecting. The mirror is designed such that it can be accessed only by two users. When the user 1 presses the button his/her respective schedule from the google calendar can be retrieved and is displayed on the mirror. The load cell senses the weight of a person which after processed by the Raspberry Pi can be uploaded to cloud later this data can be displayed on the mirror via the Wi-Fi module.



Fig. 4 Hardware design of the system

V. RESULT



Fig. 5 Smart Mirror Result

Smart Mirror displays applications so that we can check the weather, local news, etc while getting ready in the morning. It is also modular so we can easily move it around or hang it on the wall as we like.

VI. CONCLUSION

We have designed a smart mirror keeping in mind the upcoming future advancements in the field of IoT. The prototype of the mirror is powered and controlled by the Raspberry Pi 3 and all the final output in the form of real time data feeds are displayed on screen. In future work, we can add advanced gesture controls, automated salutation using face recognition of the end user.

REFERENCES

- [1] Python Essential Reference (4th Edition), David M Beazley
- [2] Programming the Raspberry Pi, Second Edition: Getting Started with Python
- [3] www.raspberrypi.org
- [4] hackers shack

This page is kept blank intentionally

Machine Learning Applications in Medical Image Analysis

Shital Patil
Research Scholar, EE,VJTI MUMBAI
spatilp17@ee.vjti.ac.in

Surendra Bhosale
Associate Professor, EE,VJTI MUMBAI
sjbhosale@ee.vjti.ac.in

Abstract - Machine learning has a vital role in Image Analysis and Computer Vision field. Problems ranging from image segmentation, image registration to structure-from-motion, object recognition and scene understanding use machine learning techniques to analyze information from visual data.

The medical image analysis is growing field of deep learning. DL techniques and their applications to medical image analysis includes standard ML techniques in the computer vision field, ML models in deep learning and applications to medical image analysis. One of the most recently use of ML in computer aided diagnosis and medical image analysis is the classification of objects such as lesions into certain classes based on input features like contrast, area obtained from segmented objects. Artificial neural network conceptually inspired by neural systems.

The important deep-learning techniques including the Neocognitron, CNNs, neural filters. ML with image input including deep learning is a useful technology with higher performance. The deep learning will become the mainstream technology in medical image analysis in upcoming decades.

Keywords - Convolutional neural networks (CNNs), ANN, Medical image analysis, Machine learning, Deep Learning.

I..INTRODUCTION

Machine learning techniques are widely used in medical imaging research field as successful classifier and clustering algorithms [1]. The Best classifiers used are support vector machine and clustering algorithms, such as k-nearest neighbor (k- NN) [3]. Now a days deep learning (DL) has come into the picture as the methodology to effectively improve the performance of existing machine learning techniques. Next, Deep learning is a generic methodology that has a disruptive impact in other scientific fields as well. Therefore, it has become imperative for medical imaging researchers to fully embrace Deep Learning technology. Medical image processing refers to a set of procedures so as to get clinically meaningful information from various imaging modalities, commonly for diagnosis or prognosis. The modalities are typically in vivo types. The extracted information/data could be used further to enhance

diagnosis and prognosis according to the need of patient's.

The main comparison between Machine learning with image input including "deep learning" and Machine learning with feature input is the direct use of pixel values with machine learning model. Machine Learning algorithms have the capability to be invested deeply in vast area of medicine right from discovery of drugs to clinical decision making, significantly altering the way medicine is practiced. The success of machine learning algorithms at computer vision tasks in recent years comes at time when medical records are increasingly digitalized. Therefore, it is ideal for medical image analysis to be carried out by an automated, accurate and efficient machine learning algorithm. Deep learning has got great interest in almost each and every field and especially in medical image analysis and it is expected that it will hold \$300 million medical imaging market by 2021. Therefore, by 2021, it will get more investment for medical imaging than the entire analysis industry spent in 2016. It is the most effective and supervised machine learning approach. This approach use models of deep neural network which is variation of Neural Network but with large approximation to human brain using advance mechanism as compare to simple neural network. The term deep learning implies the use of a deep neural network model. The basic computational unit in a neural network is the neuron, a concept inspired by the study of the human brain, which takes multiple signals as inputs, combines them linearly using weights, and then passes the combined signals through nonlinear operations to generate output signals.

Machine Learning (ML) and Artificial Intelligence (AI) have progressed rapidly in recent few years. ML and AI have played important role in medical field like medical image processing, computer-aided diagnosis, image interpretation, image fusion, image registration, image segmentation, image retrieval and analysis. ML extracts information from the images and represents information effectively and efficiently. The ML and AI together can diagnose and predict accurate and faster the risk of diseases and prevent them in time. These techniques enhance the abilities of doctors and researchers to

understand that how to analyze the generic variations which will lead to disease. These techniques composed of conventional algorithms without learning like Support Vector Machine (SVM), Neural Network (NN), KNN etc. and deep learning algorithms such as Convolutional Neural Network (CNN), Recurrent neural Network (RNN), Long Short term Memory, Extreme Learning Model etc.

A. Medical Imaging Types:

Medical Imaging is the use of imaging modalities and processes to get pictures of the human body, which can assist diagnosis and treatment of patients. It can also be used to track any ongoing issues, and can therefore help with treatment plans. There are many different types of medical imaging techniques, which use different technologies to produce images for different purposes. Here the most common imaging techniques uses AI in radiology indicates how these techniques, mixed with AI, will direct the way for more accurate imaging.

Various medical imaging modalities and digital medical images incorporates as magnetic resonance imaging (MRI), computed tomography (CT), X-ray Computed Tomography and positron emission tomography (PET), Single Photon Emission Computed Tomography (SPECT) etc could provide specific information for the patient being imaged. Research in medical image processing mainly targets to extract important features that might be difficult to assess with the naked eye.

A histology slide is an image file of a few megabytes while a single MRI may be a few hundred megabytes. This has technical implications on the way the data is pre-processed, and on the design of an algorithm's architecture, in the context of processor and memory limitations.

B. History of medical image analysis:

Initially, medical image analysis was done using sequential application of low level pixel processing and mathematical modeling to construct a rule-based system that could solve only specific task. Similarly there were some rules, likely in the area of Artificial Intelligence commonly known as GOFAI (Good Old Fashioned Artificial Intelligence) agent[3].

At the end of 1990s, supervised techniques were becoming more popular where training data was used to train models and they were becoming increasingly popular in medical image analysis field. Examples may involves active shape model, atlas method. This pattern recognition and machine learning is more popular with the introduction of some innovative ideas. Therefore, Change in shift from systems that were designed by humans to systems that are trained by computers based on example data.

Machine learning includes constructing data-driven models to solve research problems [5]. There are two basic categories of ML as supervised learning and un-supervised learning. In supervised learning, The training data consist of a set of training examples

and each example is a pair consisting of an input object and a desired output value. Supervised machine learning systems provide

the learning algorithms with known quantities to support future judgments. we train the models using input data with matched labels [6]. The model is a mathematical model that can associate input data with the matched labels and a predictive model, which is validated using unseen test data. In Unsupervised Learning is a class of Machine Learning techniques to find the patterns in data. The data

given to unsupervised algorithm are not labeled, which means only the input variables(X) are given with no corresponding output variables.

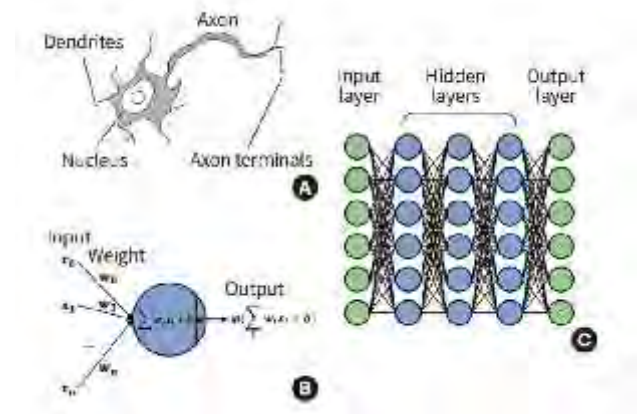


Figure 1: Artificial neural network. (A) A neuron, transforms the inputs from the dendrites into electric signals. (B) In a node, the input values are transformed by the weights, biases, and activation functions. The output values are transmitted to the next perceptron. (C) Multilayer perceptron consists of multiple perceptrons.

ANN is a statistical method inspired by brain mechanism from neuroscience as shown in figure 1 [7]. A typical neuron is the basic unit of the very important brain system. The neuron is an electrically excitable cell that receives signals from other neurons, it processes the received information, and transmits electrical signals to other neurons. The input signal to a given neuron needs to exceed a certain threshold for it be activated and further transmit a signal. The neurons are interconnected to each other and forms a network that collectively steers the brain mechanism. ANN is an abstraction of an interconnected network of neurons with layers of nodes, and it consists of an input layer aggregating the input signal from other connected neurons, a hidden layer responsible for training and an output layer [8]. Each node takes the input from nodes from the previous layer using various weights and computes the activation function, which is relayed onto the next layer of nodes. The activation function approximates the

complex process of a physical neuron, which regulates the strength of the neuronal output in a non-linear manner. The mathematical processing in a node can be represented using the following equation:

$$\text{Output} = \varphi(W^T x + b).$$

A node takes an input value 'x' and multiplies it by weight 'W,' and then a bias of 'b' is added, which is fed to the activation function 'φ.'

The losses are back-propagated through the network, and they are used to modify the weights and biases [6].

C. Deep Learning in Image analysis :

The accurate and most useful type of models for analysis of images till date are Convolutional Neural Networks as shown in figure 2. A single CNN model has many layers which work on identifying edges and normal features on shallower layers and more deep features in deeper layers. An image is convolved with filters and after that pooling is applied, this process may be applied for some layers and at last recognizable features are extracted..

Introduction of GPUs have favored the research in this field and since the introduction of challenge, a sudden rapid growth in development of such models may be seen.

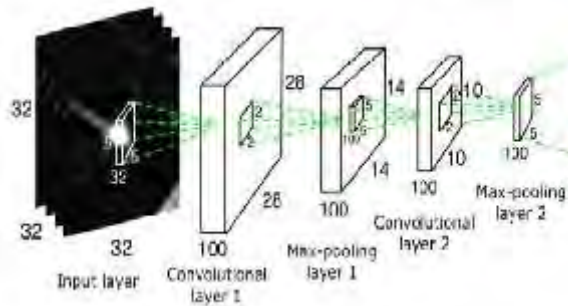


Figure 2 : Illustration of CNN (Convolutional Neural Network)

The medical image analysis community has taken notice of these pivotal developments. However, transition from systems that used handcrafted features to systems that learn features from data itself has been gradual.

D.Organization :

The aim of this paper is to provide an overview on the state of machine learning algorithms as applied to medical imaging, with an emphasis that will most useful to the doctors, clinicians and provide more impact in medical science and patient healthcare system.

In Section I, It describes various machine learning architectures used in medical image analysis, with an emphasis on CNNs. Machine learning is broadly classified into Supervised, Unsupervised, Semi-supervised and Reinforcement learning methods; it is the first two which are currently most applicable to image analysis. Section III dives into different application areas. Section IV gives conclusion

with obstacles that the field of medical image analysis faces, and some of the future possible directions.

II. MACHINE LEARNING ARCHITECTURES

Supervised learning models:

1) Convolutional neural networks:

a)Convolution Layer: A convolution is defined as an operation on two functions. In image analysis, one function consists of input values (e.g. pixel values) at a position in the image, and the second function is a filter (kernel) each can be represented as array of numbers.

Convolution indicates ideas intrinsic to perform computationally efficient machine learning with sparse connections, parameter sharing [8]. Few neural networks where each input neuron is connected to every output neuron in the subsequent layer, CNN neurons have sparse connections, means only few inputs are connected to the succeeding next layer.

The convolution operation is defined by the * symbol. An output s(t) is defined below when input I(t) is convolved with a filter or kernel K(a)

$$s(t) = (I * K)(t). \quad (1)$$

Now if t can only take integer values,

then discretized convolution can be expressed as,

$$s(t) = \sum I(a) \cdot K(t-a) \quad (2)$$

The equation (2) assumes a one- dimensional convolutional operation. Two dimensional convolution operation

with input I (m, n) and a kernel K (a, b) is expressed as:

$$s(t) = \sum_a \sum_b I(a, b) \cdot K(m-a, n-b).$$

(3)

Next the kernel is flipped and the above equation can be written as,

$$s(t) = \sum_a \sum_b I(m-a, n-b) \cdot K(a, b). \quad (4)$$

Further Neural networks implement the cross-correlation function, and it is similar to as convolution but without flipping the kernel

$$s(t) = \sum_a \sum_b I(m-a, n-b) \cdot K(a, b). \quad (5)$$

b) Rectified Linear Unit (RELU) Layer:

The Rectified Linear Unit is the most commonly used activation function in deep learning models. The function returns 0 if it receives any negative input, but for any positive value x it returns that value back.

So it can be written as

$$f(x) = \max(0, x). \quad (6)$$

where x is the input to the neuron. Other activation functions include the sigmoid, tanh, leaky RELUs.

It's surprising that such a simple function (and one composed of two linear pieces) can allow your model to account for non-linearities and interactions so well. But the ReLU function works great in most applications, and it is very widely used as a result.

c) Pooling Layer:

Convolutional networks may include local or global pooling layers which combine the outputs of neuron clusters at one layer into a single neuron in the next layer [9]. The important concept of CNNs is pooling, which is a form of non-linear down-sampling. There are several non-linear functions to implement pooling among which max pooling is the most common. It partitions the input image into a set of non-overlapping rectangles and, for each such sub-region, outputs the maximum. The pooling layer operates independently on every depth slice of the input and resizes it spatially.

The Pooling layer is inserted between the Convolution and RELU layers to reduce the number of parameters to be calculated, as well as the size of the image.

d) Fully Connected Layer:

Fully connected layers connect every neuron in one layer to every neuron in another layer. It is in principle the same as the traditional multi-layer

perceptron neural network. After several convolutional and max pooling layers, the high-level reasoning in the neural network is done via fully connected layers. Neurons in a fully connected layer have connections to all activations in the previous layer, as seen in regular (non-convolutional) artificial neural networks. Their activations can thus be computed as an affine transformation, with matrix multiplication followed by a bias offset.

2. Recurrent neural networks (RNNs):

A recurrent neural network (RNN) is an extension of a conventional feedforward neural network, which is able to handle a variable-length sequence input. It handles the variable-length sequence by having a recurrent hidden state whose activation at each time is dependent on that of the previous time.

Because of its ability to generate text [10], RNNs have been used in text analysis tasks as machine translation, speech recognition, language modelling, text prediction and image caption generation [11]. In general, the output of a layer is added to the next input, and this is fed back into the layer, resulting in a capacity for contextual 'memory'.

Therefore to avoid vanishing gradient problems with back propagation through time, plain RNNs have evolved into Long Short Term Memory (LSTM) networks and Gated Recurrent Units (GRUs). These are modifications of RNNs to hold long term dependencies and to discard or forget some of the accumulated information.

In the medical image analysis, RNNs have been used mainly in segmentation[12], together CNN as well RNN to segment neuronal and fungal structures from three-dimensional electron microscope images.

III. APPLICATIONS IN MEDICAL IMAGE ANALYSIS

- Classification : This is the first areas where in medical image analysis where deep learning was used. Diagnostic image classification includes classification of diagnosed images, in such setting every diagnosed exam is a sample and data size is less than that of a computer vision.

- Detection : Anatomical object localization such as organs is important pre-processing part of segmentation task. Localization of object in a image requires 3D parsing of image, several algorithms have been proposed to convert 3D space as composition of 2D orthogonal planes.

- Segmentation : The segmentation of organs and other substructures in medical images allows quantitative analysis related to shape, size and volume. The task of segmentation is typically defined as identifying set of pixels that define contour or object of interest. Segmentation of lesions combines the challenge of object detection and organ and substructure segmentation in the application of deep learning algorithms.

- Registration : Referred as spatial alignment is common image analysis task in which coordinate transform is obtained from one image to another image. Though lesion detection and object segmentation are eyed as main use of deep learning algorithms but researchers have found that deep networks can be beneficial in getting best possible registration performance.

1) Future Applications:

There are many challenges in area of Deep Learning in medical image analysis, Unavailability of large dataset is often mentioned as one. Some of the innovative applications that span across traditional medical image analysis categories are described in medical imaging. Content based image retrieval (CBIR) is a technique for knowledge discovery in large databases and offer similar data retrievals for case histories and understand rare disorders. Image

generation and enhancement is another task that uses Deep Learning to improve image quality, normalizing images, data completion and pattern discovery. Combining Image data with reports is yet another task that seems to have a very large scale application in the real world.

IV. CONCLUSION :

Deep learning is widely used in all areas and it will continue to grow in the nearer future in almost all fields of science. Scientists and expert peoples in this area are actively involved in research teams to solve critical severe medical problems. Medical image processing will benefit immensely from deep learning approaches as it has shown remarkable performance in non-medical regular imaging research compared to conventional machine learning approaches. Here we have explained a brief history from traditional machine learning to deep learning, highlighted various deep learning applications in medical imaging finally concluded with few drawbacks and future perceptions of deep learning in medical imaging. This will be definitely an essential tool for diagnosis and prognosis in the era of precision medicine.

REFERENCES

- [1] Wang S, Summers RM. Machine learning and radiology. *Med Image Anal* 2012;16:933–51.
- [2] J. Ker, L. Wang, J. Rao and T. Lim, "Deep Learning Applications in Medical Image Analysis," in *IEEE Access*, vol. 6, pp. 9375–9389, 2018.
- [3] Wernick MN, Yang Y, Brankov JG, Yourganov G, Strother SC. Machine learning in medical imaging. *IEEE Signal Process Mag* 2010;27:25–38.
- [4] Nasrabadi NM. Pattern recognition and machine learning. *J Electron Imaging* 2007;16:49901.
- [5] Hagan MT, Demuth HB, Beale MH, De Jesus O. *Neural network design*. 2nd ed. Boston (MA): PWS Publishing; 2014.
- [6] Le QV, Ngiam J, Coates A, Lahiri A, Prochnow B, Ng AY. On optimization methods for deep learning. In: Getoor L, Scheffer T, editors. *Proceedings of the 28th International Conference on Machine Learning*; 2011 Jun 28–Jul 2; Bellevue, WA. Madison (WI): Omnipress; 2011. p. 265–72.
- [7] Prospects of deep learning for medical imaging, *Precis Future Med*. 2018;2(2):37-52.
- [8] Goodfellow, Y. Bengio, A. Courville, *Deep Learning*, Cambridge, MA, USA: MIT Press, 2016
- [9] Ciresan, Dan; Ueli Meier; Jonathan Masci; Luca M. Gambardella; Jurgen Schmidhuber, "Flexible, High Performance Convolutional Neural Networks for Image Classification". *Proceedings of the Twenty-Second International Joint Conference on Artificial Intelligence-*

Volume Volume Two. 2: 1237–1242. Retrieved 17

November 2013.

[10] Sutskever, J. Martens, G. E. Hinton, "Generating text with recurrent neural networks", *Proc. 28th Int. Conf. Mach. Learn. (ICML)*, pp. 1017-1024, 2011.

[11] A. Karpathy, L. Fei-Fei, "Deep visual-semantic alignments for generating image descriptions", *Proc. IEEE Conf. Comput. Vis. Pattern Recognit.*, pp. 3128-3137, Jun. 2015.

[12] J. Chen, L. Yang, Y. Zhang, M. Alber, D. Z. Chen, "Combining fully convolutional and recurrent neural networks for 3D biomedical image segmentation", *Proc. Adv. Neural Inf. Process. Syst.*, pp. 3036-3044, 2016.

This page is not for circulation

Deep Convolutional Neural Network for Classification of Remote Sensing Scene

Sujata Alegavi

PhD. Research Scholar, Electronics &
Telecommunication,
Thakur College of Engineering & Technology
Mumbai, India
sujata.dubal@live.com

Raghvendra Sedamkar

Professor & Dean Academic
Thakur College of Engineering & Technology
Mumbai, India
rrsedamkar@thakureducation.org

Abstract— With the evolution of convolutional neural networks, extraction of deep features for accurate classification of Remote Sensed (RS) images have gained lot of momentum. The proposed approach extracts deep features of the RS images by employing several convolutional, pooling and fully connected layers which are discriminant, nonlinear and invariant. These deep features are useful for classification of remote sensing scenes. Moreover as RS images are diverse in nature there always is a common issue of high dimensionality of RS images and limited amount of training data. To address this issue we propose a CNN model that, uses multiscaled RS images combined with regularization parameter to extract spectral-spatial features. The RS images at multiscale level are applied to the CNN model for deep feature extraction and further classification. A hybrid multiscale model is being developed by altering the parameters of the CNN network to improve the performance. For authentication and evaluation purpose, the proposed approach is evaluated via experiments on five challenging high resolution remote sensing datasets. The experimental results provides optimum values for the given datasets for different parameters of the CNN. Classification accuracy of 92.25% is achieved for remote sensed images using 1-D CNN model compared to the other supervised and unsupervised classification algorithms.

Keywords— Deep feature extraction, Convolutional neural networks, Multiscale remote sensed images, Classification of Remote sensed images.

I. INTRODUCTION

Collection of data through remote sensing devices have become much easier in the recent years due to various new earth observation programs which collects high resolution data for various applications. Construction of robust feature maps to represent various characteristics in the high resolution imagery has become very important for driving different applications. In Hyperspectral remote sensing there are hundreds of data channels of the same given scene and this high resolution spectral information helps in differentiating between different materials and also increases classification accuracy. Even small spatial structures can be analyzed finely due to the advantage of high end sensors collecting images with fine spatial resolution. [1]. Collection of fine spatial resolution data leads to increased dimensionality problems in the spectral

domain. Techniques such as PCA, IDA are no longer found to be completely efficient for the processing of high dimensional data. [2]. Feature extraction plays a major role in high dimensional data processing. However, as the spectral signatures of different materials are different but sometimes might be close to each other feature extraction of such images still remains a challenging task [3]. Lot of studies in the recent era are made on extracting spatial and spectral information for feature extraction [4]. Detailed spatial resolution has become easily [5] available due to sensors with good spatial resolution. FE spatial spectral classification improves overall classification efficiency [6]. Low-level and mid-level classification gives good results for normal images but when it comes to RS images the results are not that good due to high dimensionality problems. In order to bridge the semantic gap, multiscale image analysis is used for classification. The new state-of-the-art solution for all the computer vision recognition problems is given by Deep learning [2], [7]. Human intelligence works on different parameters and on different levels. For recognition of different objects visual system of human's uses sequential processing and this kind of processing gives rises to learning of new objects or identification (recognition) of the existing objects [9]. Deep architectures gives rise to deep learning of different objects like in human neural system. Due to the nature of RS images there is always a possibility of mixing of spectral signatures due to scattering which makes classification of the desired objects much more difficult. Moreover factors such as sensor used, the range of IFOV, atmospheric conditions makes the process more complicated. To address such various problems classifying RS images at a deeper level gives us a better classification result compared to all the existing techniques [10]. If features are derived at a single level they tend to be variant to rotation, this problem can be easily solved for general images, but due to the nature of RS images, multilevel analysis is required to solve the problem which is not possible without a proper hierarchical architecture. Deep architectures gives a more potential solution to deduce abstract features at high levels, which are generally robust and invariant [11]. In case of few hundreds of training samples training a fully new CNN becomes much more difficult. [22]. In this paper, we investigate the application of Convolutional Neural Network

(CNN), which is one of the deep models, for feature extraction of RS images and develop a Multiscale CNN model for effective RS classification. It is demanding to apply deep learning to RS images due to complexity of the data and limited amount of samples for training. The main goal of this paper is to propose a deep FE method for RS classification using CNN architecture. The CNN model will extract deep robust features of the RS image which are invariant to rotation. The novelty of this paper is:

- 1) We present a multiscale feature extraction for RS imagery in spatial and spectral domain.
- 2) We propose the use of CNN for forming feature discrimination map.
- 3) The proposed methods is applied on five well-known hyperspectral data sets. A comparative study is made for parameters such as classification accuracy, number of epochs required for training and processing time for original image which is directly applied to the CNN for training and for RS image which is first multiscaled and then applied to CNN for training.

The remainder of this paper is organized as follows. In Section II, we present the related studies, Section III presents the proposed approach, Section IV presents Experimental results and analysis and finally Section V summarizes the conclusions.

II. RELATED STUDY

A. Neural Network and Deep Learning

Deep learning is a newly developed approach in the field of machine learning. Unlike neural networks which builds a fully connected network, deep learning networks does this but in a hierarchical manner. Deep Neural networks generally extracts deeper features by building a hierarchical network in first few layers followed by fully connected network which is finally given to a softmax classifier for final classification. Due to this feature of deep networks, any complicated data can be represented with much more confidence. But, the real challenge lies in training of such data. Initial stages of deep learning are generally unsupervised followed by final stages which are fine tuned in a supervised manner. Many deep learning models like DBN [12], [13], SAE [14], and CNN [11] are developed in the past for applications. Recently, CNNs have gained momentum in the field of image processing and have proved to be much more effective to other deep learning models in classification [15], [16] and detection [17]. Classification of SAR images is done using soft thresholding to reduce the classification error [20]. In this paper, we investigate the application of deep CNN for feature extraction of RS images.

B. Spectral–Spatial FE Framework

A special type of deep neural network is convolutional neural network (CNN). A complete CNN layer contains a convolution layer and a pooling layer. Several convolutional layers and pooling layers are stacked together to form deep architecture for deep CNN. The first layer is the convolutional layer. The value of a neuron s at position x of the j th feature map in the i th layer is denoted as follows:

$$S_{ij}^x = g(b_{ij} + \sum_m \sum_{p=0}^{m-1} w_{ijm}^p s^{x+p}(i-1)m) \quad (1)$$

$$g(x) = \tanh(x) = (e^x - e^{-x}) / (e^x + e^{-x}) \quad (2)$$

where the feature map in the previous layer ($(i-1)$ th layer) is represented by m which is connected to the current feature map, w is the weight of position p connected to the m th feature map, The kernel width is given by P with the spectral dimension, and b is the bias of j th feature map in the i th layer. By reducing the resolution of the feature maps pooling can offer invariance to the feature maps [18]. ReLu activation function is given by eq. no. 2 which is a sigmoid function. Each pooling layer corresponds to the previous convolutional layer. A small $N \times 1$ patch of the convolution layer is combined by the neurons in the pooling layer. Max pooling along with softmax classifier is used in this paper for implementation of CNN. The max pooling is as follows:

$$a_j = \max_{N \times 1} (a_i^{n \times 1} u(n, 1)) \quad (3)$$

where $u(n, 1)$ is a sigmoid function to the patch of the convolution layer, and a is the maximum in the neighborhood. All layers, including the convolutional layers and pooling layers of the deep CNN model, are trained.

III. IMPLEMENTATION

Figure 1, shows a diagrammatic representation for classification of multiscale SAR/Hyperspectral images. As remotely sensed images are diverse in nature, hence while classification many aspects needs to be considered for precise classification. Fig. 1 shows a simplified version of the architecture used for the constructing CNN. The same overall architecture used in [6] is developed here. A single pixel of a data cube with dimensions $1 \times 1 \times D$ is taken as input. The entire block diagram is divided into three stages wherein the first stage of the architecture consists of a RS image which is directly fed to CNN and after class allocation results are obtained.

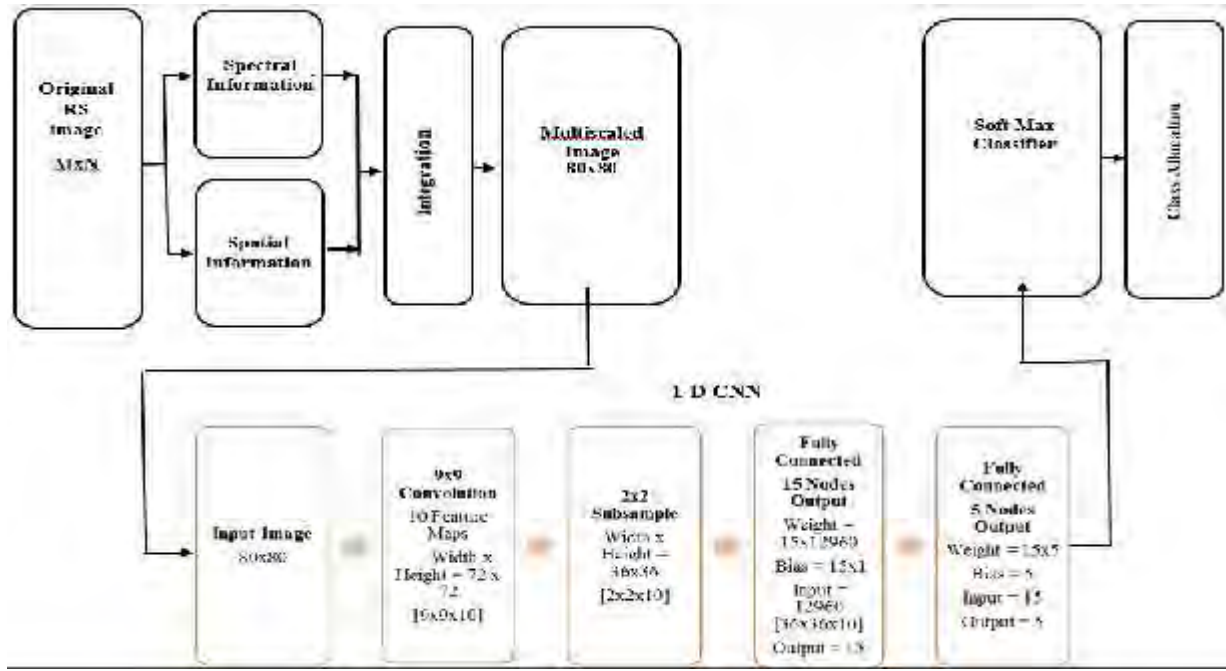


Fig.1. Block Diagram for classification of Multiscale RS Images using 1-D Convolutional Neural Network Model

In the second stage the image is first multiscaled by separating the spectral components and the spatial components of the RS image. In the third stage we construct a CNN with the input parameters. For getting the spatial values, RS images are first unmixed in the spectral domain to form fractional images further, bilinear interpolation is applied to these fractional images to get the spatial characteristics of these images.

$$X = a_1s_1 + a_2s_2 + \dots + a_Ms_M + n \quad (4)$$

$$= \sum a_i s_i + w = S a + w \quad (5)$$

Where M is the number of endmembers, S is the matrix of endmembers, and n is an error term for additive noise. The predicted values in spatial domain are given by,

$$Pv_{spa}(kj) = (k=1,2,\dots,K) (j=1,2,\dots,M) \quad (6)$$

Where Pv_{spa} is the predicted values in spatial domain in x and y direction, which are derived from spectral unmixing followed by bilinear interpolation are selected as spatial terms. Spectral terms are derived by first deriving high resolution RS imagery from low resolution RS imagery using bilinear interpolation. For getting the spectral values, RS images are first scaled using bilinear scaling and further fractional images are generated using spectral unmixing.

The linear optimization technique is employed to transform the finer multiscale values $Pv(kj)$ into a hard classified land cover map at a multiscale level. Once single RS image is converted to multiscale image we apply this multiscaled image to the CNN network for further classification.

Further in the third stage a CNN is developed whose input is an image resized at [80 x 80] size. Further 9 x 9 convolutional layer is designed with 10 feature maps of size [9 x 9 x 10]. The data is further subsampled and given to 15 node fully connected layer and further to 5 node fully connected layer. Further classification is done by softmax classifier to allocate final classes to the end members. Appropriate numbers of convolutional and fully connected layers are used. To train the CNN on the composite data set, all parameters were randomly initialized.

IV. RESULT ANALYSIS & DISCUSSIONS

The experiments are implemented using MATLAB 2017a, and the platform has X64 based PC, Intel (R) Core (TM), i5 processor – 7400 CPU @ 3.00 GHz, 3001 MHz, 4 cores CPU, 8 GB RAM, NVIDIA Titan XP GPU and Windows 10 Pro operating system. The database consists of scenes from Indian_pines_corrected, JasperRidge2_F198, Jasperridge2_F224, SalinasA_corrected and Urban_F210. Original and Multiscale RS images are applied to the convolutional neural networks. Different tests are carried out by varying different parameters to test the results using 1-D CNN. Different parameters are calculated and the results precisely shows that, when features of images are derived at multiscale level yields very good recognition rate compared to features of single scale images. Further CNN network enhances the overall classification results compared to other classification techniques. The results show that, with the use of convolutional neural networks the classification accuracy improves for multiscale RS images compared to original RS images. For class 1 total

of 200 images are considered, for class 2 total of 205 images are considered, for class 3 total of 198 images are considered, for class 4 total of 197 images are considered and for class 5 total of 194 images are considered for training and testing purpose.

A. Results of Training and Testing of SAR/Hyperspectral images on CNN network.

Phase - I deals with applying of single scale and multiscale RS image to CNN network when different sizes of feature vectors are considered. The following table shows classification accuracy when different sizes of the feature vector are applied to the RS images.

TABLE I. CLASSIFICATION ACCURACY FOR DIFFERENT SIZES OF FEATURE VECTORS USING CNN

Sr. No.	Feature Vectors	Elapsed Time (Seconds)	Classification Accuracy (%)
1	100x100	7.1	94.75
2	90x90	6.1	85
3	80x80	3.1	90
4	70x70	3.6	91.25
5	60x60	3	91.75
6	50x50	1.4	89.5
7	40x40	1.9	91.5
8	30x30	1.2	90
9	20x20	0.3	82.75
10	10x10	0.1	60.75

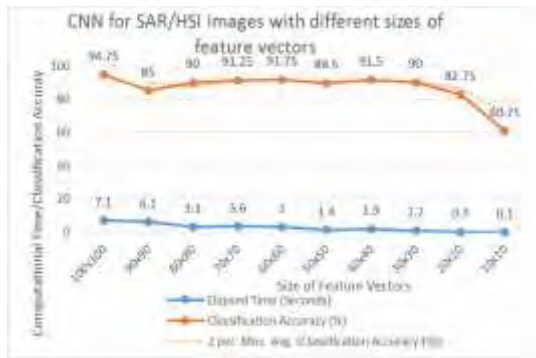


Fig 2: Classification Accuracy for SAR/Hyperspectral images with different sizes of feature vectors using CNN

The above figure shows different sizes of feature vectors considered and tested using CNN. We can clearly observe that, as we go on increasing the number of feature vectors, the recognition rate also goes on increasing, but at the same time the computational time and the amount of data for further computation also goes on increasing. The graph above shows that, for the size of 100x100 of feature vectors the classification

accuracy is 94.75% with the computational time of 7.1 secs. For further calculations we will, now keep the size of feature vector to be 100x100 and observe the changes in the accuracy by varying other parameters.

TABLE II: CLASSIFICATION ACCURACY FOR DIFFERENT SIZE OF KERNELS USING CNN

Sr. No.	Size of Kernel	Elapsed Time (Seconds)	Classification Accuracy (%)
1	19	24	83.25
2	17	21.8	92.75
3	15	16.95	87.25
4	13	13.8	89.25
5	11	11.1	95.75
6	9	8.2	95.5
7	7	5.5	95
8	5	4.3	94.5
9	3	3.4	87.8
10	1	4	93

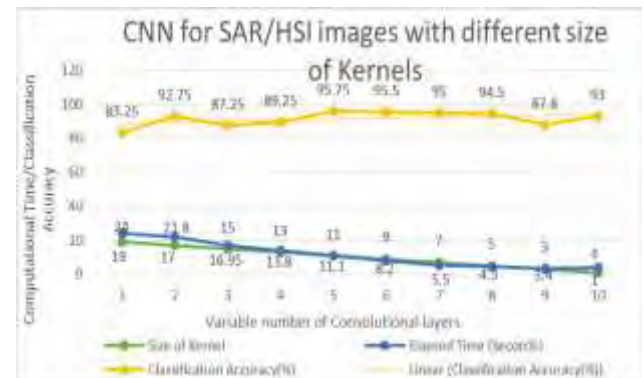


Fig 3: Classification Accuracy for SAR/Hyperspectral images with different size of kernels using CNN

The figure above shows different sizes of kernels considered and tested using CNN. We can clearly observe that, as we go on increasing the size of kernels, the classification accuracy also goes on increasing, but after a certain size the accuracy starts decreasing. As we go on increasing the size of kernels beyond a certain limit, data dimensionality reduction becomes difficult. Hence, we cannot increase the size of the kernel invariably. The computational time and the amount of data for further computation also goes on increasing. The graph above shows that, for the 11 size of kernel the classification accuracy is 95.75% with the computational time of 11.1 secs. For further calculations we will, now keep the size of kernel to be 11 and observe the changes in the accuracy by varying other parameters.

The above figure shows different number of epochs considered for training and testing of data using CNN. We can clearly observe that, as we go on increasing the number of epochs, the classification accuracy also goes on increasing, but after a certain number of epochs the accuracy starts decreasing. As we go on increasing the number of epochs beyond a certain limit, the over fitting problem comes into picture where data is over trained which starts gives a negative result which in turns reduces the classification accuracy. Hence, we cannot increase the number of epochs invariably. The computational time and the amount of data for further computation also goes on increasing. The graph above shows that, for the 11 epochs the classification accuracy is 92.25% with the computational time of 7.3 secs. As, remote sensed images have more number of different spectral signatures, classification using normal classification algorithms does not yield good classification result. Thus, we can clearly see that, when remote sensed images are classified using convolutional neural networks the classification accuracy increases to a larger extent as compared to classification using traditional algorithms.

V. CONCLUSION

Many supervised and unsupervised algorithms are proposed to classify images which extract features within an image. But, in remote sensed images there lies features deep within the image which cannot be extracted efficiently using general classifying algorithms. Hence, a 1-D CNN model for feature extraction is proposed which not only extracts the features at spatial level but also extracts it at the spectral level, whenever less number of training labelled datasets are available. Remote sensed images are scaled at different levels to derive the information that lies deep within which is then applied to the CNN network. The experiments are conducted on five publically available well known datasets and 1-D CNN is tested with different parameters. The optimum parameters are selected for the final network and the remaining data is tested on this network. Results show that, classification accuracy largely increases when CNN networks are used for classification compared to other supervised and unsupervised techniques. More insights can be gained by designing new algorithms to reduce the computational cost of the network.

ACKNOWLEDGEMENTS

This work is supported in part by NVIDIA GPU grant program. We thank NVIDIA for giving us Titan XP GPU as a grant to carry out our work in deep learning. We also thank the anonymous reviewers for their insightful comments.

REFERENCES

- [1] J. A. Benediktsson and P. Ghamisi, *Spectral–Spatial Classification of Hyperspectral Remote Sensing Images*. Boston, MA, USA: Artech House, 2015.
- [2] G. Hughes, “On the mean accuracy of statistical pattern recognizers,” *IEEE Trans. Inf. Theory*, vol. IT-14, no. 1, pp. 55–63, Jan. 1968.
- [3] X. Jia, B. Kuo, and M. M. Crawford, “Feature mining for hyperspectral image classification,” *Proc. IEEE*, vol. 101, no. 3, pp. 676–679, Mar. 2013.
- [4] A. Plaza, J. Plaza, and G. Martin, “Incorporation of spatial constraints into spectral mixture analysis of remotely sensed hyperspectral data,” in *Proc. IEEE Int. Workshop Mach. Learn. Signal Process.*, Grenoble, France, 2009, pp. 1–6.
- [5] M. Fauvel, Y. Tarabalka, J. A. Benediktsson, J. Chanussot, and J. C. Tilton, “Advances in spectral–spatial classification of hyperspectral images,” *Proc. IEEE*, vol. 101, no. 3, pp. 652–675, Mar. 2013.
- [6] Y. Tarabalka, M. Fauvel, J. Chanussot, and J. A. Benediktsson, “SVM- and MRF-based method for accurate classification of hyperspectral images,” *IEEE Geosci. Remote Sens. Lett.*, vol. 7, no. 4, pp. 736–740, Oct. 2010.
- [7] J.B. Dias et al., “Hyperspectral remote sensing data analysis and future challenges,” *IEEE Geosci. Remote Sens. Mag.*, vol. 1, no. 2, pp. 6–36, Feb. 2013.
- [8] Y. Bengio, A. Courville, and P. Vincent, “Representation learning. A review and new perspectives,” *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 35, no. 8, pp. 1798–1828, Aug. 2013.
- [9] N. Kruger et al., “Deep hierarchies in primate visual cortex what can we learn for computer vision?” *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 35, no. 8, pp. 1847–1871, Aug. 2013.
- [10] Yushi Chen, Member, IEEE, Hanlu Jiang, Chunyang Li, Xiuping Jia, Senior Member, IEEE, and Pedram Ghamisi, Member, IEEE, “Deep Feature Extraction and Classification of Hyperspectral Images Based on Convolutional Neural Networks”, *IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING*, VOL. 54, NO. 10, OCTOBER 2016.
- [11] Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner, “Gradient-based learning applied to document recognition,” *Proc. IEEE*, vol. 86, no. 11, pp. 2278–2324, Nov. 1998.
- [12] G. E. Hinton, S. Osindero, and Y. Teh, “A fast learning algorithm for deep belief nets,” *Neural Comput.*, vol. 18, no. 7, pp. 1527–1554, Jul. 2006.
- [13] N. LeRoux and Y. Bengio, “Deep belief networks are compact universal approximators,” *Neural Comput.*, vol. 22, no. 8, pp. 2192–2207, Aug. 2010.
- [14] P. Vincent, H. Larochelle, I. Lajoie, Y. Bengio, and P. Manzagol, “Stacked denoising autoencoders,” *J. Mach. Learn. Res.*, vol. 11, no. 12, pp. 3371–3408, Dec. 2010.
- [15] C. Szegedy et al., “Going deeper with convolutions,” in *Proc. IEEE CVPR*, Boston, MA, USA, 2015, pp. 1–9.
- [16] K. Simonyan and A. Zisserman, “Very deep convolutional networks for large-scale image recognition,” in *Proc. ICLR*, 2015, pp. 1–14.
- [17] R. Girshick, J. Donahue, T. Darrell, and J. Malik, “Rich feature hierarchies for accurate object detection and semantic segmentation,” in *Proc. IEEE CVPR*, Columbus, OH, USA, 2014, pp. 581–587.
- [18] Z. Zuo et al., “Learning contextual dependence with convolutional hierarchical recurrent neural networks,” *IEEE Trans. Image Process.*, vol. 25, no. 7, pp. 2983–2996, Jul. 2016.
- [19] Peng Wang, Liguang Wang, and Jocelyn Chanussot, Fellow, IEEE, “Soft Then-Hard Subpixel Land Cover Mapping Based on Spatial-Spectral Interpolation”, *IEEE GEOSCIENCE AND REMOTE SENSING LETTERS*, VOL. 13, NO. 12, DECEMBER 2016.
- [20] S. Alegavi and R.R. Sedamkar, “Improving Classification Error for Mixed Pixels in Satellite Images using Soft Thresholding Technique”, in *Proc. IEEE CONFERENCE IN INTERNATIONAL CONFERENCE ON INTELLIGENT COMPUTING AND CONTROL SYSTEMS*, 2018

[21] Erzhu Li, Junshi Xia, Member, IEEE, Peijun Du, Senior Member, IEEE, Cong Lin, and Alim Samat, Member, IEEE, "Integrating Multilayer Features of Convolutional Neural Networks for Remote Sensing Scene Classification", IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 55, NO. 10, OCTOBER 2017.

[22]. S.Alegavi, R.R. Sedamkar, "Classification of Hybrid Multiscaled Remote Sensing Scene using Pretrained Convolutional Neural Networks", INTERNATIONAL CONFERENCE ON IOT, SOCIAL, MOBILE, ANALYTICS AND CLOUD IN COMPUTATIONAL VISION AND BIO-ENGINEERING (ISMAC - CVB 2019), March 2019.

Image Superresolution Technque : A Novel Approach for Leaf Diseased Problems.

Dr.Sanket B.Kasturiwala,
[1]Assistant Professor, Dept.of Electroncs and
Communication Engineering,
Shri Ramdeobaba College of Engineering and
Management, Nagpur –
Maharashtra.sanket.kasturiwala@gmail.com.

Hemant P. Kasturiwale
Associate Professor,
Dept. of Electronics Engineering, Thakur College of
Engineering and Technology, Mumbai.

Abstract-Superresolution is a concept to increase the resolution. The main objective of this paper is the study of iterative curvature based method for super-resolving low resolution of a leaf diseased images. The domain specific prior is incorporated into superresolution by the means of iterative curvature SR based estimation of missing high frequency details from infected leaf images. The model is composed of two step pixel filling approach. Through this proposed work, fine edges of SR images are preserved without applying complex mathematical algorithms based on wavelet, fast curvelet, etc. In this paper, we have validated proposed scheme over 9 infected leaf images of **Keywords**-Markov Random Field, high-resolution, SR images.

I. INTRODUCTION

In agriculture, the analysis of infected leaf area is of great importance for the application of techniques such as pruning, fertilization and planting density [2]. A feature that can be extracted by analyzing the leaf area is the quantification of damage caused by pests and diseases. Such damage can be detected through the study of damaged leaf area by pests [2]. Detecting the precise amount of damaged leaf area is essential to determine control actions such as application of pesticides, since a small damaged leaf area may dispense control measures. In this paper, we have analyzed infected leaf image using adaptive based image superresolution techniques in order to recover the high frequency details such edges, various features, etc.

Obtaining a high-resolution (HR) image from single or multiple low-resolution (LR) images, known as “super-resolution” has been a classic problem. High resolution means high pixel density, also referred to as high-definition (HD). An HR image brings out details that would be blocked out in an LR image.

Super resolution problem is an ill-posed inverse problem. Estimating details is an inverse problem since low resolution observation is the result of a smoothing and downsampling process [3]. Basically, SR technique is broadly categorized in two parts. First is traditional non-adaptive image reconstruction and registration technique [5],[6] in these methods attempt to solve the problem by employing and fusing a number of low resolution images. The images are of an underlying scene are positioned into a common coordinate frame by sub-pixel shifts of images. Most of the literature available on super-resolution is for

various crops like soybean, cotton, rose, citrus family etc. Shows better result in visual as well as subjective quality as that of complex multi frame SR algorithms like reconstruction and registration along with less computational time. This concept is most useful for agricultural expert for helping our farmers for exact leaf disease detection and accurate remedial actions The experimental result shows the best visible SR result of an infected leaf along with MSE and PSNR i.e. Statistical results. Also shows the comparison of proposed method with the existing techniques successfully.

multi-frame and majority of them are based on the motion as cue. The super-resolution idea was introduced by Tsai and Hung, where a pure translation motion has been considered [1]. In such methods the quality of reconstructed SR image obtained from a set of LR images depends upon the registration accuracy of the LR images and some prior knowledge of imaging system [5, 6]. Nearly all SR reconstruction algorithms are based on the fundamental constraints that provide less useful information as the magnification factor increases also less computationally efficient to get more accuracy. Baker and Kanade found these limitations and developed a SR algorithm by modifying the prior term in cost to include the result of a set of recognition called as recognition based super-resolution or hallucination [11].

And second is single image adaptive learning based SR methods [7] which is more powerful and useful, when only a single observation image is available and several other high resolution images are present in the data set. All high resolution images from data set will act as training images. This method is classified under the motion free superresolution scheme as the new information required for predicating the HR image is obtained from a set of training images rather the subpixel shifts among low resolution observations.

In this paper, we have proposed an adaptive iterative curvature based spatial SR method for accurate analysis of infected leaf diseased images.

II. EXISTING SUPERRESOLUTION TECHNIQUES.

As per the superresolution imaging analysis is concerned, there are two main domain i.e. Frequency domain and Spatial domain approach for image registration.

In our case, the results of the spatial domain are very much better in visual quality as well as in analytical parameter also than the frequency domain, which typically failed to adequately register images.

By the nature of frequency domain, Fourier transform methods are limited to only global motion models. In the early stages, most of the research work is carried out under frequency domain approach but as more general degradation models were considered; later research has tended to concentrate almost exclusively on spatial domain formulations.

Basically, image superresolution can be obtained in two categories- Non-adaptive SR & Adaptive SR in spatial domain approach.

A. Non-adaptive Image SR

Non-adaptive image SR techniques are based on direct manipulation on pixels instead of considering any feature or content of an image. These techniques follow the same pattern for all pixels and are easy to perform and have less calculation cost. Various non-adaptive techniques are *nearest neighbor*, *bilinear* and *bicubic*. But these techniques having some drawbacks such as problems of blurring of edges or artifacts around edges. It stores only low frequency component of an original leaf image also produces blurry images quality. Mainly it misses the required information from superresolved infected leaf image. To overcome these, we approached for Adaptive Image SR for our agricultural information for more accuracy.

B. Adaptive Image SR.

This technique considers image features like intensity value, edges as well as texture informations. It also provides better visual image quality result as it preserves high frequency components from an original infected leaf image, so it is much easier for detection and classification accuracy. Various adaptive SR techniques are *NEDI*, *DDT*, *FCBI*, *Learning based approach*. Only main drawback is it requires much more computational time. So, here, we have worked over this problem while maintaining the SR quality of an infected leaf image. So, as far as infected leaf image problems are concerned, adaptive image SR approach is much better in practice and advantageous.

Machine learning based detection and recognition of plant diseases can provide clues to identify and treat the diseases in its early stages. Comparatively, visually identifying plant diseases is expensive, inefficient, and difficult. Also, it requires the expertise of trained botanist. There are several methods for measuring leaf area, however, in practice, it is used mainly three: the human evaluation, the method of leaf dimensions and the methods which use devices such as planimeter and area integrator. Nevertheless, these methods require extensive work and are time-consuming. Moreover they have some degree of inaccuracy. And, the

measurement techniques are not performed in the most cases by a farmer, but by an expert (agronomist), which delays the diagnosis. With the advances in computing, especially in the graphics processing, it is possible to develop alternative methods for determining the damaged leaf area. Plant diseases have turned into a dilemma as it can cause significant reduction in both quality and quantity of agricultural products.

III. ADAPTIVE ITERATIVE CURVATURE BASED IMAGE SUPER- RESOLUTION

Iterative curvature-based interpolation technique focuses on estimation of direction and based on second order derivatives. Main purpose of introducing ICBSR technique to minimize the artifacts presented in image compare to other technique like patch based learning and other adaptive and nonadaptive SR techniques. ICBSR technique has lower computational cost then other non-adaptive techniques. Image magnification generally results in loss of image quality. Therefore image magnification requires interpolation to read between the pixels. Generally the enlarged images suffer from imperfect reconstructions, pixelization and jagged contours. The proposed system provides error-free high resolution for real time infected leaf images. The basic idea behind the system comprises two basic steps: ICBSR technique is a combination of two techniques. In first technique, the new pixels are computed by interpolating along the direction (FCBI, Fast Curvature Based Interpolation). In second technique, we modified the interpolated pixels using iterative method with energy term for edge preservation purpose [14].

First technique, FCBI is same the Data Dependent Triangulation interpolation technique, but instead of taking the average value of two opposite neighbor pixels, we consider second order derivatives in two diagonal direction I_{11} and I_{22} and compute new pixel values in such a direction where the estimated derivative is low.

In second technique, the energy term is sum of the curvature continuity, curvature enhancement and isolevels curves. First we compute, for each new pixel, the energy function $U(2i+1; 2j+1)$ and the two modified energies $U+(2i+1;2j+1)$ and $U-(2i+1;2j+1)$, i.e. the energy values obtained by adding or subtracting a fixed value called threshold value to the local pixel value $I(2i+1;2j+1)$ [14] and assign this intensity value to pixel. This procedure is iteratively repeated until the sum of the modified pixels at the current iteration is lower than a fixed threshold value. Overall procedure for ICBSR technique is as follows [14]:

Step 1: Put original pixels in the enlarged grid at locations $2i, 2j$

- Step 2: Insert pixels at locations $2i+1, 2j+1$ with the FCBI method
- Step 3: Apply iterative correction until the image variation is above a given threshold
- Step 4: Insert pixels in the remaining locations with the FCBI method
- Step 5: Apply iterative correction to the added pixels
- Step 6: Repeat the whole procedure on the new image for further enlargements

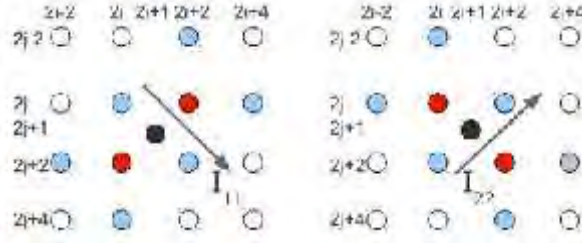


Fig. 1. The average of the two neighbors in the direction of lowest second order derivative (I_{11} or I_{22}).

IV. MATHEMATICAL ANALYSIS

Mathematical analysis of SR is basically based on accurate MAP estimation [4]. According to the MAP estimator, the additive noise, the measurements, and the ideal image are all assumed stochastic signals. The MAP estimation of the unknown image X is done by maximizing the conditional probability density function of the ideal image given the measurements $P\{X/Y\}$. Based on Bayes rule, maximizing $P\{X/Y\}$ is equivalent to maximizing the function $P\{Y/X\}P\{X\}$.

Bayesian approach provides a flexible and convenient way to model a priori knowledge concerning solution

$$X = \arg \max P(x|y_1, y_2, \dots, y_p)$$

$$X = \arg \max \{ \ln P(x|y_1, y_2, \dots, y_p) + \ln P(X) \}$$

The mathematical operation shows the final result as:

$$R = \hat{X} \cdot P \quad \text{Where,} \quad R = Q^{-1} + \sum_{k=1}^p H_k^T W_k H_k$$

$$P = \sum_{k=1}^p H_k^T W_k Y_k$$

and

If we assume that the measurements additive noise is zero mean Gaussian random process with auto-correlation matrix W with autocorrelation matrix Q for unique estimate image $\hat{X}$ using iterative technique.

By considering the stochastic least mean square filtering operation in order to minimize the error function as

$$e^2 = \min E \left\{ [f(x, y) - \hat{f}(x, y)]^2 \right\}$$

(3)

The solution can be achieved through following expression

$$\hat{F}(u, v) = \left[\frac{1}{H(u, v)} \frac{|H(u, v)|^2}{|H(u, v)|^2 + S_h(u, v)/S_f(u, v)} \right] G(u, v)$$

(4)

Where, the ratio $S_h(u, v)/S_f(u, v)$ is called the *noise-to-signal* power ratio. For inverse filtering action it is equal to zero and $|H(u, v)|^2$ is the product of complex conjugate of $H(u, v)$ and self $H(u, v)$.

The analytical parameter such as MSE and PSNR can be calculated as, let, $x_{i,j}$ be the original image and $x'_{i,j}$ be the SR frame whose dimensions are $M \times N$. Then, Mean Square Error can be defined as

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (x_{i,j} - x'_{i,j})^2$$

(5)

PSNR avoids many problem of measuring image quality by scaling the MSE according to the image range. It is defined by the equation

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

(6)

The MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio) shows the better analytical result as that of conventional SR interpolation methods.

V. EXPERIMENTAL ANALYSIS

The experiments were executed on an Intel Core TM 2 duo CPU @ 2.5 GHz with 3 GB RAM and results are obtained using MATLAB 7.10 tool. Images are captured by using a low cost LG mobile camera with resolution which is pre-setted. Initially, we had captured all possible high resolution infected leaf images from surveying various farm fields in order to prepare a huge database i.e. dictionary. And they are preprocessed to convert in low resolution for validation.

Fig. 2 shows the original quality of images. Fig. 3 output SR images with SR factor of 4. Table 1 shows the SR image with factor 4. While table 2 shows the SR image quality results. Table 3 and table 4 shows the comparison results of PSNR parameter and timing constraints among existing SR techniques with respect to proposed technique respectively.

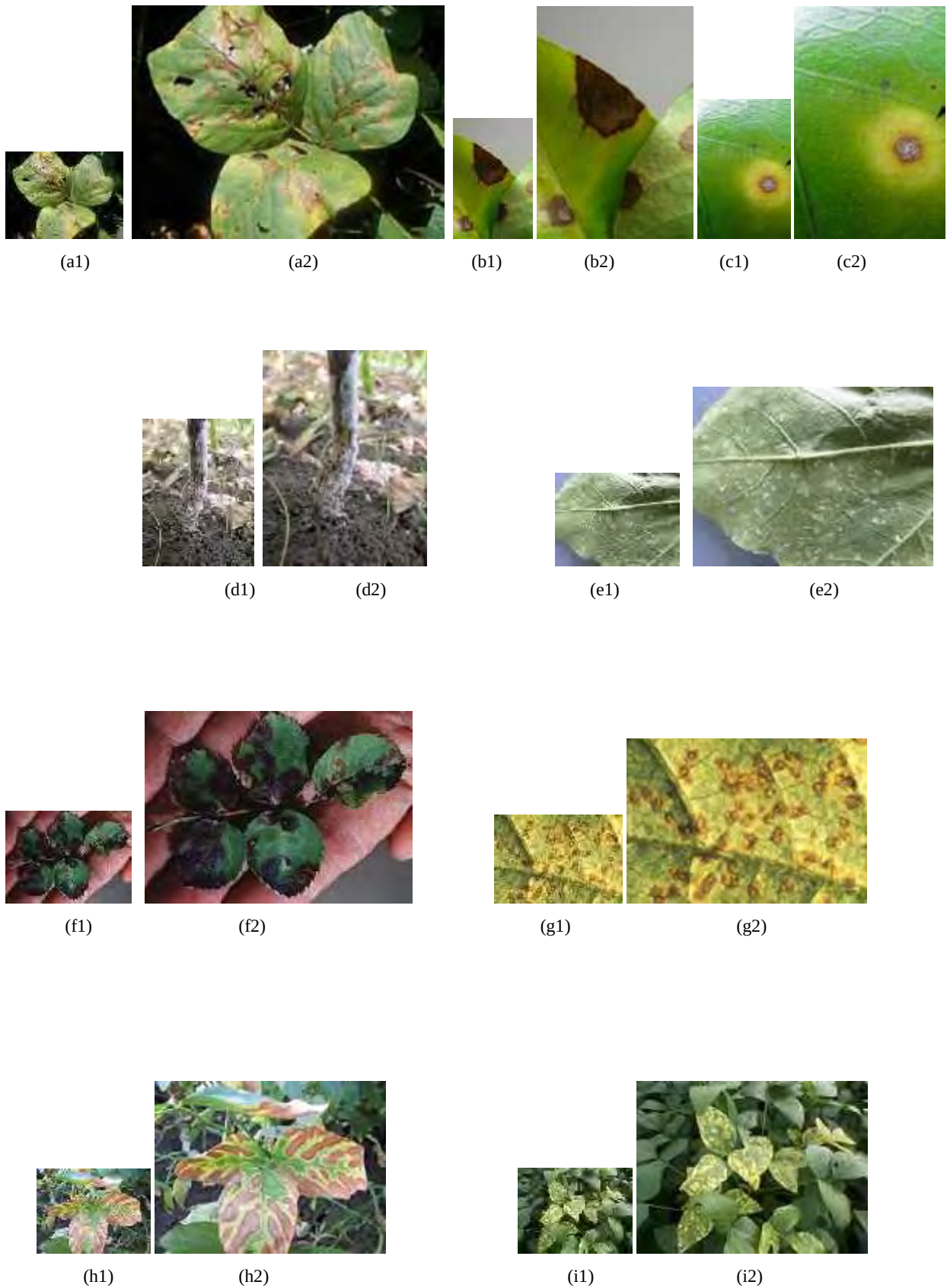


Fig. 2.(a1),(b1),(c1),(d1),(e1),(f1),(g1),(h1),(i1) : Original Low Resolution Leaf diseased images.

Fig. 3. (a2),(b2),(c2),(d2),(e2),(f2),(g2),(h2),(i2) : Super Resolution Leaf Images by Factor 4

TABLE 1. RESULT OF SR IMAGE (FACTOR 4) WITH TIME REQUIRED

Sr. No.	Diseases	Original Size	SR Size	Time for SR, (Sec)
a	ALS	150x112 (73.5kb)	2385x1777 (2.60Mb)	295.450
b	Alternaria	100x150 (2.04kb)	1585x2385 (1.20Mb)	161.617
c	Citrus Canker	100x150 (2.18kb)	1585x2385 (1.54Mb)	136.860
d	Collar Rot	100x133 (36.4kb)	1585x2113 (2.48Mb)	162.943
e	Cotton Dahiya	150x112 (24.7kb)	2385x1777 (2.69Mb)	200.321
f	Rose Downy Mildew	200x114 (16.1kb)	3185x2289 (4.20Mb)	544.163
g	Rust	150x103 (8.00kb)	2385x1633 (2.75Mb)	170.774
h	SuddenDeath Syndrom	150x112 (29.6kb)	2385x1777 (3.12Mb)	258.930
i	Yellow Mosaic Virus	150x112 (75.1kb)	2385x1777 (2.95Mb)	245.046

SR TECHNIQUES	AVG. PSNR, DB
INEDI	27.42682
SPARSE RECOVER.	28.00597
ADAPTIVE	29.77813
ICBI	32.09667

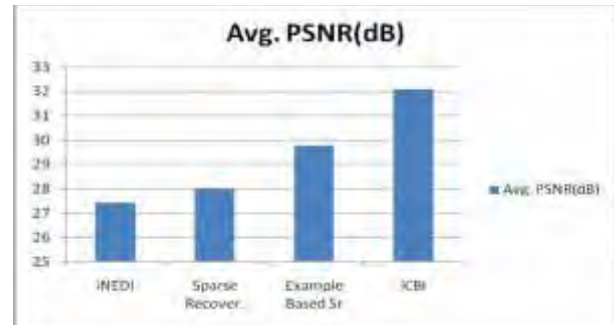


Fig.5. Avg. Statistical PSNR results

TABLE 2. PARAMETERS OF SR IMAGE QUALITY

Sr. No.	Diseases	MSE	PSNR, (dB)	NAE	Time for SR, (Sec)
a	ALS	3.95	28.90	0.0531	295.450
b	Alternaria	7.63	39.30	0.0124	161.617
c	Citrus Canker	3.147	36.94	0.0178	136.860
d	Collor Rot	1.43	27.66	0.0583	162.943
e	Cotton Dahiya	6.70	30.29	0.0364	200.321
f	RoseDowny Mildew	2.91	31.80	0.0501	544.163
g	Rust	1.39	29.59	0.0401	170.774
h	SuddenDeath Syndrom	4.99	27.16	0.0540	258.930
i	YellowMosaic Virus	1.87	28.09	0.0618	245.046

TABLE 4: Comparison between Timing Constraints various SR Techniques

SR Techniques	Avg. Timing in Sec
iNEDI	635.4349
Sparse Recover.	168.8007
Adaptive	29.57959
ICBI	5.907997

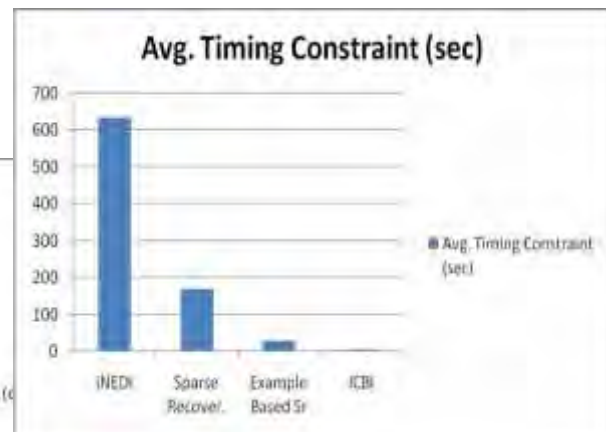


Fig.6. Avg. Statistical Timing Constraints results



Fig.4. Statistical Analysis of PSNR, dB

TABLE 3: COMPARISON BETWEEN PSNR OF VARIOUS SR TECHNIQUES

VI. CONCLUSION AND FUTURE SCOPE

From the observational result, it is verified that the disease infected single LR image with low cost camera is only sufficient to improve its resolution with better visual quality. Information from leaf edges are recovered

successfully. The proposed algorithm is very much fast with reduced size of database due to k -means clustering, hence memory requirement is low. Patch based learning SR technique gives improved MSE and PSNR over analytical as well as appearance result.

Properly analyzed infected leaf images are mostly useful for plant pathologist for the following purposes:

- Identification of diseased leaf, stem, fruit ;
- Identification and quantification of affected area by disease;
- Identification of intensity of diseases and their effect on productivity.

Our proposed methodology is the best option for costly and complex hyper spectral satellite imagery system.

This paper will definitely bring some smile on farmer's face for improvement in crop production and agricultural development through agricultural experts.

In future, this concept can be extended to different plant pathologist for solve various agricultural engineering problems. There is a great scope for doing further research on the creation of self-learning database for any kinds of single image SR. Also, the work should be independent from the interpolating factor.

ACKNOWLEDGMENTS

The proposed research work is carried out under the guidance of Department of Plant Pathology, College of Agriculture, Nagpur affiliated under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. I kindly express my gratitude towards time to time support and making availability of the resources for the collection leaf images for the development of this project.

REFERENCES

- [1] R.Y. Tsai and T.S. Huang, "Multiframe image restoration and registration," in *Advances in Computer Vision and Image Processing*, vol.1, chapter7, pp.317–339, JAI Press, Greenwich, USA, 1984.
- [2] Jaymala Patil, Rajkumar, "Advances in Image Processing for Detection of Plant Diseases", *Journal of Advanced Bioinformatics Applications and Research*, Vol 2, Issue 2, June-2011, pp 135-141.
- [3] S. C. Park, M. K. Park, and M. G. Kang, "Super-resolution image reconstruction -a technical overview", *IEEE Signal Process. Magazine*, vol. 20, pp. 21-36, May 2003.
- [4] H.Shen, L.Zhang, B.Huang, and P.Li, "A map approach for joint motion estimation, segmentation, and super-resolution," *IEEE Trans. Image Process.*, vol.16, no.2, pp.479–490, Feb.2007,
- [5] M. Elad and A. Feuer, "Super-resolution reconstruction of image sequences", *IEEE Trans. on Pattern Analysis and Machine Intelligence*, 21(9):817 1999.
- [6] F. Sroubek, G. Cristobal and J. Flusser, "Simultaneous super-resolution and blind deconvolution", 4th AIP International Conference and the 1st Congress of the IPIA IOP Publishing *Journal of Physics: Conference Series* 124 (2008) 012048.
- [7] S.Farsiu, D. Robinson, M. Elad, and P. Milanfar, "Advances and challenges in super-resolution", *International Journal of Imaging Systems and Technology*, vol. 14, pp. 47-57, 2004.
- [8] S. Baker and T. Kanade, "Limits on super-resolution and how to break them", In *Proceedings of CVPR 00*, pp. 372-379, 2000.
- [9] Takeda, S.Farsiu, and P.Milanfar, "Kernel regression for image processing and reconstruction," *IEEE Transactions on Image Processing*, vol.16, no.2, pp.349–366, 2007.
- [10] M.V.Afonso, J.M.Biucias-Dias, and M.A.T.Figueiredo, "Fast image recovery using variable splitting and constrained optimization," *IEEE Transactions on Image Processing*, vol.19, no.9, pp.2345–2356, 2010.
- [11] C.H.Bock and G.H.Poole, "Plant disease severity estimate visually and by Hyper spectral imaging," *Plant Science*, 2010 pp.59-107.
- [12] Tian You-wen and Wang Xiao-juan, "Analysis of leaf parameters measurement of cucumber based on image processing", *World congress on software engineering*, pp. 34-37, 2009.
- [13] Stéphane Pelletier and Jeremy R.Cooperstock, "Preconditioning for Edge-Preserving Image SuperResolution". *IEEE Transactions on Image Processing*, VOL.21, NO.1, JANUARY 2012
- [14] W.K.Pratt. *Digital Image Processing*. Wiley-Interscience, 1991.
- [15] Sanket B. Kasturiwala, Dr.S.A.Iadhake, "Soybean Leaf Diseased Image Superresolution using Spatial Domain Approach", *International Journal on Engineering & Research Technology*, (IJERT) Vol. 1(02), 2012. ISSN 2278-0181.
- [16] X. Gao, K. Zhang, D. Tao, X. Li. "Joint Learning for Single Image Super-resolution via Coupled Constraint". *IEEE Trans. on Image Processing*, Vol. 21, Issue 2, pp. 469 – 480, 2012.
- [17] Jaffe, L., Sundram, S., & Martinez-Nieves, C. (2017). Super-resolution to improve classification accuracy of low-resolution images. Tech. Rep. 19, Stanford University.
- [18] Jia-Bin Huang, Abhishek Singh, and Narendra Ahuja, "Single Image Super-Resolution from Transformed Self-Exemplars", *CVPR*, 2015.
- [19] Timofte, Radu and Rothe, Rasmus and Van Gool, Luc, *Seven Ways to Improve Example-Based Single Image Super Resolution*, CVPR, 2016.(website).

Implementation of Automatic Speech Emotion Recognition System using Convolution Neural Network

Purnima Chandrasekar Electronics and Telecommunication, Thakur College of Engineering and Technology, Mumbai, India purnimasekar2411@gmail.com	Bhumika Sharma Electronics and Telecommunication, Thakur College of Engineering and Technology, Mumbai, India sharmabhumika16@gmail.com	Aasman Patel Electronics and Telecommunication, Thakur College of Engineering and Technology, Mumbai, India aasman86.27@gmail.com	Anamika Pandey Electronics and Telecommunication, Thakur College of Engineering and Technology, Mumbai, India anamikadb207@gmail.com
--	---	---	--

Abstract— The human emotion is expressed through facial expression and speech. The emotion expressed in the speech can be judged and understood by any human, but a machine cannot understand this emotions, therefore a need to design an algorithmic approach as a solution to the problem in robotics. Our proposing algorithm is a two-stage approach, firstly the extraction of the features from the speech signal that corresponds to the emotional state of the speaker, and the second is the classification of the extracted features into proper emotional state. The accuracy of this system is depended upon the classification of the signal into appropriate emotional category. With tremendous increase in the advancement in the field of computer, it has now become possible to do real time computations on speech data, so a system which automatically detects the emotions through speech signals has become an important area of research.

In this paper, we have discussed the steps of extracting emotional features from a speech signals. Our main interest is to find the proper technique for classifying the emotional features extracted from the speech signals using suitable classification technique. In this we have categorized the emotions into Happy, Anger, Fear, Sad, Neutral, Disgust, Surprised using SAVEE database. Mel Frequency Cepstral Coefficient (MFCC) and energy features have thereby been extracted.

Keywords: Emotions, Speech, MFCC, Energy.

I. INTRODUCTION

Speech is one of the oldest human tools which are used for interaction with each other. Therefore, it is one of the most natural ways to interact with the computers as well. Generally a speech signal consists of two main parts: one carries the speech information, and the other includes silent or noise sections. The informative part of speech can be further classified into three categories: (a) The voice speech (b) unvoiced speech (c) silence. Voiced speech consists mainly of vowel sound. It is produced by constriction in the vocal tract, proper adjustment of the tension of the vocal tract resulting in opening and closing of the cords, and a production of almost periodic pulses of air. These pulses excite the vocal tract.

Psychoacoustics experiments show that this part holds most of the information of the speech and thus holds the keys for characterizing a speaker. Unvoiced speech parts are generated by forcing air through a constriction formed at a point in the vocal tract (usually toward the mouth end), thus producing turbulence. The last category is Silence, when there is no vibration of the vocal cords after the air is discharged from the lungs. Speech recognition is the ability of a machine or program to identify words and phrases in spoken language and determine the emotions of the speaker such as normal, anger, happiness and sadness. The founder of modern philosophy “René Descartes” identified six simple and primitive emotions wonder, love, hatred, desire, joy, and sadness. Other philosophers identified categories of emotions which include composed of some of these six or species of them. As a result of the experiences and observations experienced by man over the centuries it became easy for him to distinguish emotions.

Emotion recognition technology is essential for the assistance if they are to become more seamlessly integrated into our daily lives. Automatic emotion recognition has a direct application in the space of medication and therapy. For the people that have social communication disorders like Alexithymia, social-emotional agnosia, or even autism, emotions are very complex to understand and can often feel out of reach. The inability to detect emotions limits their interactions with familiar people and they are commonly at risk of severely damaging interpersonal relationships. A Scientific American report notes that these diseases are characterized by difficulty identifying different types of feelings, limited understanding of what causes feelings, difficulty expressing feelings, and difficulty recognizing facial cues in others, among others. Tools that can help such individuals identify emotions in people around them could prove to be extremely useful in therapy settings as well as in day-to-day social interactions[6]. Based on the state of the art survey of the importance of emotions in a human’s life, we decided to implement a system that detects emotion from voice, as most appropriate in the context of the applications intended.

In the next section, we relate our work to prior speech emotion recognition studies. We then describe our proposed approach in detail in Section 3. We show the experimental results in Section 4 and conclude the paper in Section 5.

II. METHODOLOGY

A. Database

In [3], authors have used A German Corpus (Berlin Database of Emotional Speech EmoDB) database which is self-fabricated Chinese databases. In [1], author have used Self-generated Romanian language Dataset. In [2], author have used SEMAINE DATABASE. In [4], author have used SEMAINE DATABASE. In [5], author have used Interactive Emotional Dyadic Motion Capture (IEMOCAP) database. All these databases are in English language where as EMODB database is in German language.

B. Feature extraction

Feature extraction can be defined as the process of collecting discriminative information from a set of samples.

In [3], the authors have extracted features like MFCC's z(Mel-frequency cepstral coefficients), pitch area, vitality. In [1], the authors have extracted features like MFCC's(Mel-frequency cepstral coefficients), pitch intensity, rate. In [2], author have extracted features Spectral roll off, MFCC ,Pitch, magnitude. from speech. In [4], the authors have extracted features like MFCC , Formants, Pitch, Delta features from speech. In [5], the authors have extracted features like 13 MFCC's (Mel-frequency cepstral coefficients), spectral entropy , energy from speech. The most common features extracted are MFCC, PITCH and ENERGY

C. Classifier

Classification can be defined as a process of predicting the class of given data points. In paper [3], author have used SVM (Support Vector machine) classifier and got the mean accuracy of about 94%. In paper [1], author have used Convolutional Neural Networks (CNN) classifier and got mean accuracy of about 71.33%. In paper [2] author have used Convolutional Neural Networks (CNN) & Recurrent Neural Network(RNN) classifier and got mean accuracy of about 74.5%. In paper [4], author have used Deep Neural Networks(DNN) classifier and got mean accuracy of about 54%.In paper [5] ,author have used Recurrent Neural Network(RNN) classifier and got mean accuracy of about 70%.There are many classifier's to train the model but most common classifier's are SVM,CNN,RNN.

III. PROPOSED WORK

The proposed system is divided into two parts:

- Training the model: In this suitable features are extracted and given as input to the classifier for training it..
- Testing the model: In this we will test whether the classifier is able to classify a random speech sample into appropriate emotion category based on its training.

We are implementing the project in Python language and Keras library for training purpose. Keras is a high-level neural networks API, written in Python and capable of running on top of TensorFlow, CNTK, or Theano. It was developed with a focus on enabling fast experimentation[9].

• Collection of Database:

The first step is collecting the speech database. Various audio speech database of different languages spoken by male and female are available online. We have considered 2 databases Emo-DB and SAVEE databases.

Emo-DB: It is a berlin Database of emotion speech spoken in German language. It consists of 500 speech files spoken by actors in Angry, Anxious, Happy, Fearful, Bored, Disgust and Neutral emotions.

SAVEE: Surrey Audio-Visual Expressed Emotion (SAVEE) database is an British-English speech Database. It consists of 480 speech files of 7 different emotions such as Angry, Happy, Fear, Neutral, Sadness, Surprise, Disgust emotions

• Feature Extraction

The features extracted from speech files(.wav) in our system include:

A. Energy[6]:

Energy associated with the speech signal is time varying in nature. The loudness of a speech signal is the most prominent characteristics according to human aural perception. There are several interchangeable terms like volume, energy, intensity which are commonly used to describe the loudness of speech signals. The formula for energy is given as:

$$ENERGY: \sum n|x(n)|^2$$

B. Pitch[6]:

Pitch is a fundamental property of speech. It is well known that speech is driven by noise which is produced by the vibration of the vocal folds that varies at a rate between 50 Hz to about 400Hz, which is known as fundamental frequency. Pitch is known as the fundamental frequency of the speech signal

MFCC[6]:

The steps in MFCC are as follows :

Step 1: Frame Blocking The process of segmenting the speech samples into a small frame with length ranging between 20 msec to 40 msec. The voice signal is divided

Implementation of Automatic Speech Emotion Recognition System using Convolution Neural Network

into frames of N samples and adjacent frames are separated by M ($M < N$). The values used for M is 100 and N is 256.

Step 2: Windowing The speech signal is segmented into frames by this technique. Hamming window is used as the window shape and represented as $W(n)$ and $0 \leq n \leq N-1$ where N is the number of samples in each frame. The result is given by $Y(n) = X(n) \times W(n)$ where $X(n)$ is the input signal and $Y(n)$ is the output signal.

$$W(n) = 0.54 - 0.46 \cos\left(\frac{2\pi n}{N-1}\right) \quad 0 \leq n \leq N-1.$$

Step 3: Fast Fourier Transform Each frame of N samples is converted to frequency domain from time domain using the Fast Fourier Transform (FFT).

$$Y(w) = FFT[h(t) * X(t)] = H(w) * X(w) \quad (4)$$

where $X(w)$, $H(w)$ and $Y(w)$ are the Fourier Transform of $X(t)$, $H(t)$ and $Y(t)$ respectively.

Step 4: Mel frequency wrapping In FFT spectrum voice signal does not follow the linear scale. The weighted sum of filter spectral components are computed using triangular filters so that the output is appropriate to a Mel scale. The magnitude frequency response of each filter is triangular in shape and at the centre frequency equals to unity and decrease linearly to zero between two adjacent filters. The sum of its filtered spectral components is the output of each filter.

$$F(m) = [2595 * \log_{10}(1 + \frac{f}{700})]$$

The equation is used to calculate the Mel for frequency f in Hz

Step 5: Cepstrum (Discrete Cosine Transform) Here the log Mel spectrum is converted into time domain using Discrete Cosine Transform (DCT). The output of the conversion is known Mel Frequency Cepstrum Coefficient.

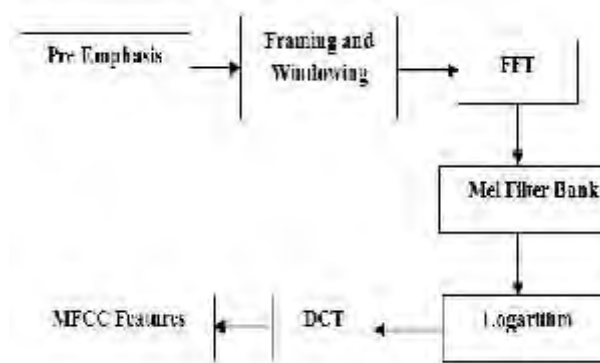


Fig.1 Steps in MFCC

Mel frequency cepstral coefficients was introduced in 1980 by Davis and Mermelstein. It is based on the human peripheral auditory system. MFCC is less susceptible to noise and provides better recognition performance. MFCC due to its good performance is used widely in audio classification experiments. It is

used to extract features from speech signal. Mel is a unit to measure the perception of speech or frequency of a tone. The formula for converting from frequency (f) to Mel scale is:

$$M(f) = 1125 \ln(1 + f/700)$$

Classifier [7]:-

Various classification techniques have been employed for classification purpose. After the procedure of selecting features, classification is needed is train the chosen classifier with the task of emotion recognition.

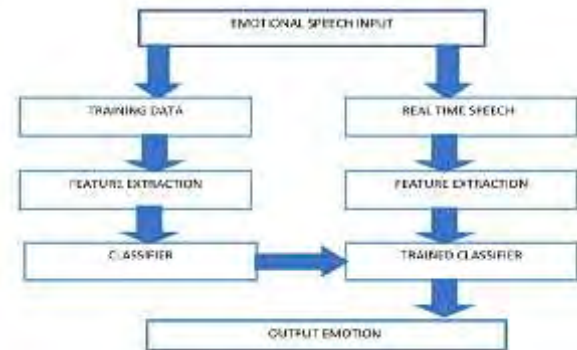


Fig.2 Basic Block Diagram of our proposed System

- Deep learning model: Convolutional Neural Networks (CNN)

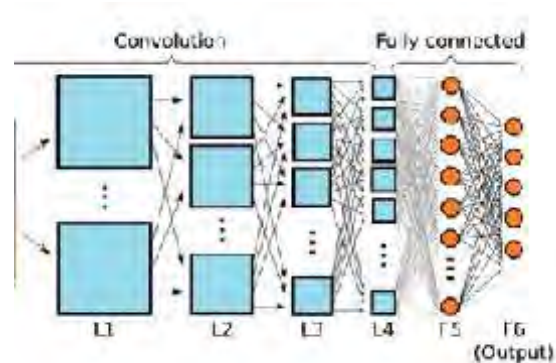


Fig.3. Generic representation of CNN architecture[2]

The CNN neural network has an architecture inspired from primate visual cortex. The visual cortex has multiple cortex levels (layers), each one capable to recognize more structured

information. A DCNN consists of repeated CNN pairs, followed by a number of dense (fully connected) layer. The final (top) layer must contain the classifier.

The convolutional layer has the purpose to extract the structured information with sub-matrices filters (strides) parsing on the two-dimensional input data. The pooling layer, summarize the output of the convolution matrix by progressively reducing the spatial size of the representation to reduce the amount of the computation and parameters in the network. Then in the flattening step we end up with the long vector of the input data that can be passed through the artificial neural network to have it processed further. By aggregating the values of the stride

sub-matrix into a single value . Generic representation of the CNN architecture.

In contrast with the standard neural layer, characterized by a two-dimension weight matrix, a convolutional layer has a more complex structure. Convolutional layers are used to filter the initial data, to extract features from input.

The CNN model consists of one pair of convolutional and pooling layer, with 200 convolutional filters of size 5x5, with ReLu activation, followed by a max-pooling. The CNN has 400 x 12 neurons as input. The final stage consists of a flattening and a dense (fully connected) layer of 1000 neurons, followed by the six emotions classifier. The CNN neural network was implemented in Python, using the TensorFlow backend, with Keras library.

The convolutional layer consists of 20 layers which compute, in 20 steps, the 2D convolution (repeated 20 times) of the input 'image' (of dimension 400 x 12). The convolutional layer extract the structural information and reduces of the input image which is then reduced (by MaxPool and Flatten layers) for the final computation with a classical neural network made of two fully connected (dense) layers. The hidden layer has N HIDDEN = 1000 neurons, while the output layer has 6 neurons for classification.

The code in Python is given in Figure 6. In the first part of the code we have the list of modules imported from the Keras library and the parameters definition. The second part of the code is for building-up the architecture (the model) as a sequential stack of layers. The last part of the code is for training the network and finally the evaluation of performances with the test files.[1]

IV. RESULTS AND DISCUSSION

A. Energy Extraction:

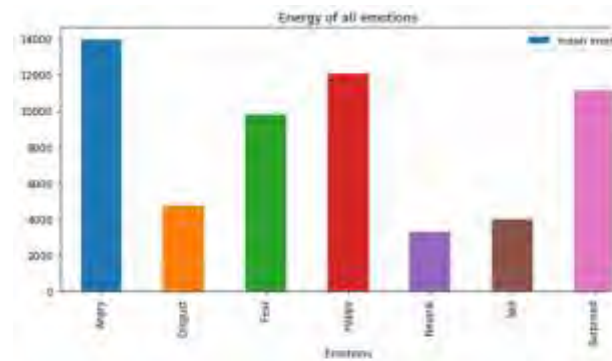


Fig 4. Energy extraction

Above graph represents the amount of energy in each emotion. From this graph we also came to know about the how much energy required by the different type of emotion.

First. We found out the Energy values for each 460 files of SAVEE database. Then we categorize the

files according to the emotion such as Angry, Happy, Fear, Neutral, Sadness, Surprise, Disgust. After the categorization, each emotion category is taken (each category contains 60 files) and the sum of the energy of that category is calculated and displayed in the form of graph. For example, For Angry emotion there are total 60 files in SAVEE Database. Energy values are calculated for each 60 files and therefore we got a matrix of [60x1]. After this, the sum of all the Energy is taken of all 60 files so as to get a vector of size [1x1] and same procedure is done for all the set of emotions and so we got a matrix of size [7x1].

B. Pitch Extraction

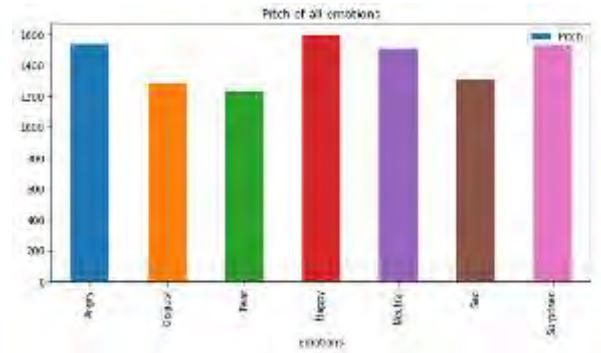


Fig 5. Pitch extraction

Above graph represents the amount of pitch in each emotion. From this graph we also came to know about the pitch of different type of emotion. First. We found out the pitch for each 460 files of SAVEE database. Then we categorize the files according to the emotion such as Angry, Happy, Fear, Neutral, Sadness, Surprise, Disgust. After the categorization, each emotion category is taken (each category contains 60 files) and the sum of pitch of that category is calculated and displayed in the form of graph.

C. MFCC Extraction

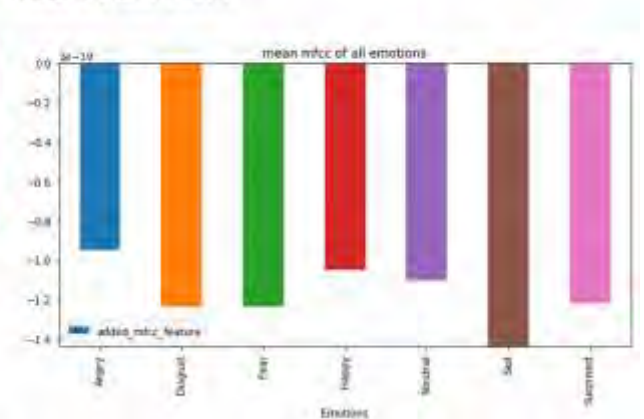


Fig.6 MFCC feature extraction

Above graph represents the MFCC coefficients extracted for each set of emotions speech file of SAVEE database.

The colors in a particular bar represent the amount of the particular MFCC coefficient percentage respectively.

First we found out the 13 MFCC for each 460 files of SAVEE database. Then we categorize the files according to the emotion such as Angry, Happy, Fear, Neutral, Sadness, Surprise, Disgust. After the categorization, each emotion category is taken (each category contains 60 files) and the sum of all the MFCC's of that category is calculated and displayed in the form of graph.

V. CONCLUSION

We have successfully collected the databases and classified them according to the type of emotion. We have learnt about the features like MFCC, Energy and Pitch and have successfully extracted the features which are required for the training of the classifier model. It can be clearly seen from the MFCC graph that emotions like Angry, Happy, Surprise have less amount of MFCC coefficients and emotions like Neutral, Sad have more amount of MFCC coefficients. From the Energy graph we can conclude that emotion like Angry have the highest amount of energy and emotion like Sad have the lowest amount of the energy. The pitch for emotions like Angry, Surprise, Happy, Neutral are comparatively high and pitch for emotion like Sad, Fear, Disgust are comparatively low. Usually the emotions for excited emotions are high but as it is high for neutral emotion, we cannot use only pitch for emotion recognition system. We are able to determine the

characteristics of different type of emotions from the extracted features.

REFERENCES

- [1] Elteto ZOLTAN, Ioan Cristian STOICA, "Voice Based Emotion Recognition with Convolutional Neural Networks for Companion Robots," ROMANIAN JOURNAL OF INFORMATION SCIENCE AND TECHNOLOGY ', Vol 20, NO.3, pp.1-20, 2017.
- [2] AnushaBalakrishnan, Alisha Rege , "Reading Emotions from Speech using Deep Neural Networks" ,''Standfort University," pp.1-8,2017.
- [3] R.LakshmiMadhuri et al, "Emotion Recognition using Wavelets and SVM Speech System ," International Journal of Research in computer and communication Technology ,Vol 6, Issue- 7, pp.1-9,July – 2017
- [4] Kun Han, Dong Yu, Ivan Tashev, "Speech Emotion Recognition Using Deep Neural Network and Extreme Learning Machine", INTERSPEECH 2014, pp.1-5,2014.
- [5] Vladimir Chernykh, Pavel Prikhodko, "Emotion Recognition From Speech With Recurrent Neural Networks", pp.1-18,July-2018.
- [6] SwetaBhadra, Uzzal Sharma, AlokChoudhury, "Study on Feature Extraction of Speech Emotion Recognition", Don Bosco College of Engineering and Technology, pp.1-3,2016.
- [7] SurabhiVaishna, SaurabhMitra, "Speech Emotion Recognition: A Review", Department of Electronics & Communication, Dr. C. V. Raman University, Vol 03, Issue- 4, pp.1-4, Apr –2016
- [8] Steven B. Davis and Paul Mermelstein. "Comparison of parametric representations for monosyllabic word recognition in continuously spoken sentences," IEEE Transactions on Acoustics, Speech and Signal Processing, 1980
- [9] Keras.io. (2019). *Home - Keras Documentation*. [online] Available <https://keras.io/>
- [10] Comparative Study of Isolated Word Recognition System for Hindi Language - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Block-Diagram-of-MFCC_fig2_281684338

This page is kept blank intentionally

A Review on Online Signature parameter using Altitude parameter

Deviprasad Pandey

Electronics and Telecommunication

Thakur college of Engineering and Technology

Pandeydev100@gmail.com

Kusum Mishra

Electronics and Telecommunication

Thakur college of Engineering and Technology

Mishrakusum100@gmail.com

Abstract—Signature verification is most widely and commonly accepted practice for authentication and authorization of an individual. Off-line signature verification is very less accurate for identification. Online signature has information such as x co-ordinate, y co-ordinate, pressure, velocity, Azimuth and Altitude of pen tip. Due to this better accuracy can be achieved when signatures are captured in real time with digitizer device like pressure pad. On-line signature verification gives 80%-98% of accuracy. Different method have been used to implement biometric signature recognition some of which are dynamic time warping (DTW), Bayesian Learning, Hidden Markov model (HMM), Neural Networks, Support Vector machine (SVM) etc. It has been found that the HMM and KNN gives low FAR and FRR and hence provide better accuracy

Keywords—Signature Verification, Biometric, HMM, Bayesian Learning, Neural Networks, DTW, SVM

I. INTRODUCTION

Handwritten signature is most widely used and accepted as

a way to verify people's identity; we usually sign documents to verify their contents or to authenticate any financial transactions. Signature verification is divided into two types

Online signature verification and offline signature verification

.Offline Signature verification usually consists just an "eye inspection" as if we compare two photographs, but this is not at all efficient because of skill forgerians forge the signature and is almost same as the genuine one . So in this case it might happen that genuine signature may be verified as forged and vice versa so it is inefficient method and so online verification of signature is to be done.

Nowadays, smart cards are being introduced in many countries, for example the Aadhar card in India. The Unique Identification Authority of India (UIDAI) is the regulatory body for this. For defining the individuality of a person, the theoretical details (individual's address information, phone number) of the person and his/her biometric information (photograph, iris-scan, fingerprints) is collected and stored in a centralized database. This

Aadhar card information will be valid throughout the life of an individual and does not require any modifications at any time in the future. These smart cards find applications in many occasions like opening an account, booking e-tickets, applying for passport or any other place that requires identity of a person. A person's signature can also be included in this card as the purpose is to authenticate a signature i.e. to validate that the signature is not forged and it actually belongs to the person who claims to be the owner of

the signature. It will enable efficient signature verification and provide high level of authenticity.

Offline properties of a signature deals with only the structural characteristics whereas the online features represent the structural as well as behavioral characteristics of a signature such as x-coordinate ,y-coordinate, altitude ,azimuth, velocity, pressure of the pen tip. This is done through a digitizing tablet i.e. Wacom Intuos pro pressure pad which is a signature capturing device which records the structure of a signature and also stores the different dynamic features of a signature.

A number of techniques and their variations have been implied to implement a fool proof signature verification system such as Hidden Markov Model (HMM) [1], [2], [3], Dynamic Time Warping (DTW) and its variations Neural Networks (NN) , [4], [5], Support Vector Machine (SVM) [3], [6],[7] etc. This paper gently introduces these techniques and presents a comparative analysis of these techniques for biometric signature verification.

The accuracy of the verification system is based on two parameters: The **false acceptance rate (FAR)**, is the measure of how many times a forged signature sample is accepted as genuine. A system's FAR can be typically calculated as the ratio of the number of false acceptances and the number of total attempts. The **false rejection rate (FRR)**, is the measure of how many times a genuine signature sample is rejected as forged. A system's FRR can be calculated as the ratio of the number of false rejections and the number of total attempts.

II. COMPONENTS REQUIRED

The user will be asked to provide some sample signatures on pressure sensitive writing pads. One of such writing pads, Wacom Intuos Pro is shown in the figure.



Every signature consist of X-coordinate - scaled cursor position along the x-axis, Y-coordinate - scaled cursor position along the y-axis, Time stamp - system time at which the event was posted, Button status - current button status (0 for pen-up and 1 for pen down), Azimuth - clockwise rotation of cursor about the z-axis, Altitude - angle upward toward the positive z-axis, Pressure - adjusted state of the normal pressure. For the current research the signature samples from 40 different users are taken, 40samples are taken for each user out of which 20 are genuine and 20 are forged. Pressure applied by the tip of the pen on the pressure sensitive pad varies during the process of signing. This altitude is chosen for the feature vector

III. DIFFERENT METHODS FOR BIOMETRIC SIGNATURE VERIFICATION

A. Hidden Markov Model (HMM)

HMMs have been applied in many application areas such as signal processing, speech recognition, pattern recognition and can be effectively implied in signature verification as well. HMM is a generalization of Markov Model. It is a robust method to model the variability of discrete time random signals where time or context information is available [13]. It can manage time duration varying signals such as signatures speech etc. For this reason it is popular for speech and signature recognition applications [9]. The signing process is divided into several states that constitute the markov chain. Each of the signature segments corresponds to each state in the model. A Sequence of probability distributions of the different features that are used in the verification task is taken and a matching is done on it [5]. The verification score in these systems is usually obtained as the signature log-likelihood. An important part in generative model-based signature verification systems is the verification score normalization [2]. The verification score is a score that determines whether a particular signature is genuine or forged using a threshold value. These threshold values can be writer dependent or feature dependent. The disadvantages of using HMM in signature verification is

that it requires huge number of features to be set, and the number of data to train the model is very large as a result of which its time complexity is very high.

In an HMM model the states are hidden (i.e. it cannot be observed) and there are some other observations depending on the initial probabilities of these two terms the most likely state is determined using an algorithm like Baldi-Chauvin or Baum- Welch. In signature verification the model can be represented as:

States= {genuine, forged}

Observations = {total time, velocity, pressure, no. of strokes}

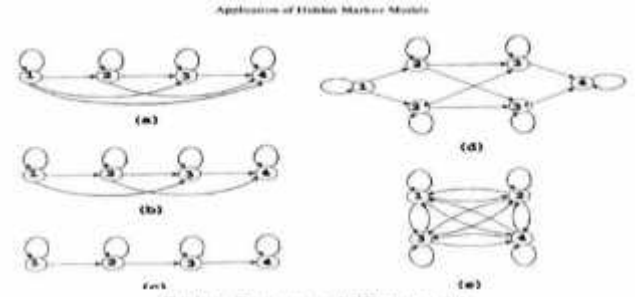


Table 1. Error rates of different models.

Model structure	Type of error rates (%)		
	False acceptance	False rejection	Average
LTR-1	6.45	1.18	3.815
LTR-2	8.47	1.87	5.17
LTR-3	11.69	1.41	6.55
Parallel	5.24	2.54	3.89
Generalized	14.11	0.78	7.445

B. Dynamic Time Warping (DTW)

DTW is the most popular technique for implementing signature verification. It is a method that determines the similarity between two time varying sequences. DTW can efficiently determine the most optimal distance between two sequences even if the accelerations of these time varying patterns are different. The most important feature of DTW is its ability to compute fast which makes it the most popular method in signature verification. It does not require huge data for training. It simply takes two sequences of time varying data or features and compares them and finds an optimal similarity between the two sample set. DTW uses a dynamic programming strategy that can manage the variability on the signatures length [9]. In this method two signature samples are

taken as sequences where points are taken in different discrete times. $S=\{s_1, s_2, \dots, s_n\}$, $T=\{t_1, t_2, \dots, t_m\}$ are two time varying sequences that represents the value of the features at 1st, 2nd and nth time. S is the sample signature stored in the database and T is the test signature sample. The time complexity of DTW is $O(n^2)$ where n is the number of points in the sequence. Although DTW is a fast technique but if the points taken on the sequence is very large then the time taken to compute the results in DTW becomes

very high and therefore a variation of DTW i.e. VQ-DTW is used. VQ stand for vector Quantization. In this method clustering of some points that are in the same region are clustered together thus reducing the time complexity of algorithm.

C. Neural Networks

Neural network is a mathematical model that can learn from examples and based on this knowledge can solve many problems such as pattern recognition. A number of genuine and forged samples are stored in the database which is used for learning and thus judging whether a given test signature is genuine or forged. An artificial Neural Network is trained to recognize the variation that exists in the target signature with respect to the sample signature. Handwritten signature samples are considered input for the artificial neural network model and typically weights are learned during training a NN. The major factors of using ANN are Expressiveness, ability to generalize, sensitivity to noise, and graceful degradation. The major drawback of using ANN model is that it takes a lot of time for training.

In modeling of a signature verification system Neural Network can be used as follows: As training data, a vector of n number of sensors can be used where n is the number of features of the signature considered for verification. Here each of these vectors would estimate the similarity of the target feature with respect to the features of genuine signature samples. The ANN used for this purpose is a multilayer feed forward network which consists of n number of input units, one output unit signaling genuine or not genuine, and some units in one or more hidden layer(s). Back propagation algorithm is used for training.

D. Support Vector Machine (SVM)

Support vector machines are supervised learning models whose foundations stem from statistical learning theory. The support vector machine takes a set of input data sample and predicts, for each given input, which of two possible classes the output belongs, which makes it a non-probabilistic binary linear classifier. SVM has been considered a good choice for solving the signature verification problem as it is frequently used for pattern recognition applications, classification and regression problems [10]. An SVM maximally separates hyper plane that determines clusters by mapping input vectors to a higher dimensional space [6]. An SVM takes a set of input data and determines to which of the two classes the input data belongs.

IV. FEATURE EXTRACTION

This is a very important step in signature verification since it is very important to find the most significant features of a signature that minimizes intrapersonal variations and maximizes interpersonal variations. The features of a signature can be of two types, global features and local features. The global features of a signature are those that describe about the whole signature for example

total time duration for signing, the boundary box of the signature, and the overall direction of the signature, the dimensions, and the pixel distribution. Whereas the local features of a signature gives the temporal information about the signature i.e. the features that refer to a particular position within a signature for example speed, acceleration, pressure, local curvature, pen-ups and pen-downs etc. In recent years pressure and force have been the most used and studied features for signature verification.

These attributes of the signature are captured using a biometric device/tablet and a pen, this device has the capability of recording all the features of a signature.

Two types of features can be used for signature verification: functions or parameters [6]. When the feature is represented as a function it represents the value of the feature at a particular time whereas the parameters are a vector of elements that characterizes a signature. Functions in general yield better performance in case of signature verification. Selecting appropriate features for verification is an important and crucial task in signature verification as the efficiency and accuracy of the system depends hugely on the features.

V. COMPARISON OF THE TECHNIQUES

Online Signature Database :

There are different database of online signatures available. Some of them are SVC2004, SUSIG etc. SVC2004 is a database of the First International Signature Verification Competition. For each of the two tasks of the competition, a signature database involving 100 sets of signature data was created, with 20 genuine signatures and 20 skilled forgeries for each set. The major difference between the two tasks is in the information provided by the signature data. The signature data for the first task contain coordinate information only, but the signature data for the second task also contain additional information including pen orientation and pressure. When evaluated on data with skilled forgeries, the best team for Task 1 gives an equal error rate (EER) of 2.84% and that for Task 2 gives an EER of 2.89%. We believe that SVC2004 has successfully achieved its goals and the experience gained from SVC2004 will be very useful to similar activities in the future.

A. Techniques and their attributes

A number of techniques are used in the implementation of signature verification system. In template matching techniques, an input sample is matched against the templates of sample signature sets stored in the database. These sample set consists of genuine as well as forged signature samples. Dynamic Time warping (DTW) is the most relevant approach in this type of template matching method. While using statistical approach, Bayesian learning and hidden

Markov Model (HMM) are the most common methods that are used. Other possible approaches are also used such as neural networks (NN) and Support Vector Machine (SVM) that use supervised Learning.

TABLE I. COMPARATIVE TECHNIQUES

Technique	Attributes		
	Approach	Basis	Type
Support Vector Machine	Predictive Modeling	Principle of structural minimization	Statistical, Supervised Learning
Feed Forward Neural Network	Machine Learning	Adaptive system changing its structure during a	Supervised Learning

		learning phase	
Dynamic Time Warping	Template Matching	Time series matching	Dynamic Programming
Bayesian Learning	Probabilistic	Use of priori information to obtain posteriori information	Statistical
Hidden Markov Model	Probabilistic	The hidden variables control the mixture component to be selected for each observation	Statistical

TABLE II. ADVANTAGES AND DISADVANTAGES OF COMPARATIVE TECHNIQUES

Technique	Attributes		
	Advantages	Disadvantages	Appropriateness in signature Verification
Support Vector Machine	Good Generalization Properties	Direct decision problem cannot be extended to multi class problem	Since it is a direct decision problem and signature verification is also a direct decision problem that either the signature belongs to genuine class or forgery class therefore it is appropriate for signature verification problem.
	Convex objective function with efficient training algorithms	Training Time is very long	
	Good for smaller number of training samples	Selection of parameter is difficult	
Neural Network	Ability to learn how to do tasks using some training data	Difficult to train a NN for large variation in number of training samples.	Neural network can create its own meaningful representation of the information it gets as input which is good for performing signature verification with inter class variations.
	Self Organization	Time complexity is high	
Dynamic Time Warping	Robust distance measurements required for accurate pattern classification	Memory space problem	This method can be effectively applicable to this problem since this would not require too many samples of input signatures to be stored and nonlinear time variations that persist even for genuine signatures can be reduced.
	Non-linear time variations of time series are reduced	Difficult to perform if the training data is large	
	Fast	Each sample must have its own reference template	
Bayesian Learning	Gives the probability of a particular event that can happen based on priori information	Does not account for any uncertainty in the value of the parameter	This method could be applicable to solve the problem because instead of just mapping the input data to one of the two output class, Bayesian network can give the probability of a particular sample of being either genuine or forged.
		Requires initial knowledge of the probability of hypothesis	

Hidden Markov Model	HMM can manage signals of different time durations	Computationally expensive Does not perform well if the sample set is too low	HMM is a very popular tool for solving signature verification problem as it has less computational burden and gives accurate results.
	Can be trained automatically		
	Less computational complexity		

All these methods and some of their descriptions are listed in Table I.

B. Advantages and Disadvantages of Comparative Techniques

While considering functions the matching becomes complicated due to writer's pauses or hesitations which can be due to emotional, weather conditions or environment. DTW is used to find out the similarity or dissimilarity between two time varying sequences which have intra-individual variations [7], the natural non-linear variations of the time sequences are reduced in DTW that even persists in genuine signatures. If the number of sample data is too high then DTW becomes computationally expensive. Therefore, to accelerate computations DTW can be used with some variations such as area bound DTW (AB_DTW) [7], VQ_DTW [9] etc. Some People exhibit a lot of variability in their signatures due to Emotional conditions, weather conditions or due to lack of habit, this limitation can be overcome using DTW. DTW uses dynamic programming algorithm to match the similarity between two sequences of sample signature.

Statistical methods are generally chosen while using parameters as features. Bayesian networks and Hidden Markov model are the most popular statistical methods used in signature verification. An HMM is a double stochastic process in which one unobservable state can be estimated through a set of observations [6]. Many topologies are used in implementing HMM, the most frequently used is left-to-right HMM [1], [5], [13].

Support Vector Machines are another promising statistical approach in signature verification. SVM use kernel functions to measure the similarity of two sample sets [10].

Neural Network is an information processing paradigm inspired by the way biological nervous system works. Similar to human brains, NNs learn by examples, a set of sample data is given to a neural network which is used for training and then further used for solving different problems like pattern recognition. Different models of Neural Networks are used for signature verification such as back propagation Neural Network, multilayer perceptron (MLP) [3], [17] and self organizing maps etc. MLP networks in particular, are widely used in signature verification systems because it is very simple to train them, very fast to use in pattern recognition and achieves high recognition rate. The two main limitations that MLP exhibit in classification problems are:

The classification problem and MLP structure has no theoretic relation.

MLP derives hyper planes separation surfaces, in feature representation space, which are not optimal in

terms of margin between the examples of two different classes [3].

Bayesian approach has also been used in signature verification, which uses the priori information to find out the most likely hypothesis. The most practical difficulty that lies while using Bayesian learning technique is that it requires initial knowledge of probabilities of hypotheses. Another difficulty is the computational cost required to determine the Bayes' optimal hypothesis.

The major advantages, disadvantages and the use of these methods in signature verification are summarized in Table II.

Author	Method	FAR (%)	FRR (%)
Houng et al [10]	Neural network	11.80	11.10
Ferrer et al [9]	HMM & SVM	12.60	14.01
Varagas et al [17]	pseudo-Cepstral coefficients & SVM	14.66	10.01
Sansone et al [18]	SVM & HMM	12.45	12.04
Ava Tahmasebi et al	HMM & KNN	11.03	10.50

VI. CONCLUSION

The paper provides an overview of the most popular methods used in signature verification. The advantages and disadvantages of these methods are given which gives an estimate of which method should be used in which case. A handwritten signature is a result of complex psychological procedure and therefore it is very difficult to estimate it using any method therefore it is required to find out the most optimal method that approximates the distinguishing features of a signature and use it to verify an individual. This paper provides a considerable amount of clearance to understand which method is suitable for signature verification. The most commonly used strategies are matching by Dynamic Warping and by using Hidden Markov Model. Dynamic warping approaches give a flexible matching of the local features. An HMM performs stochastic matching of a model and a signature using a sequence of probability distributions of the features along the signature. It is evident that hidden markov model method is worthy of further research in order to obtain better performance.

REFERENCES

- [1] S. Garcia-Salicetti and B. Dorizzi, "On using the Viterbi path along with HMM likelihood information for online signature verification," *IEEE Trans. Syst., Man, Cybern. B*, vol. 37, no. 5, pp. 1237–1247, Oct. 2007.

- [2] E. A. Rúa and J. L. Alba, "Online Signature Verification Based on Generative Models," *IEEE Trans. Syst., Man, Cybern. B*, vol. 42, no. 4, pp. 1231-1242, Aug. 2012.
- [3] E. Frias-Martinez, A. Sanchez and J. Velez, "Support vector machines versus multi-layer perceptrons for efficient off-line signature recognition," *Engineering Applications of Artificial Intelligence* vol.19 pp.693-704, March 2006.
- [4] M. M.M. Fahmy, "Online handwritten signature verification system based on DWT features extraction and neural network classification," *Ain Shams Engineering Journal*, Elsevier, vol. 1, pp. 59-70, 2010.
- [5] R. S. Kashi, J. Hu, W. L. Nelson, and W. L. Turin, "A hidden Markov model approach to online handwritten signature verification," *Int. J. Doc. Anal. Recognit. (IJ DAR)*, vol. 1, no. 2, pp. 102-109, 1998.
- [6] D. Impedovo and G. Pirlo, "Automatic Signature Verification: The State of the Art," *IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS—PART C: APPLICATIONS AND REVIEWS*, VOL. 38, NO. 5, SEPTEMBER 2008.
- [7] M. Bashir and J. Kempf, "Area bound dynamic time warping based fast and accurate person authentication using a biometric pen," *Digital Signal Processing*, Elsevier, <http://dx.doi.org/10.1016/j.dsp.2012.08.013>, 2012.
- [8] M. F. Zanuy and J. M. P. Gaspar, "Efficient on-line signature recognition based on multi-section vector quantization," *Pattern Anal Applic*, vol.14, pp.37-45, 2011.
- [9] M. F. Zanuy, "On-line signature recognition based on VQ-DTW," *Pattern Recognition*, Elsevier, vol. 40, pp. 981 – 992, 2007.
- [9] C. Gruber, T. Gruber, S. Krinninger, and Bernhard Sick, "Online Signature Verification With Support Vector Machines Based on LCSS Kernel Functions," *IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS—PART B: CYBERNETICS*, VOL. 40, NO. 4, pp. 1088-1100, AUGUST 2010.
- [10] D. Pu and S. N. Srihari, "A Probabilistic Measure for Signature Verification based on Bayesian Learning," *International Conference on Pattern Recognition*, IEEE, pp. 1188-1191, 2010.
- [11] D. Pu and S. N. Srihari, "A Probabilistic Measure for Signature Verification based on Bayesian Learning," *International Conference on Pattern Recognition*, IEEE, pp. 1188-1191, 2010.
- [12] A. Kholmatov and B. Yanikoglu, "Identity authentication using improved online signature verification method," *Pattern Recognition Letters*, Elsevier, vol. 26 pp. 2400-2408, 2005.
- [13] J. Fierrez , J. O. Garcia and D. Ramos, "HMM-Based On-Line Signature Verification: Feature Extraction and Signature Modeling," *Pattern Recognition Letters*, Elsevier, vol. 28, no. 16, pp. 2325-2334, December 2007.
- [14] V. S. Nalwa, "Automatic On-Line Signature Verification," *PROCEEDINGS OF THE IEEE*, VOL. 85, NO. 2, pp. 215-239, FEBRUARY 1997.
- [15] D. Bhattacharyya and T. H. Kim, "Design of Artificial Neural Network for Handwritten Signature Recognition," *INTERNATIONAL JOURNAL OF COMPUTERS AND COMMUNICATIONS*, Issue 3, Vol. 4, pp. 59-66, 2010.
- [16] L. Nanni and A. Lumini, "Advanced methods for two-class problem formulation for on-line signature verification," *Neurocomputing*, vol. 69, pp. 854-857, 2006.
- [17] A. Szklarzewski and M. Derlatka, "On-line Signature Biometric System with Employment of Single-output Multilayer Perception," *Biocybernetics and Biomedical Engineering*, Vol. 26, No. 4, pp. 91-102, 2006.
- [18] A. McCabe, J. Trevathan and W. Read, "Neural Network-based Handwritten Signature Verification," *JOURNAL OF COMPUTERS*, VOL. 3, NO. 8, pp. 9-22, AUGUST 2008.

Techniques for Estimating Vocal Tract Shape for Speech Training Aids

Shilpa Chaman
Assistant Professor, EXTC Department
St. Francis Institute of
Technology, Mumbai University
Mumbai, India
shilpachaman@sfitengg.org

Abstract— The main goal of this paper is to review various techniques for mapping acoustical properties of speech to the geometry of vocal tract which is helpful in speech synthesis, speech recognition, coding, music control and in speech training aids. Mathematically, the synthesis of speech from a given set of time-varying articulatory parameters, known as direct problem, is well understood but the inverse problem of estimating vocal tract geometry from natural input speech is difficult because of the non-uniqueness of acoustic to articulatory mapping. Different techniques are discussed which may provide visual feedback of articulatory efforts in speech training aids for the hearing impaired people.

Keywords— articulatory synthesis, vocal tract estimation, speech training aids

I. INTRODUCTION (HEADING 1)

Articulatory synthesizer is a model for human speech production from articulatory parameters like lung pressure, jaw angle, nasality, tongue movement, velum opening, lip opening etc. In articulatory speech mimic, the articulatory synthesizer is combined with methods for estimating its control parameters to generate natural speech. The direct problem of speech synthesis from a given time-varying geometry of the vocal tract and glottis is well understood but the inverse problem of estimating vocal tract geometry from natural input speech is difficult because of the non-uniqueness of acoustic to articulatory mapping. This has attracted many researchers to estimate the articulatory parameters from acoustic information obtained from speech and to display these features for various purposes like speech training aids for hearing impaired people, musical control, text-to-speech synthesis, synthesis of best quality speech from the recovered shapes, for coding etc.

In hearing impaired people, the absence of auditory feedback eventually leads to speaking disability in them. Hence, in spite of having proper speech production mechanism, they are unable to speak. The hearing impaired often tries to speak by visualizing lip movements but they are not able to understand proper articulation, speech intensity or pitch variations. Several computer based speech training aids are developed based on visual feedback of acoustic parameters for the hearing impaired people.

This paper is structured as follows. Section II describes a simplified acoustic model of vocal cord and vocal tract. A review various techniques for speech synthesis and acoustic to articulatory mapping is discussed in section III, followed by a discussion on

methods for improving the estimation of vocal tract shape in Section IV. A visual model for speech training aids is mentioned in Section V and Section VI concludes this paper and also provides future scope.

II. ACOUSTIC TUBE MODEL OF VOCAL TRACT

Human acoustic system of vocal tract and chord [1] is depicted in Fig. 1. The vocal tract can be considered as a non-uniform tube with varying cross sectional area from zero to 20 cm² and of length 17 cm approximately. When a person speaks, the subglottal air pressure is applied, which leads to the oscillations of the vocal cord model and results in the glottal volume velocity. Sound is radiated from the system which results in volume velocities at the mouth and nostrils.

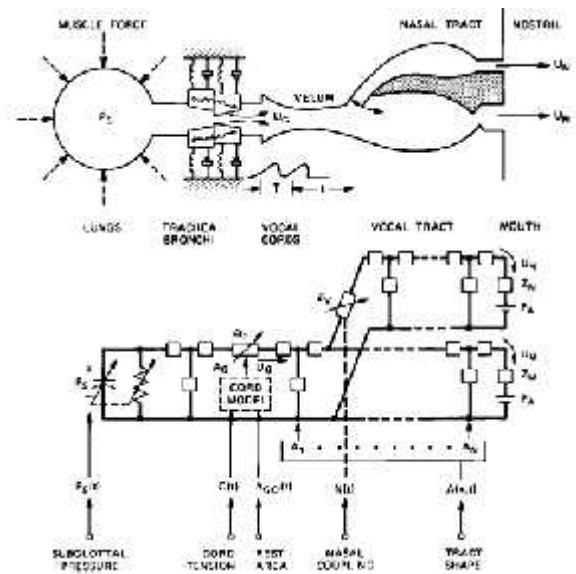


Fig. 1. Acoustic tube model of human vocal tract

Cross-dimensions of the human acoustic model are small as compared to sound wavelengths, therefore planar wave motion can be confined in the tract. The vocal tract can be straightened out and hence approximated as a variable-area tube and hence the linear wave equation is valid. The shape of a vocal tract is completely specified by the area function, $A(x)$, which specifies the cross-sectional area as a function of position along the tract, with $x = 0$ at the glottis end of the tract. The pressure, $P(x,s)$, and the volume velocity, $U(x,s)$ in the tube satisfy the pair of first order differential equations (1), (2), assuming no viscous or thermal losses.

$$\frac{dP}{dx} = \frac{ps}{A} U \text{ --- (1)}$$

$$\frac{dU}{dx} = -\frac{As}{\rho c^2} P \text{ --- (2)}$$

where, s is the complex frequency variable, p is the density of air, and c is the velocity of sound. By Webster's Horn equation [2], the volume velocity can be eliminated from (1), to yield equation (3).

$$\frac{dy}{dx} \frac{dA}{dx} - \frac{s^2}{c^2} AP = 0 \text{ --- (3)}$$

Similarly, an equation for $U(x,s)$ alone can be derived by eliminating $P(x,s)$. These equations relate pressure and volume velocity directly to area function. If frequency dependent viscous and thermal losses $M(x,s)$ and wall impedance $N(x,s)$ are considered [3] then the equation is modified to

$$\frac{dM(x,s)}{dx} \frac{dP}{dx} - N(x,s)P = 0 \text{ --- (4)}$$

Here the functions $M(x,s)$ and $N(x,s)$ can be computed in terms of $A(x)$.

III. TECHNIQUES FOR SPEECH SYNTHESIS AND ESTIMATION OF VOCAL TRACT SHAPE

There are two main problems in the area of speech production. One is the direct problem of speech synthesis from a given set of time-varying articulatory parameters and other is the inverse problem of estimating vocal tract geometry from the natural input speech. The second problem is relatively difficult because of the non-uniqueness of acoustic to articulatory mapping.

A. Direct Problem

Speech signal can be synthesized if the articulation information, like the area function $A(x)$, the wall impedance, and the loss parameters of the vocal tract, are specified. Then (1) or (2) can be solved for any given boundary conditions at the lips and glottis. With a proper choice of boundary conditions, we can generate the speech signal for a variety of sounds.

If the case of computation of non-nasalized vowel sounds is taken with boundary condition at the lips is such that the tract is terminated with the radiation impedance, $Z_L(s)$. The solution for the pressure in the tract which satisfy this boundary condition is $H_p(x,s)$ and the volume velocity at the glottis is unity. Let $H_u(x,s)$ be the corresponding volume velocity. Then the volume velocity in the vocal tract due to any other input $U_g(s)$ at the glottis is

$$U(x,s) = H_u(x,s)U_g(x,s) \text{ --- (5)}$$

In particular, the volume velocity at the lips is obtained by setting $x = L$, the length of the vocal tract. The function $H_u(L, s)$ is called the transfer function of the tract. Then the speech signal in the frequency domain is

$$S(L,s) = U(L,s)Z_L(x,s) \text{ --- (6)}$$

Flanagan, Ishizaka, and Shipley in [4] created such type of articulatory speech mimic systems. Further they put a closed optimization loop around their articulatory speech synthesizer in [5] by comparing the spectra of the synthesized speech with given spectra of consecutive target speech frames. For each frame, an optimization procedure tried to minimize an acoustic distance between the two speech signals, thus, in effect, estimating articulatory parameters by an analysis-by-synthesis procedure. Further on these lines Schroeter et al. continued and created a new articulatory synthesizer [6], and an articulatory speech mimic [7]. Elsewhere, similar approaches were taken (e.g., [8], [9]).

A major problem in articulatory analysis-by-synthesis procedure is the initialization of the optimization loop. One need to choose good startup parameters since most optimization algorithms will only find the local minimum of a given cost function that is near the initial parameters. This can be achieved by employing an acoustic-to-articulatory mapping. One possible realization of such a map is called articulatory codebook.

1) *Articulatory Codebook*: It is a table of corresponding acoustic and geometric vectors [10]. The acoustic representation is given as a key to look up (retrieve) the associated vocal-tract shape. Such articulatory codebooks provides a good set of start-up vectors for global optimization. In fact, if the codebook-lookup were good enough, one might avoid the iterative optimization altogether.

2) *Non-Uniqueness*: It can be seen that the acoustic input impedance of the tract uniquely specifies the area function while the transfer function does not. Two kinds of nonuniqueness can be defined. The first kind is due to the fact that different tract shapes may have (almost) the same transfer function. The second kind arises from the fact that the same speech spectrum may be produced by two different tract shapes with appropriately selected inputs at the glottis (vocal cords). Both types of non-uniqueness have to be dealt with in an articulatory analysis/synthesis system. Direct problem of speech synthesis is well understood but the inverse problem of estimating vocal tract geometry from natural input speech is difficult because of the nonuniqueness of acoustic to articulatory mapping. In order to show this non-uniqueness lets discuss the inverse problem.

B. Inverse Problem

They employ techniques to estimating articulatory information especially the vocal tract area function $A(x)$

using acoustic measurements i.e. from the analysis of the speech signal, but this inverse problem is slightly ambiguous because of the non-uniqueness of acoustic-to-articulatory mapping. The vocal tract shape can be computed using numerous direct and indirect methods.

1) *Direct methods*: In these methods by exposure to electromagnetic waves, the vocal tract shape is acquired by extracting its various articulatory features. Following are the various direct methods :

a) *X-Ray*: In this traditionally method [11], the movement of vocal tract is captured on high speed films using X-Ray beams and it provides the best view the for speech research, but it is no longer in practice due to its possible harmful effects.

b) *X-Ray Microbeam (XRMB)*: In this method [12] the vocal tract shapes are estimated using a narrow beam of high energy X-Rays which track the motion of gold pellets glued at certain positions on the tongue, jaw, lips, and soft palate. This provides details of articulators in the mid sagittal plane (side-view) and is also known as an articulograph. User can also control the rate of display of the articulograph, and it also displays the pitch, RMS trace of the audio signal, and spectrogram.

c) *Multi-Channel Articulatory (MOCHA)*: In this method [13] both Electro Magnetic Articulograph (EMA) and Electro Palatograph (EPG) are used for various utterances. The EMA provides details of mid-sagittal plane similar to the XRMB sampled at a rate of 500 Hz. It uses 6 pellets to track the motion of vocal tract. The EPG, on the other hand, provides tongue-palate contact details at a sample rate of 200 Hz. It uses 62 contacts which are distributed along 8 rows over the upper palate. Contact made by the tongue on any one of the contact causes that particular contact to be shaded in the display. The contact made in the first three rows, the next two and the last three indicates an alveolar, palatal, and velar contact respectively in an utterance. There is a provision to simultaneously listen to the audio recording and observe articulatory data for these sentences.

d) *Ultrasound imaging*: This method [14] is based on the application of ultrasound which produces an image by using the reflective properties of sound waves. Although its a non-invasive method without any harmful effects on the speaker but the images produced tend to be very noisy and estimation of places of articulation is prone to error especially for the base or the tip of the tongue.

e) *Magnetic Resonance Imaging (MRI)*: In this method MRI is used for vocal tract area measurements directly [15]. A 3D volume could be constructed by scanning over a period of around 65 minutes and taking 26 slices. The area then can be estimated by counting the 3D voxels in a given section. The major drawback of this method is that the speaker has to be in supine

position when articulating and also have to sustain the articulatory position during the scanning. This may cause speaker to get tired. Also the absence of simultaneous speech recordings for corresponding articulatory efforts hinders this method's usefulness for validation of vocal tract shape estimation.

2) *Indirect methods* : They employ various time-domain and frequency domain methods to estimate the vocal tract shape using acoustic measurements or from the analysis of the speech signal.

a) *Time Domain Methods*: One of the acoustic measurements for vocal tract shape estimation involves measurement of the acoustic impedance at the lips [16] by using a long impedance tube. The speaker has to articulate without phonation, and hence this method cannot be used for speech training.

Another method was proposed by Sondhi and Gopinath [17] which is based on the time domain specification of the input impedance, $z_{in}(t)$. They showed that there is a unique one-to-one correspondence between $z_{in}(t)$ for $0 < t < T$ and $A(x)$ for $0 < x < cT/2$. Further, the method can be generalized to include the effect of losses and yielding walls [18], [19], provided that these losses are known. However, this method is not useful for deriving $A(x)$ from the speech signal, because one needs to make a measurement of the input impedance.

b) *Frequency Domain Methods*: Almost 65 years ago Borg [20] considered an ideal, lossless vocal tract and proved a remarkable result that allows computation of area function from the knowledge of certain sets of eigenvalues of boundary value problems associated with (2).

Ladefoged et al. [21] estimated vocal tract shapes from formant frequencies. The first three formants were extracted from speech and used for vocal tract shape estimation of vowels. As different vocal tract shapes may correspond to the same set of formant frequencies, constraints were imposed to exclude the vocal tract shapes which are not physically possible. Methods based on inverse filtering of speech signal generally used linear predictive coding (LPC) proposed by Wakita [22]. The method modelled vocal tract as a lossless acoustic tube with equal-length segments of varying cross-sectional areas as shown in Fig.2. The analysis gives reflection coefficients which are used to obtain the area ratios at the section interfaces using the relation.

$$\frac{A_i}{A_{i+1}} = \frac{1+r_i}{1-r_i} \quad \text{--- (7)}$$

where, A_i is the area of i th section and r_i is the reflection coefficient at the section interface of A_i and A_{i+1} . Generally, the scaling is carried out by assuming the glottis end of the vocal tract to have a normalized area of unity which is used as the reference area for scaling.



Fig. 2. Vocal tract modelled as sections of equal length and varying area

However, the change in the area at the glottis end during speech production introduces gross errors during dynamic estimation of the vocal tract shape, as also seen in MRI images [23] for different utterances. Hence the assumption of a constant reference area at the glottis end cannot be considered.

IV. METHODS FOR IMPROVING ESTIMATION OF VOCAL TRACT SHAPE

The proposed solution to improve the LPC based estimation done by Wakita [22], is to use the area of mouth opening i.e. the inner lip contour area as the reference area for scaling purposes. Nayak et al. [24] estimated the required inner lip contour area from the video recording of speaker's face during speech utterance. The points corresponding to lip opening were manually marked and joined using straight line and the number of pixels within the polygon formed was used as its area. This was repeated for all frames of the video. The area values were normalized by the area obtained for the largest opening, which occurs during the utterance of vowel /a/. It was reported that the scaling of the vocal tract using the area of mouth opening resulted in better estimation of vocal tract shape area compared to the one obtained by using a constant reference area.



Fig. 3. Block diagram for inner lip contour area detection

Jain et al. [25] continued on these lines and developed an image processing technique based on colour transformation and template matching for consistent and accurate detection of the inner lip contour.

This technique was robust against variations in illumination, skin hues across speakers and also not affected by the presence of tongue and teeth. It is compared with reference to manually estimated values and the results were much better. Block diagram of the technique used for detection of inner lip contour is depicted in Fig.3.

V. VISUAL SPEECH TRAINING AID

Normal people can acquire the ability to control various articulators parameters like lung pressure, jaw angle, nasality, tongue movement, velum opening, lip opening etc. by the age of four since they receive both visual and auditory feedback. However, hearing impaired people do not have access to the auditory feedback and hence they are not able to speak, in spite of having proper speech production mechanism. They have neither auditory loop nor any remembrance of speech by themselves. Lip reading technique also fails, since vowels & consonants with tongue movement hidden in the mouth are not distinguishable to them by simply visualizing lip movements.

Speech-training systems can be designed based on visual or tactile feedback of acoustic parameters such as speech intensity, fundamental frequency, spectral features or based on feedback of articulatory parameters such as voicing, nasality, lip & vocal tract movement [28]-[29]. The tactile feedback is difficult to understand, delayed and unnatural whereas visual speech training aid provides better feedback as the person's voice and articulation can be immediately shown on the computer display. This way, hearing impaired person would be able to evaluate and correct their utterance or pronunciation based on expected and actual parameters that are displayed to him. Like, they can compare the articulation of their vocal tract shapes with the reference articulation and suitably correct their articulation defects.

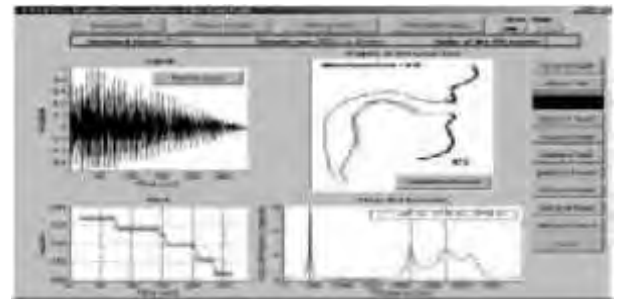


Fig. 4. Speech training aid based on visual feedback

VI. CONCLUSION AND FUTURE SCOPE

In this paper a review of various available techniques for mapping acoustical properties of speech to the geometry of vocal tract is done. After a brief introduction of the acoustic system of vocal tract, the direct and inverse problems are discussed. This led to the discussion of the important issue of non-uniqueness, that is, more than one tract shape can produce a given tract transfer function. Various ideas for alleviating this ambiguity are discussed. Also a discussion on how to reduce errors in estimated vocal tract shape, caused by variation in the area at glottis end is done. By considering lip area as a reference for scaling instead of glottis area, this problem can be solved. Finally the model of visual speech training aid is presented.

It remains to be seen if novel and improved applications of image processing and neural network are considered, the lip area estimation may further be improved and it may provide significantly better mappings than the other approaches.

REFERENCES

- [1] J. L. Flanagan, K. Ishizaka, and K. L. Shipley, "Synthesis of speech from a dynamic model of the vocal cords and vocal tract," *Bell Syst. Tech. J.*, vol. 45, no. 3, pp. 199-229, 1975.
- [2] J. L. Flanagan, *Speech Analysis Synthesis and Perception*, 2nd ed. New York: Springer, 1972.
- [3] M. M. Sondhi, "Model for wave propagation in a lossy vocal tract," *J. Acoust. Soc. Am.*, vol. 55, no. 5, pp. 1070-1075, 1974.
- [4] J. L. Flanagan, K. Ishizaka, and K. L. Shipley, "Signal models for low bit-rate coding of speech," *J. Acoust. Soc. Am.*, vol. 68, no. 3, pp. 780-791, 1980.
- [5] J. L. Flanagan, K. Ishizaka, and K. L. Shipley, "Synthesis of speech from a dynamic model of the vocal cords and vocal tract," *Bell Syst. Tech. J.*, vol. 45, no. 3, pp. 199-229, 1975.
- [6] M. M. Sondhi and J. Schroeter, "A hybrid time-frequency domain articulatory speech synthesizer," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. ASSP-35, no. 7, pp. 955-966, July 1987.
- [7] J. Schroeter, J. N. Larar, and M. M. Sondhi, "Speech parameter estimation using a vocal tract model," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Processing*, vol. 1, 1987, pp. 308-311.
- [8] S. Maeda, "A digital simulation method of the vocal-tract system," *Speech Communication*, vol. 1, pp. 199-229, 1982.
- [9] P. Meyer, R. Wilhelms, and H. W. Strube, "A quasiarticulatory speech synthesizer for the German language running in real time," *J. Acoust. Soc. Am.*, vol. 82, no. 2, pp. 523-539, 1989.
- [10] J. N. Larar, J. Schroeter, and M. M. Sondhi, "Vector quantization of the articulatory space," *IEEE Trans. Acoust., Speech, Signal Processing*, vol. 36, no. 12, pp. 1812-1818, 1988.
- [11] G. Fant, *Acoustic Theory of Speech Production*. The Hague: Mouton, 1960.
- [12] J. R. Westbury, *X-ray Microbeam Speech Production Database User's Handbook (Version 1.0)*, June 1994. [Online]. Available: https://files.nyu.edu/ag63/public/fhs_atelier/ubdbman.pdf (Last accessed in May, 2011).
- [13] A. A. Wrench, "MOCHA multichannel articulatory database," 2008. [Online]. Available: http://data.cstr.ed.ac.uk/mocha/README_v1.2.txt (Last accessed in May, 2011).
- [14] B. Denby and M. Stone, "Speech synthesis from real time ultrasound images of the tongue," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process.*, 2004, vol. 1, pp. 685-688.
- [15] B. H. Story, I. R. Titze, and E. A. Hoffman, "Vocal tract area functions from magnetic resonance imaging," *J. Acoust. Soc. Am.*, vol. 100, no. 1, pp. 537-554, 1996.
- [16] M. R. Schroeder, "Determination of the geometry of the human vocal tract by acoustic measurements," *J. Acoust. Soc. Am.*, vol. 41, no. 4, pt. 2, pp. 1002-1010, 1967.
- [17] M. M. Sondhi and B. Gopinath, "Determination of vocal tract shape from impulse response at the lips," *J. Acoust. Soc. Am.*, vol. 49, no. 6, pp. 1070-1075, 1974.
- [18] M. M. Sondhi and B. Gopinath, "Determination of the shape of a lossy vocal tract," in *Proc. Seventh Int. Congr. Acoust. (Budapest, Hungary)*, 1971.
- [19] J. R. Resnick, "Acoustic inverse scattering as a means for determining the area function of a lossy vocal tract: theoretical and experimental model studies," Ph.D. dissertation, Johns Hopkins Univ., Baltimore, MD, 1979.
- [20] G. Borg, "Eine Umkehrung der Sturm-Liouvilleschen Eigenwertaufgabe," An inversion of the Sturm-Liouville eigenvalue problem," in *German Acta Mathematica*, vol. 78, pp. 1-96, 1946.
- [21] P. Ladefoged, R. Harshman, L. Goldstein, and L. Rice, "Generating vocal tract shapes from formant frequencies," *J. Acoust. Soc. Amer.*, vol. 64, no. 4, pp. 1027-1035, 1978.
- [22] H. Wakita, "Direct estimation of the vocal tract shape by inverse filtering of acoustic speech waveforms," *IEEE Trans. Audio Electroacoust.*, vol. AU-21, no. 5, pp. 417-427, 1973.
- [23] S. Narayanan, A. Toutios, V. Ramanarayanan, A. Lammart, J. Kim, S. Lee, K. S. Nayak, Y. Kim, Y. Zhu, L. Goldstein, D. Byrd, E. Bresch, P. K. Ghosh, A. Katsamanis, and M. Proctor, "Real-time magnetic resonance imaging and electromagnetic articulography database for speech production research," *J. Acoust. Soc. Am.*, vol. 136, pp. 1307-1311, 2014.
- [24] N. S. Nayak, R. Velmurugan, P. C. Pandey, and S. Saha, "Estimation of lip opening for scaling of vocal tract area function for speech training aids," in *Proc. 18th National Conf. Commun., Kharagpur*, 2012, pp. 521-525.
- [25] S. Jain, P. C. Pandey, and Rajbabu Velmurugan, "Lip Contour Detection for Estimation of Mouth Opening Area," in *Proc. 5th National Conf. on Computer Vision, Pattern Recognition, Image Processing and Graphics*, Patna, 2015.
- [26] P. Viola and M. Jones, "Robust real-time face detection," *Int. J. of Computer Vision*, vol. 57, no. 2, pp. 137-154, 2004.
- [27] R. Hsu, M. Abdel-Mottaleb, and A. K. Jain, "Face detection in color images," *IEEE Trans. Pattern Analysis and Machine Intelligence*, vol. 24, no. 5, pp. 696-706, 2002.
- [28] C. S. Watson, M. Elbert and G. DeVane, "The Indiana Speech Training Aid (ISTRA)," *J. Acoust. Soc. Am.*, Vol. 81, Issue S1, pp. 95, 1987.
- [29] A. M. Oster, "Auditory and visual feedback in spoken L2 Teaching," Reports from the Dept of Phonetics, Umeå University, PHONUM 4, 1997.

This page is kept blank intentionally

Automated Circuit Level Testing Of Digital Stethoscope

Sayali Shinde
M.Tech(Electronics)
EED VJTI, Mumbai, India
sayalishinde234@gmail.com

Om Patel
M.Tech(Electronics)
EED VJTI, Mumbai, India
ompatel13101995@gmail.com

Adarsha K
CEO of Ayu Devices,
An IIT Bombay Company
adarsha.k@ayudevices.com

Surendra Bhosale
Associate Professor
EED VJTI, Mumbai, India
sjbhosale@ee.vjti.ac.in

Abstract:- Stethoscope is one of the critical tool used to assess a patient's health by performing auscultation. The addition of electronic circuit in the acoustic stethoscope is called Digital stethoscope. Digital stethoscope utilizes a microphone, amplifier and electronic circuit as modifiers of the acoustic signal into digital.

Module test is required to test product functionalities and reliabilities. The device which is to be tested is digital stethoscope which is called as AYU lynk .This Paper includes hardware designing of PCB test jig using NI Virtual bench and python that will be used for automated testing of Digital stethoscope. Automated Test Equipment (ATE) will verify the PCB's functionality and its behavior .The test procedure includes generating test cases through Ni virtual bench. These test cases will verify the functionality of various components on PCB and determine the test as pass or fail. These testing results will be used to detect the exact fault location on PCB. These will reduce time, efforts & errors in testing and evaluating circuit parameters of stethoscope.

Keywords: Automated test equipment (ATE), NI Virtual Bench, Digital stethoscope, Device under test (DUT), JIG.

I. INTRODUCTION

An automated test equipment system (ATE) is composed of test instruments that are capable of applying stimuli and taking accurate measurement under the control of computer that is used to test device, known as the Device under Test (DUT) or Unit under Test (UUT) [2]. ATE can be used to test simple electronics components like resistor, capacitor to very complex Integrated Circuits and PCB [5].

The jig here is an ATE system that is a customize tool made for testing of the particular stethoscope PCB [2]. It ensures proper working of the stethoscope PCB. It tests for working of each component of the PCB. The GUI of the application will be completed with the help of Pyqt5. All the data from the jig will be forwarded to NI Virtual Bench .The messages will also be displayed on to the GUI. The purpose of testing is to detect defective PCB, to find out which part of PCB is not functioning properly, to avoid

defective PCB assembly at Production Line, to avoid Field failure and reloading of finish product, to collect data of faults for analysis purpose [2]. There are Several PCB test strategies to choose from including boundary scan and manufacturing defects analyzers

II. PRELIMINARIES

This section provides the description of how planning of the design of jig is carried out. The basic of the Digital stethoscope is to be studied to design Jig.

A. Working of Digital stethoscope PCB

It consists of battery, LDO, mic, filter and headphone and mono amplifier. LDO is use to give accurate low voltage of 3.3V from battery. Heart beat sound is received by mic circuit which is given to filter section. It will filter out all unwanted signal/frequency and pass only heart sound .filter sound is given to headphone and mono amplifier to amplify signal. The supply for all IC is given from LDO output.



Fig.1.Ayu lynk attached to normal stethoscope

B. Methodology

Digital stethoscope ATE is designed to check the following section.

1. Battery output and charging circuit.
2. Low drop out voltage section.
3. Filter section
4. Amplifier section.

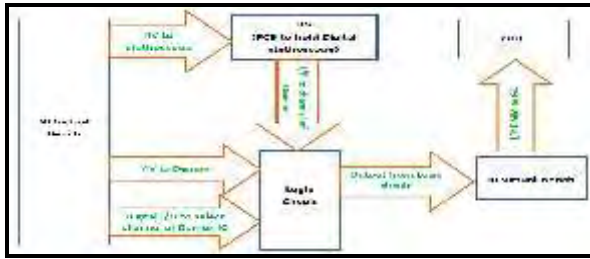


Fig.2. Block diagram of ATE

The power supply from NI is given to Digital stethoscope and Logic circuit and digital I/O inputs from NI is given to logic circuit to control select line of Demux IC. The JIG contain pogo pins which directly get contact with Digital stethoscope PCB through via points of which voltage value need to check and output of pogo pins are given to Demux channel in logic circuit. Depending upon select line, logic circuit will provide appropriate output at specific interval and it is measured by digital Multimeter of NI.

The automation of all input and output is done with the help of python language and all input and output and details of pass and fail criteria is be display on GUI .NI Virtual Bench application requires zero installation and can load automatically via Windows Auto play when connected through USB. Virtual Bench is an all-in-one instrument that integrates with PC .It combines a mixed-signal oscilloscope, a function generator, a digital Multimeter, a DC power supply, and digital I/O into a single device. JIG is device which contains PCB that is design according to required test point and pogo pins are mounted on this test points. On this pogo pins device to be testes are kept.

III. IMPLEMENTATION

1. Hardware

In this experiment JIG is used to hold DUT for test and logic circuit to link jig and NI Virtual bench.

1.1 JIG PCB

Jig PCB is used to hold assembled PCB [8].It consist of pogo pins which will be directly get connected to PCB through via points and it will give appropriate voltage of particular point.[4] The circuit designing of jig is completed using multisim. PCB layout is done with the help of Altium.

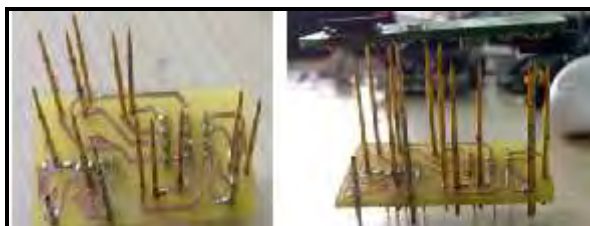


Fig.3.Assembling of JIG with digital stethoscope device

1.2 Logic circuit:

It consist of 16:1 De-multiplexer IC .All voltage value from pogo pins are given to 16 channels of Demux and depending on select line of Demux ,particular channel voltage will be present at Demux output at fixed interval

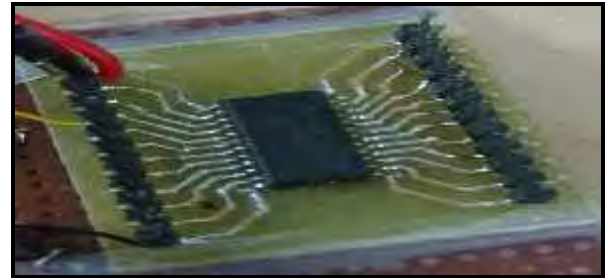


Fig.4. Logic circuit

of time through python coding with NI virtual bench. Supply to logic circuit is given from NI Virtual Bench.

1.3 Experimental setup

Below connection consist of PCB JIG, Logic circuit, assembled PCB to test and NI virtual bench. Assembled PCB is placed on JIG which contains pogo pins whose output is given to logic circuit. Logic circuit contain Demux IC, depending on channel of Demux selected via NI virtual bench I/O pins, the output of IC is given to digital Multimeter of NI virtual bench. The supply to digital stethoscope and logic circuit is given by NI Virtual bench.



Fig.5. Experimental setup

2. Software

Software PyQt5 and Python is used in this project

2.1 Python

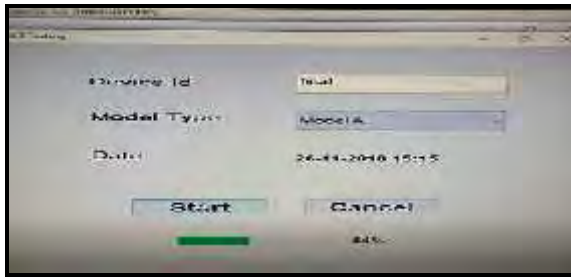
The Selection of Python code is due to its compatibility with NI Virtual Bench .It is used to integrate NI virtual bench with JIG and to automate whole setup. Latest version is python 3.7 is used for showing final output.

2.2 PyQt5

To develop Graphical user interface (GUI), PyQt5 is use to display all input, output detail and also pass and fail criteria

Following step need to perform to obtain result

1. Open GUI which will look like below



2. Enter Device ID, model type and click on start.
3. After clicking on start, the main code will run at backend which will take voltage reading from PCB and compare with pre-defined values.
4. After completion of test it will pop up result window which contain individual voltage value along with pass and fail comment.



Automated test jig is still in process of development as to provide outer casing to whole setup and to store result directly in particular folder in text file. In this paper we have successfully investigated the automated testing of PCB is much faster, appropriate and human error free than manual testing. Test automation when carried out in a planned manner, offers great benefits and is therefore worth considering.

The results and knowledge included herein have been obtained owing to support from Dr. Surendra Bhosale, Associate professor at Veermata Jijabai Technological Institute, Matunga, Mumbai-400019 and Industry supervisor Mr. Adarsha K. CEO of Ayu

- [1] Roja, G. P., & Sarala, S. M. (2017). "Automated testing of the medical device." 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT). 2017
- [2] Shafali Verma, N. M. Wagdarikar "Automated Test Jig for Refrigerator PCB Performance" International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT) International Institute of Information Technology (PIT), Pune. 2016
- [3] Anthony Coyette, Baris Esen, Wim Dobbelaere, Ronny Vanhooren and Georges Gielen "Automatic Test Signal Generation for Mixed-Signal Integrated Circuits using Circuit Partitioning and Interval Analysis", IEEE International Test Conference (ITC) 2016.
- [4] Kuo-Liang Wu1, Jwo-Shiun Sun1, and Guan, "A Novel Pogo Pin Connector Design for High Speed USB3.1 Operations" (PIERS), 2016
- [5] Nilangi U. Netravalkar, Sonia Kuwelkar, "Design of Jig for Automated PCB Testing"- International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 4, Issue 4, April 2015.
- [6] Serban, M., Vagapov, Y., Holme, R. "Universal platform for functional testing of printed circuit boards", Int. J. Circuits and Architecture Design, Vol. 1, No. 3, pp.222-241(2014).
- [7] Richard Hooper, PhD, PE "Optimal Switching Architecture for Automated Test Equipment" 978-1-4244-9363-0/11/ ©2011 IEEE.
- [8] Phang Siow Feng, Wong Kok Sun "Customized Jig For Test Debug", 2011 IEEE 13th Electronics Packaging Technology Conference, 7-9 Dec. 2011.
- [9] Gurudutt D. Mysore and James M. Conrad, "A Microcontroller based bed-of-nails test fixture to program and test small printed circuit boards", Newberry, B. SoutheastCon, 2006. Proceedings of the IEEE.
- [10] Pogo Pin Assembly and Via Design for Multi-Gigabit Interfaces on Automated Test Equipment", Proceedings of Asia Pacific Microwave Conference 2006.

- [6] Serban, M., Vagapov, Y., Holme, R. "Universal platform for functional testing of printed circuit boards", Int. J. Circuits and Architecture Design, Vol. 1, No. 3, pp.222-241(2014).
- [7] Richard Hooper, PhD, PE." Optimal Switching Architecture for Automated Test Equipment" 978-1-4244-9363-0/11/ ©2011 IEEE.
- [8] Phang Siow Feng, Wong Kok Sun "Customized Jig For Test Debug", 2011 IEEE 13th Electronics Packaging Technology Conference, 7-9 Dec. 2011.
- [9] Gurudutt D. Mysore and James M. Conrad, "A Microcontroller based bed-of-nails test fixture to program and test small printed circuit boards", Newberry, B. SoutheastCon, 2006. Proceedings of the IEEE.
- [10] Pogo Pin Assembly and Via Design for Multi-Gigabit Interfaces on Automated Test Equipment", Proceedings of Asia Pacific Microwave Conference 2006.

This page is kept blank intentionally

DOUBLE ACTING SINGLE-PHASE GENERATOR

Anirudh Pednekar
Electronics Engineering
Thakur college of engineering and
technology
Mumbai, India
pednekaranirudh.ap@outlook.com

Aditi Jain
Electronics Engineering
Thakur college of engineering and
technology
Mumbai, India
adsjain00@gmail.com

Ankita Jha
Electronics Engineering
Thakur college of engineering and
technology
Mumbai, India
ankitaamazing13@gmail.com

Abstract— Multiple types of Generators have been in existence ever since Faraday invented the first electric generator in the year 1831. Each Generator has its own designated power output capability at a certain speed. Considering latest commonly used generator, it consists of multiple poles with no enough amount of winding space available for the copper wires to be wound on it (Comparatively less in this case). Basic knowledge suggests that more the number of turns in the conductor more will be the power generated when a magnetic field cuts it at maximum attainable rotational velocity. This generator will be termed as a double acting single-phase generator (DASPG). The proposed generator provides a bigger space for conductors to be wound around and also provides a structure that can connect multiple of them in a row. Another unique thing about this generator is that it provides a free moving multi-directional axis for the magnets to rotate on one axis and revolve on the central axis respectively, so as to provide a sudden push/punch of energy/magnetic flux in the iron core and results in an amplitude spike hence giving an output of higher voltages at a lower rotor rpm. This device may also be used as a transformer in some cases where in the device will produce extra energy in the secondary/output coil acting as a transformer as well as a generator.

Keywords— Amplitude, Generator, Iron core, Voltage, rpm, double acting

I. INTRODUCTION

A generator is a device that converts mechanical force/energy into electromotive force/ electric energy which is used in external circuits/ electrical loads. Almost 97% of the city is powered by the generators in huge power plants, and rest is powered by a low output generator that is solar panel wind mill etc. A generator's basic function is to provide electricity to any external circuit connected to it.

On a Straight Current-Carrying
Conductor

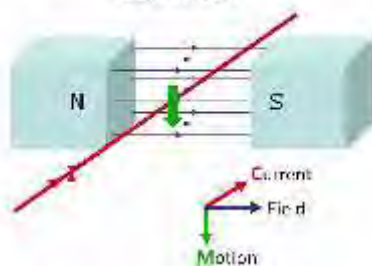


Fig. 1: Fleming's left hand rule

Generators in 1917 used to be a dc current source of power as these generators produced a direct current supply. A basic Fleming's left hand rule helps us understand how current is produced when a magnetic field is cut with a conductor. All the parameters in this case have to be perpendicular to each other to have maximum effect/absorption of energy. The faster the magnetic field cuts the conductor, more will be the energy produced.

Electromotive force is a measurement of the energy that causes current to flow through a circuit. It can also be defined as the potential difference in charge between two points in a circuit. Electromotive force is also known as voltage, and it is measured in volts.

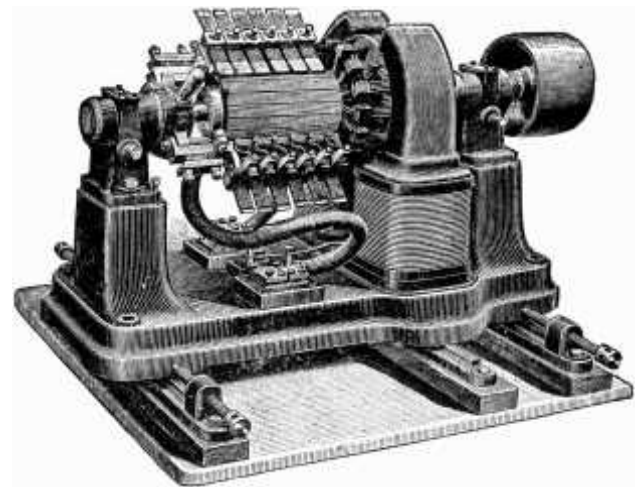


Fig. 2: 1917's 300amp 7volt dc generator

The above shown generator from 1917 could produce up to 300 amps of current at 7 volts and had multiple commutators connected to it which provide massive amounts of frictional force to the rotating quantities thus causing it to lose its efficiency.

This was until Nikola Tesla invented the AC motors and generators that turned out to be much better compared to the old outdated DC generators. In the AC generator, the magnetic field is rotated around a certain fixed path so as to have maximum magnetic field cutting the conductors and this also provided a benefit of not using commutators. Another benefit of AC is that it can be transmitted over a longer distance with least amount of losses experienced towards transmission. Ever since the

Inventions the ac generators has been preferred always all over the world.

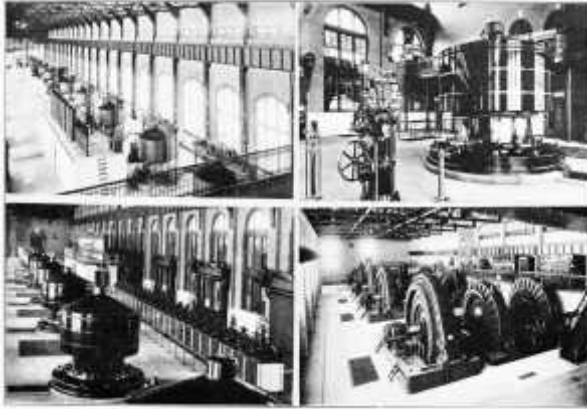


Fig. 3: First hydro power plant

II. CONCEPT AND DESIGN

The generator prototype built is a theoretically imagined idea of having a multipurpose device in one block. The device being 35cm long and 15 cm long it can work as a generator as well as a transformer at the same time. The device basically uses the same components as used in a general transformer/generator. The ferrite core (iron) is the major component as the magnetic flux passes through it feeding it to the copper coils. Another theory that we would like to suggest is that, if the tip of magnetic flux accepting face of the core is rough and pyramidal shape the magnetic flux can enter/exit with much less resistance to its flow intended to increase the efficiency of the device.



Fig. 4: Ferrite plate for magneti core

Multiple plates of these ferrite material are used so as to reduce the Eddie current that produce opposing magnetic field that may cause losses/magnetic friction in the device. These sheets are placed perpendicular to the magnetic field thus facing number of sheets reduce the opposing Eddie currents generated due to induction. The Copper wires/coils are wound on these ferrite core which convert magnetic flux in electric quantity. The energy production of a generator is dependent on the speed at which the magnetic field cuts the conductor and more the number of conductors wound on the stator.



Fig. 5: Generator coils (Copper)

DESIGN: Considering all the above given criteria's a design of this multipurpose device was imagined and sketched as per the requirements. The independent magnets are set to rotate across its own axis fixed to a place directly perpendicular to each of the iron core plates. The secondary magnets are fixed within a flywheel that makes it revolve around the shaft, also perpendicular to the iron core plates when in a certain position.

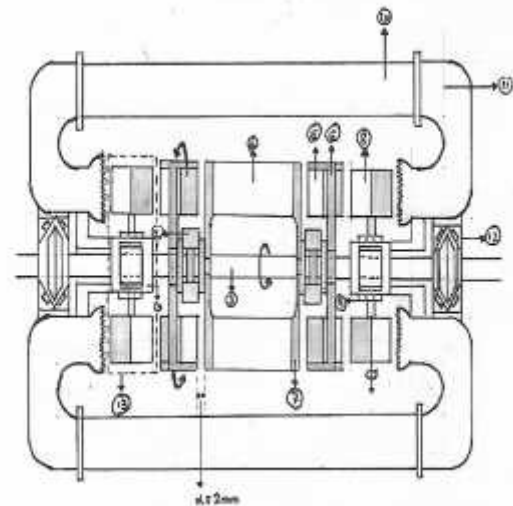


Fig. 6: Design of the DASP (master diagram)

The secondary coil (6) (7) housing is made to rotate in the opposite direction using a gear box (2) with 1:1 ratio. This ratio provides equal momentum to both the sides of the gear box.

In the generative state the secondary coil (6) will produce more amount of energy at higher frequency compared to the primary coils (10) in the stator, as the changing magnetic field in secondary coils cuts twice as fast as compared to the primary coil (10). α : represents the gap between the iron core and the magnets which is kept constant throughout as 0.2cm. As per the dimensions of the DASP the flywheels are designed accordingly as follows. All dimensions are fixed to a value of 9cm diameter.

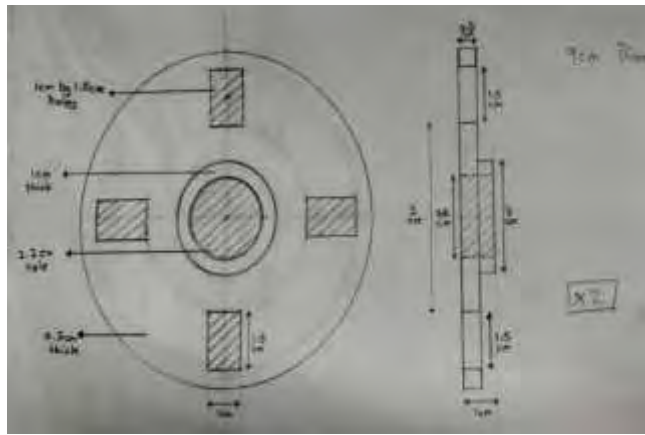


Fig. 7: Design of stator rotor wheels

The point noted as (7) in the above given diagram represents this particular diagram in brief. The above given design represents the holding wheel, that holds the stator rotor iron core in its place.

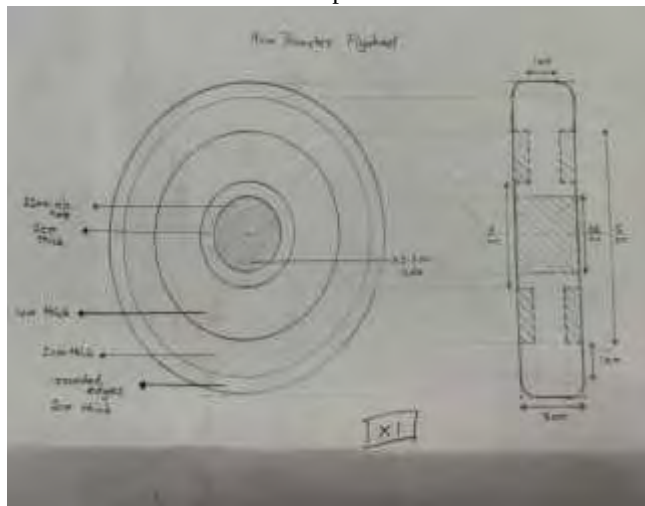


Fig. 8: Design of flywheel

The above given design is a wooden fly wheel that is meant to maintain momentum of the spinning rotor. This flywheel is designed to have a heavy circumference and a light weight centre which helps to maintain momentum of the rotating parts.

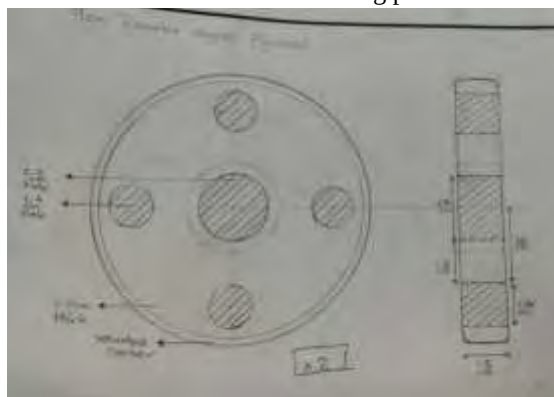


Fig. 9: Design of magnet flywheel

The above given design represents the flywheel that holds magnets for the generator. Each magnet is 90

degree apart from each other and perfectly aligned and at the centre position with the stator rotor core pieces. Also, with a size of 9cm diameter this flywheel perfectly fits into the DASPG with a centre hole for ball bearing to be attached. A 22mm diameter ball bearing is used in every part of the DASPG. As marked in master diagram this design is of the part named as (6) and (5) marks the magnets that it holds within it.

DRIVERS: The DASPG can surely be driven by any engine/motor to power or provide an output. In terms of transformer function the motor is used to power the rotation while the DASPG is used as a transformer or as an alternator. Thus, for this criterion, a single-phase self-starting motor is also designed to have a high starting torque with a vortex rotating magnetic field. This differentiates the swastika motor for the general motors as its poles are inclined at an angle to provide a starting torque that a usual single-phase ac motor can not provide, and cannot self-start.

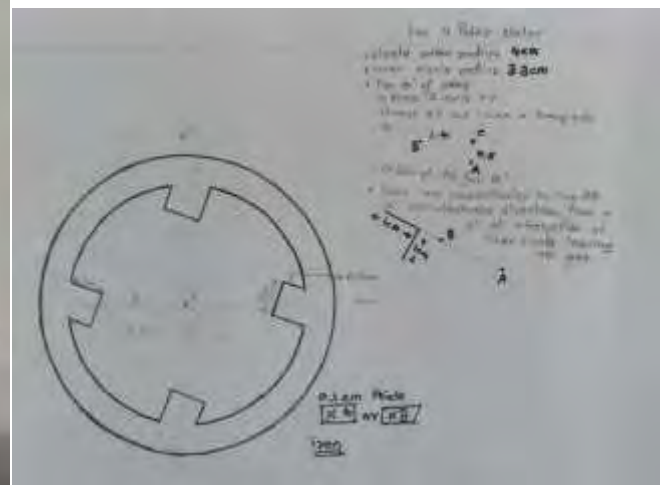


Fig. 10: Swastika motor stator design

The stator as designed produced magnetic losses as the spaces between the poles do not produce the needed magnetic intensity for the rotor to spin.

Thus, the poles during designing and poles after construction are twice in number to increase the intensity of the vortex rotating magnetic field. The angels in the stator provide the vortex rotating magnetic field that helps the single-phase ac motor to self-start with no external circuitry.



Fig. 11: Swastika motor stator construction

Accordingly, a rotor is also required for the swastika motor which is also designed as per the specific dimensions as displayed in the design diagram.



Fig. 12: Swastika motor rotor design

The rotor consists of copper plates/tubes that provides induction. Induction motors are not generally self-starting, but the inclination of the rotor copper bars/plates and stator core provides self-starting parameter to the single-phase ac induction motor.

III. MATHEMATICAL EXPRESSIONS

Consider a coil of length l and w be the width of the coil. Velocity of the coil is given by v where $v = w\omega/2$. Assume it to rotate with an angular velocity ω in a uniform magnetic field B . Emf induced in each side is given by the product of perpendicular component of B with its length and velocity. Mathematically,

$$\epsilon = B (\sin \Theta) l v \quad (I)$$

Where $(\sin \Theta)$ gives the perpendicular component of the magnetic field to the instantaneous direction of the motion and Θ is the angle of magnetic field when subtended in the normal direction of the coil.

Therefore, the motional emf generated from one side of the coil is

$$\epsilon = (BA\omega \sin \Theta)/2 \quad (II)$$

Where $a = \omega l$. The value of emf is 0 when $\Theta = 0^\circ$ or 180° . The maximum value of emf is 1 when $\Theta = 90^\circ$ or 270° .

If the coil has N turns, then the emf generated around a steadily rotating, multi-turn coil in a uniform magnetic coil is:

$$\epsilon = NBA\omega \sin(\omega t) \quad (III)$$

Where Θ is written as ωt for a steadily rotating coil.

Therefore, the maximum emf in terms of frequency can be written as

$$\epsilon_{\max} = NBA2\pi f \quad (IV)$$

Here, $f = \omega/2\pi$ is the number of complete rotations the coil executed per second.

Therefore, equation (2) can be written as

$$\epsilon = \epsilon_{\max} \sin(2\pi ft) \quad (V)$$

Hence, it can be noted that the maximum emf is directly proportional to the area, the number of turns and the rotation frequency of the coil. It is also directly proportional to the magnetic field strength.

If a resistive load R is connected across the coil of the generator, then according to the Ohm's Law, the current is given by

$$I = \epsilon/R = \{\epsilon_{\max} \sin(2\pi ft)\}/R \quad (VI)$$

Due to the presence of coil in the magnetic field, the current gives rise to torque.

$$T = NIB \sin \Theta A \quad (VII)$$

$$T = (I) \omega \quad (VIII)$$

An external torque which is equal and opposite to the breaking torque must be applied to the coil if it is to rotate uniformly. The rate at which the external torque P works is the product of torque T of the coil and the angular velocity ω of the coil.

$$P = T\omega = I \quad (IX)$$

The rate at which the external torque performs works exactly matches the rate at which electrical energy is generated in the circuit comprising the rotating coil and the load.

IV. APPLICATIONS

A. SMALL APPLICATIONS

Sizes ranging from 3 to 2000 KW generators can be used for powering remote areas and unurbanized areas as they are a great source of energy when powered by hydrocarbon fuel operating engines, hydro power turbines, etc. And can cost below the average costing of a traditional generator.

As AC generation and transportation is comparatively easy for long distance. Home and office outlets can be operated on AC from fur distances. Electrical power loss in transmission is less over high voltage usage. Thus, such a generator can power a small size building with a load of certain appliances.

Home appliances can depend on AC generators such as Fridge or dishwashers during the electricity shortage time. A small generator would always be help full for a house hold to power enough energy for important appliances.

B. LARGE APPLICATIONS

The requirement for large applications is about 200kW to 18MW such as mining, oil and gas extraction power plant etc. On a bigger scale these generators could link up one behind the other to form a chain of generators driven only by one

turbine powered by numerous varieties of engines/turbines.

Small scale applications AC is similar to large scale but the requirements differ as the large scale need much more engine power and turbine power for generators to produce electricity.

V. RESULTS

As GENERATOR: The double acting single-phase generator has proven to be a stable generator with voltage spike on the crest of its produced sine wave as predicted. The punch of magnetic flux was also observed as the current spiked up at a 60-degree delay to voltage resulting in a power output boost/punch. This dramatically proves that the magnets when aligned in pair of 2 or more and allowed to rotate in different rotational axes, do produce an extra amount of energy at the intervals, considering the sine wave crest and troughs.

As TRANSFORMER: The secondary coil (6) when powered by ac supply, and is allowed to rotate at its will also allowing the magnets to rotate in the respective axes give an abnormal pattern on the CRO screen (experimental views) thus resulting in a low efficiency transformer due to heavy leakage of magnetic flux but in this case, it also certainly generates its own power due to rotation of magnets even while working as a transformer. Thus, somehow does not have a very low efficiency comparatively.

Swastika motor: the stator of this motor has its pole inclined to a certain angle which produces vortex rotating magnetic field. The poles in this case are 8 poles to maximize the magnetic strength of the field intensity.



Fig 13: Swastika motor rotor design

VI. CONCLUSION

Double acting single-phase generator is research project based on the alignment of multiple magnets with different rotating axes to test an experimental phenomenon discovered/thought off by the group members keeping in mind the transformer functioning and its generation capabilities.

Thus, the double acting single-phase generator can be used as a moving core transformer as well as a generator at the same time. The transformer part of this device having moving core is an experiment to check the behavior of the magnetic flux through magnets in the direct path of transformer core to examine the increase or decrease in the flux density.

The present fractional horse power generations have a circular stator with least amount of winding space for the generator coils hence leading to less power generations.

The power emphasis is on the rotor and the stator in electric generators to rotate in the opposite directions to create or generate more power. Work proposes to overcome the problem by using long cylindrical stator which enhances winding space hence would increase the efficiency.

REFERENCES

- [1] A Novel Double Rotor Without Electric Motor: Theoretical and Functional Aspects, Babul Roy, 2017, Journal of Electrical Engineering and Science, Vol. 3(2).
- [2] Electric Generator with Rotating Stator and Applications, Zoran Bogdanovic, 2015, IEEE, vol.2, Issue 2
- [3] Mechanism for rotating the rotors, stators, an electric power generator, Kobi Miller, 2002, Patent: US20060125243A1
- [4] Electric Machine Design Data Book, Vol. 10, April 2011, New Age International
- [5] Electric Rotating Stator Generator with Permanent Magnets and Fixed Rotor with Concentrated Windings: Analysis and study on its Magnetic circuit, Goncalo Migueis and P.J. Costa Branco, 2007

This page is kept blank intentionally

Solar Panel Monitoring For Rural Areas

Pratik Bole
Electronics Engineering
Thakur College Of Engineering and
Technology
Mumbai, India
pratikbole39@gmail.com

Somiyam Guchait
Electronics Engineering
Thakur College Of Engineering and
Technology
Mumbai, India
somiayanguchait9819@gmail.com

Pawan Sakpal
Electronics Engineering
Thakur College Of Engineering and
Technology
Mumbai, India
pawans2812@gmail.com

Abstract— The strength of the Solar PV frameworks ought to be observed ceaselessly for their better execution and upkeep. For PV frameworks introduced at rustic areas, remote observing abilities give the data ahead of time when framework execution is debased or is probably going to come up short. In view of this data, preventive upkeep can be done to enhance the execution and life of the framework, in this way lessening the general working expense. The proposed framework will be fundamentally founded on IoT. By utilizing voltage and current sensor interfaced to a microcontroller we can send the obtained information through a Wi-Fi module to remote station or center point and even the wellbeing of the boards can be seen in an application. In this manner if any board needs fixing just those boards will be visited and fixed.

Keywords—Monitoring, IoT, Solar panels, Renewable Energy.

I. INTRODUCTION

The Project is centered on the notion that solar panels should be monitored on a regular basis to ensure their proper functioning. As solar energy becomes more accepted as a viable source of renewable energy, quantitative information on a system's post install real performance becomes a major concern. There are many factors that can impact a system's real world performance such as a bad cabling (high resistance/impedance caused by loose connectors or improper wiring), defective inverters, inconsistencies on solar panel output, environmental factors like weather, accidental damage, as well as general manufacturing defects.

Light force level speaks to an essential parameter concerning the viability of the sun powered board, the gathered sun based vitality which changed over to the electrical power is relative with the immediate dimension of light intensity.

Residue thickness level is the other parameter which speaks to an impediment between light pillars and the front surface of the sunlight based board. The residue's particles stores on the board which will diminish the measure of radiation falling on the PV cells from the daylight [8]. Other than the assortment of residue thickness in each locale, the point of the surface can gather more residues. The more flat is the surface, the more residue particles will be gathered on that surface. [9]

Encompassing temperature has high need impact on the sun powered board adequacy. In other word, expanding board temperature esteem is prompting decrease the conveyed power from the board [10].

Surrounding mugginess additionally influences adversely the board execution [11].

The cost of ownership of a solar system is tied very tightly to the system's ability to produce a minimum quality of service over a period of time in order to accurately calculate the system's Return on Investment (ROI) period. In many cases the solar panels in rural areas are neglected for their performances and no further action are taken even when the panels malfunction altogether.

This project will help monitor the important factors in proper functioning of the panels and reduce the onsite visits for panel monitoring which in this case might be very remote. India is the second largest nation in the world in terms of population. India is also considered as the fastest growing economy of the world. Even today 70% of the country's population lives in rural areas. Electricity has reached many rural areas till date but many areas still struggle to get just a few hours of electricity. Many areas are also deprived of even getting it. In such situations the use of renewable energy sources proves to be very useful. The government also funded projects involving use of renewable energy resources. One of them is solar energy.

The government supported the installation of solar streetlights in many rural areas which were otherwise in darkness. These streetlights proved to be very useful as the roads became accessible after evenings. But due to some reasons these streetlights malfunction or give less output than desired. Because of this the revenue invested by the government is wasted. This problem is not addressed at the proper time by the locals mainly because of lack of communication. It is also not possible for the locals to do a time to time analysis of the panels in the rural areas as that will also require huge revenue. To tackle this problem and to make sure the streetlights installed are working in their best phase we are developing this project.

The final product will help the locals too to monitor the panels around them and communicate to the officials if any fault arises. The data recorded will also be transmitted to a remote station from time to time. So there will be no need to visit every area for fault analysis.

II. PROPOSED WORK

A. Voltage Sensor

A straight forward yet exceptionally valuable module which utilizes a potential divider to lessen any info voltage by a factor of 5. This enables you to utilize

the simple contribution of a microcontroller to screen voltages a lot higher than it equipped for detecting. For instance with a 0-5V simple information extend you can gauge a voltage up to 25V. The module additionally incorporates advantageous screw terminals for simple and secure association of a wire.

This module depends on standard of resistive voltage divider configuration, can make the red terminal connector input voltage to multiple times littler. Arduino simple information voltages up to 5 v, the voltage location module input voltage not more noteworthy than $5V \times 5 = 25V$ (if utilizing 3.3V frameworks, input voltage not more prominent than $3.3V \times 5 = 16.5V$).



Fig.1. Voltage Sensor

TABLE I. VOLTAGE SENSOR SPECIFICATIONS

Divider ratio	5:1
Resistor Tolerance	1%
Input Voltage	25V
Resistor value	30K/7.5K Ohm

B. Current Sensor

The gadget comprises of an exact, low-balance, straight Hall circuit with a copper conduction way situated close to the outside of the bite the dust. Connected current coursing through this copper conduction way produces an attractive field which the Hall IC changes over into a relative voltage.

Arduino AVR chips have 10-bit AD, so this module mimics a goals of 0.00489V ($5V/1023$), so the base voltage of info voltage recognition module is $0.00489V \times 5 = 0.02445V$.



Fig.2. Current Sensor

TABLE II. CURRENT SENSOR SPECIFICATIONS

Output Sensitivity	100mV/A
Operating Voltage	3-5V
Internal Resistance	1.2mOhm
Operating Temperature	-40°C – 85°C

C. MSP430

The MSP430 is a blended flag microcontroller family from Texas Instruments. Worked around a 16-bit CPU, the MSP430 is intended for ease and, explicitly, low power consumption inserted applications. The MSP430 can be utilized for low fueled inserted gadgets. The current attracted inactive mode can be under 1 μA . The best CPU speed is 25 MHz It very well may be throttled back for lower control utilization. The MSP430 likewise utilizes six diverse low-control modes, which can incapacitate unneeded timekeepers and CPU. Furthermore, the MSP430 is fit for wake-up times underneath 1 microsecond, permitting the microcontroller to remain in rest mode longer, limiting its normal current utilization.



Fig. 3. MSP430 Launch pad

TABLE III. MSP430 SPECIFICATIONS

Supply Voltage	1.8-3.6V
Flash Memory	16KB
RAM	512B
Clock Frequency	16MHz

D. ESP8266

The ESP8266 is a minimal effort Wi-Fi microchip with full TCP/IP stack and microcontroller capacity created by Shanghai-based Chinese maker Espressif Systems. The ESP8266EX microcontroller coordinates a Tensilica L106 32-bit RISC processor, which accomplishes additional low power utilization and achieves a most extreme clock speed of 160 MHz The Real-Time Operating System (RTOS) and Wi-Fi stack permit about 80% of the preparing capacity to be accessible for client application programming and advancement.

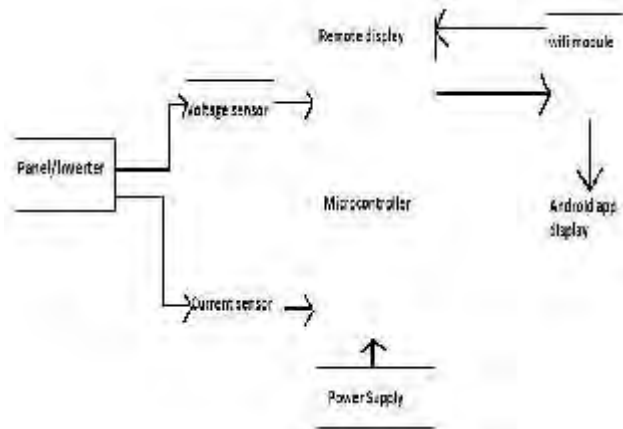


Fig.4. ESP8266

TABLE IV. ESP8266 SPECIFICATIONS

Operating Voltage	3.3V
Digital I/O Pins	12
Analog Input Pins	1
Clock Speed	80MHz/160MHz

III. BLOCK DIAGRAM.



IV. IMPLEMENTATION

The proposed system will be basically an Iot system which senses data from one place and transmits it to a remote base station. The various important steps in the working are as follows:

A. Voltage Measurement

Voltage sensor utilizes basic voltage divider plans to bring the information voltage level to quantifiable voltage. The voltage division level is acclimated to get the best goals for the info voltage level with the assistance of a couple of exchanging resistors.

B. Current Measurement

The present sensor utilizes low ohm current detecting resistor (0.05 ohm) to measure the current. The voltage over the present detecting resistor is enhanced and bolstered into the Analog to Digital Converter of the microcontroller. The gain of the enhancement of the hardware is acclimated to get the best goals for the sensor with the assistance of a couple of exchanging resistors.

C. Data Transmission

Positioning Fig.s and Tables: Place Fig.s The data collected from the current and voltage sensors is to be transmitted to remote station or a server. For this purpose we are using Wi-Fi module ESP8266. It will transmit the data acquired every time the user is connected to the internet. The Wi-Fi module consumes less power and has a high clock speed.

D. Data Display

When the user accesses the website or the application on a proper network the required data is displayed on the screen of the respective devices which is in the form of a database. The user will also receive alerts if the readings are not optimum or specified as per the ratings.

V. FUTURESCOPE

The proposed system will be basically an Iot system which senses data from Acknowledgment (Heading 5) A

sensor network can be developed to monitor a large area of solar panels. A temperature sensing unit can be incorporated to maintain the temperature of the system. Local people can be guided remotely through the application or website for correcting any faults occurring in the system.

ACKNOWLEDGEMENT

We would like to thank Dr. Sandhya Save for her time and continuous support for the project.

REFERENCES

- [1] C. Ranhotigamage, and S. C. Mukhopadhyay, "Field trials and performance monitoring of distributed solar panels using a low-cost wireless sensor network for domestic application", IEEE Sensors Journal, vol. 1, pp. 2583-2590, October 2011.
- [2] Ali Al-Dahoud, Mohamed Fezari, Thamer A. Al-Rawashdeh, Ismail Jannoud, "Improving Monitoring and Fault Detection of Solar Panels Using Arduino Mega in WSN", London United Kingdom 13 (3) Part VII, March 14-15.
- [3] Ponmozhi.G, Mr.L.Balakumar, "Embedded System Based Remote Monitoring and Controlling Systems for Renewable Energy Source", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 3 ,April 2014.
- [4] Se-Kang Ho ; Wei-Jen Lee ; Chia-Chi Chu ; Ching-Tsa Pan, "An internet based embedded network monitoring system for renewable energy systems", ICPE 07 , 2007.
- [5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.
- [6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
- [7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.
- [8] Umer Mehmood, Fahad A. Al-Sulaiman, B. S. Yibas, "Characterization of dust collected from PV modules in the area of Dhahran, Kingdom of Saudi Arabia, and its impact on protective transparent covers for photovoltaic applications," Solar Energy, vol 141, pp. 203-209, Dec. 2016.
- [9] Ruidong Xu, Kai Ni, Yihua Hu, Jikai Si, Huiqing Wen, Dongsheng Yu, "Analysis of the optimum tilt angle for a soiled PV panel," Energy Conversion and Management, vol 148, pp. 100-109, Jun 2017.
- [10] Ulrich Schwabe Peter Mark Jansson, "Performance Measurement of Amorphous and Monocrystalline Silicon PV Modules in Eastern U.S-Energy production versus ambient and module temperature" I2MTC 2009 - International Instrumentation and Measurement Technology Conference Singapore, 5-7 May 2009,p.p.
- [11] Manoj K. P., Ghous B. N., "Effect of Humidity on the Efficiency of Solar Cell (photovoltaic)", International Journal of Engineering Research and General Science Vol. 2, Iss. 4, 2014. pp. 499-503.
- [12] Jiju K. et. al., 2014. "Development of Android based on-line monitoring and control system for Renewable Energy Sources." Computer, Communications and Control Technology (I4CT), International Conference on IEEE, 2014.
- [13] Hocine Belmili, Salah Med Ait Cheikh, Mourad Haddadi, Cherif Larbes "Design and development of a data acquisition system for photovoltaic modules characterization" Renewable Energy 35 (2010) p.p. 1484-1492.
- [14] P. Baronti, P. Pillai, V.W.C. Chook, S. Chessa, A. Gotta, Y.F. Hu, Wireless sensor networks: A survey on the state of the art and the 802.15.4 and ZigBee standards, Computer Communications 30(7) (2007) 1655-1695.

This page is kept blank intentionally

Automated Speed Regulation of BLDC Motor

Vishal Singh
ETRX dept.
TCET
Mumbai, India
mailsforvishalsingh@gmail.com

Talha Shaikh
ETRX dept.
TCET
Mumbai, India
talhaatair@gmail.com

Sunil Yadav
ETRX dept.
TCET
Mumbai, India
sunilyadav2882000@gmail.com

Abstract—Brushless DC Motors which are also called as electronically commutated motors or synchronous DC motors, are synchronous motors. They are powered by DC electricity via switching power supply or an inverter which produces an AC electric current to drive each phase of the motor by a closed loop controller. This project is used to measure and control the speed of BLDC motor using an IR speed sensor mechanism. Controlling the speed of BLDC motor is required in industries. BLDC motors are used in industries for various applications such as drilling, spinning, lathes, elevators, etc. This system provides competent and proficient mechanism for controlling the speed of BLDC motors. An added advantage this system is energy conservation as the components used are power efficient. Here we are using IR sensor, at the output of BLDC FAN MOTOR. When BLDC motor rotates, IR sensor will detect its speed and system will control its speed according to the requirement. When the speed of BLDC motor is high and required speed is low, IR sensor will detect the speed and system will respond as per the need. The cost of this circuit is also low, so it would be valuable and profitable to the industries if they adopt and implement this system as their efficiency and profits will escalate considerably.

Keywords—BLDC motors, automated, Speed control

I. INTRODUCTION

We have developed this portal so as to help the industry as well as the workers during operation. This project will totally digitize the workload in industries. Here with the help of IR sensor we will read the speed of BLDC Motor and system will respond to it. Here the workload of human is eliminated by reading the speed automatically and it will set the speed according to the input given. The brushless DC motor is a synchronous electric motor that, from a modeling perspective, looks exactly like a DC motor, having a linear relationship between current and torque, voltage and rpm. It is an electronically controlled commutation system, instead of having a mechanical commutation, which is typical of brushed motors.

Additionally, the electromagnets do not move, the permanent magnets rotate and the armature remains static. This gets around the problem of how to transfer current to a moving armature. In order to do this, the brush-system / commutator assembly is replaced by an intelligent electronic controller, which performs the same power distribution as a brushed DC motor. BLDC motors have many advantages over brushed DC motors and induction motors, such as a better

speed versus torque characteristics, high dynamic response, high efficiency and reliability, long operating life (no brush erosion), noiseless operation, higher speed ranges, and reduction of electromagnetic interference. In addition, the ratio of delivered torque to the size of the motor is higher, making it useful in applications where space and weight are critical factors, especially in aerospace applications. IR Sensors is serially interfaced to microcontroller in order to get the speed of BLDC Motor. Microcontroller is connected to motor driver circuit which controls the speed as per the requirement. In this way the proposed system can be very useful for the Industries in the absence of workers.

II. REALATED WORK AND DESIGN RULES

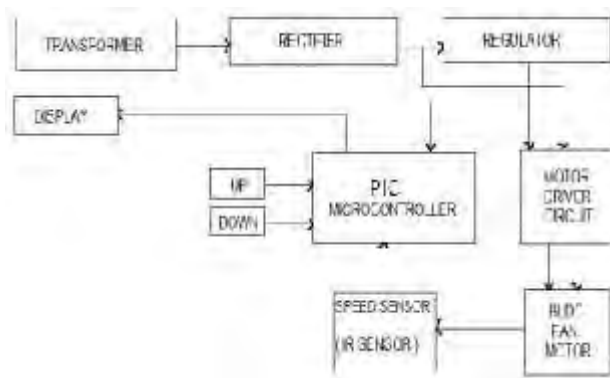
A. Technological Solution

- Transforming traditional cities into SMART cities, since they provide the core tourism to the local public as well as foreign tourists.
- Easy to use and flexible module to help people of all kinds.
- Smart power consuming module with the help of IR sensors.
- Wireless solution to the tourists so as they are not strangled at one place bu can roam around while listening to the information through the wireless Bluetooth headphones.
- Can be utilized by the physically challenged people as well as there are provisions for deaf, dumb and blind people.
- The RIDT module also provides the local as well the foreign tourists to listen to the guide information in their own native or familiar language which will extensively eliminate the language.

B. Scope

As the use of workers is increasing in different industries. This system will reduce human workload. Input shaping is occurred in this portal which will be automated without any human work. IR Sensor is used to measure the speed of BLDC Motor which gives input to the micro-controller that is in closed loop with the motor driver circuit. Motor driver circuit is used to control the BLDC Motor as per the need. Further this system can be implemented where BLDC Motors are used such as Lathe machine, drilling, spinning, elevators, etc.

III. SYSTEM ARCHITECTURE



A. Applications

- **Used at industries**

This module can be useful at many popular industries where the use of drilling, spinning, lathe machine is generated.

- **Can be used by private company**

This module can turn out to be very useful and effective for the private companies as this will completely eliminate the wholesome cost of a physical work by implementing this machine.

- **Can be used for disabling the use of people**

This module can turn out to be very useful for eliminating the use of human as it will operate by itself.

- **Easy to use**

This module is very easy to use as the user has to implement this system with the machine in use and it will work easily.

B. Designing of Model

1) Power supply circuit given to motor driver

Power supply is given to Transformer which gives its output to Rectifier. Rectified output is given to Regulator where voltage regulation takes place. Regulated supply is provided to motor driver circuit.

2) Designing the motor driver circuit

A motor driver circuit is designed to drive the BLDC Motor accordingly.

3) Interfacing the BLDC Motor to IR Sensor

IR Sensor is used at the output of BLDC to measure its speed and give it to micro-controller.

4) Programming the micro-controller

Here comes the software part, we need to program the module as per the requirement of speed and displaying its speed on LCD display for which this module is generally designed.

5) Connecting the LCD display to micro-controller

LCD Display is connected to the micro-controller which will display the current speed of BLDC Motor.

ACKNOWLEDGMENT

This project cannot be entirely created by an individual. The timely completion of the project '**Automated Speed Regulation of BLDC Motor.**' has been possible because of our teacher and project guide Mrs. Sonal Barvey who provided us with guidance and motivation throughout its making. We thank him for giving us an opportunity to create this project. We are also thankful to Dr. Sandhya Save (Electronics Department, HOD) for her guidance and to our parents for providing all possible resources to gain the possible knowledge. Finally we would thank our college 'Thakur College of Engineering and Technology' for providing us with a platform and the necessary facilities to make this project.

REFERENCES

- [1] GAO, X., Cao, H., Ming, D., Qi, H., Wang, X., Wang, X., & Zhou, P. (2014). BLDC control, 94(3), 399-406.
- [2] Vernon, D., Peryer, G., Louch, J., & Shaw, M. (2014), 93(1), 134-139.
- [3] Pratt, H., Starr, A., Michalowski, H. J., Dimitrijevic, A., Bleich, N., & Mittelman, N. (2010). 262(1), 34-44.
- [4] https://www.researchgate.net/publication/28538021_Mathematical_Model_and_Characteristics_Analysis_of_the_BLDC_Motor
- [5] <https://ieeexplore.ieee.org/document/6919048/>
- [6] <https://ieeexplore.ieee.org/document/7473409/>

Temperature Based Jacket With Tracking System

Tanmay Kalal
Department of Electronics
Engineering
TCET
Mumbai, India
tanmaykalal03@gmail.com

Akanksha Rai
Department of Electronics
Engineering
TCET
Mumbai, India
akanksharai9987@gmail.com

Abhishek Singh
Department of Electronics
Engineering
TCET
Mumbai, India
abhise101@gmail.com

Abstract—This project outlines the implementation of Peltier driven heating system. Heating jacket works according to the atmospheric conditions. If the atmosphere is cooler than the required for an individual, then the jacket gives the required amount of warmth to the human body, without causing any side effects. This jacket entirely depends upon the principle working of “Peltier effect”. The product simply uses electrons rather than heater as a heat carrier. This cooling or heating system does not contain any moving parts like compressor or solution pumps and also it does not require any condenser, expansion valve or absorber. So, its productive design is simple and easy to construct. In this project, the working model of jacket utilizes the required essential thermo electric modules that plays a vital role for the performance. The performance of this model is experimentally evaluated with copper cabinet. The present article available till date explains about how Peltier cooler is used in jacket and its advantages over conventional cooling system. Heating jacket reduces the use of convectional Heating system, therefore effect of skin cancer, ozone depletion potential, and global warming potential reduces. This jacket is compact in size, easy to manage and is eco-friendly in nature. Because of all these reasons peltier effect principle is used in heating jacket. Function of this jacket interface is to provide thermal latency and comfort to user. Peltier cooling module is used to cool fluids stored in reservoir, etc. Thermal resistance and cooling jacket size slightly decrease the Peltier cooling capacity on human.

Keywords—Temperature Jacket, Microcontroller, Battery (2000MAH), Global Positioning System, LCD display, Peltier plates, Temperature Sensor (LM35), Environmental Analyzer.

I. INTRODUCTION

Important resources of Army are soldiers. Soldiers play a very important role to protect one's country. The soldier includes all those service men and women from the Army, Air Force, Navy and Marines. They always manage taking and holding the duty in extreme weather conditions throughout the year with the same integrity and passion and respect for their country. While providing security for the country, they may face troubles in extreme hot/cold weather conditions. In market, there is such suit which is expensive. Because the suit have many parts which includes many mechanical and gripping devices. This suit consists of pumps & radiators to provide cooling as well as heat respectively. For cooling the body, these pumps spray water on human body. We can provide both cooling and

hot service with this jacket. The different climatic conditions such as very cold and very hot temperatures can cause danger to one's health. Heat stress causes because of excessive exposure to heat and cold stress causes because of excessive exposure to cold. In a very hot climatic situation, the most risky condition is sun or heat stroke as well as at very cold temperatures, the most serious concern is the risk of hypothermia or dangerous overcooling of the body which are not suitable for one's survival [1]-[2].

II. CONCEPT

Indian Army faces many environmental challenges associated with Temperature and Safety. Throughout the history of humans, the very important source of survival that is temperature has related inconveniences such as heat stroke, heat rash, frostbite, dehydration, hypothermia, etc. are the major problems and one cannot escape from these problems.

Some of these conditions led to unfortunate demises of people. Some technological solutions are introduced to keep people thermally comfortable such as air conditioning & heaters units, are most successful in helping people in their houses, in cars & Camps etc. but not in personal mobility extreme situations.

If one wants to ease their survival in such type of climatic conditions, temperature adaptable jacket is a very beneficial product. This jacket can naturally keep up the specific temperature inside the jacket using the Template.

A. Designing of Block Diagram

The designing of the block diagram is the main and a very important role as it visually describes the system as a whole displaying the significant elements of the system. The diagram below is the block diagram of the project. Fig. 1 shows the Block Diagram of Temperature Control Jacket with Tracking System consisting of following parts. The figure 2 shows the expected jacket:

- The Heart Beat sensor gives an easy way to study the function of the heart. This sensor is used to monitor the blood through the fingers as well as arms.
- The Temperature sensor are sensed with the help of the LM35 sensor. This series is accurate integrated circuit sensors, whose o/p voltage is linearly related to the Celsius temperature.

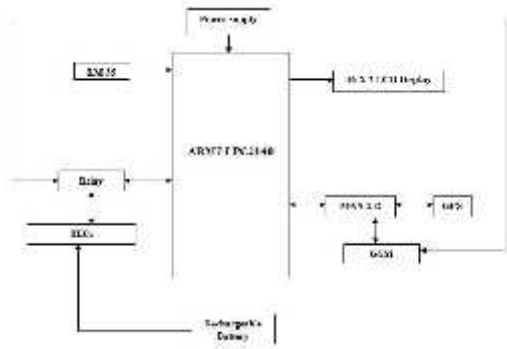


Fig. 1. Block diagram of temperature controlled trackable jacket

- The GSM stands for “Global System for Mobile communications”, controls as the world’s most extensively used cell phone communication. Cell phones use a GSM network by searching for cell phone towers in the nearest area.
- The LCD display is used to display the temperature and heart beat rate, current time, date and the position of the soldier

B. Designing of Model

1. **Heartbeat Sensor:** The Heart Beat sensor gives an easy way to understand the function of the heart. This sensor is used to monitor the blood through a finger/arm. As the heart services blood through the blood vessels in the finger/arm, the blood amount in the finger/arm changes with respect to time.

2. **Temperature Sensor:** The Temperature sensor can be sensed with the help of the LM35 sensor. This series is accurate integrated circuit sensors, whose o/p voltage is linearly related to the Celsius temperature. A Station, which is pressed directly will be made aware to the Base station and thus will not delay for heart beats to go out of the normal range.

3. **PIC-Microcontroller:** The term PIC stands for “Programmable Interface Controller”, these are standard with both industrial as well as the hobbyists are corresponding due to their huge availability, low cost, large user base, a wide collection of application notes, and are available at low cost

4. **Global Positioning System:** The term GPS stands for Global Positioning System (GPS) is a space-based global navigation satellite system that offers consistent accurate location and information about the time in all environmental conditions from anywhere on the Earth when and where there is a free line of sight to four or more GPS satellites.

5. **LCD Unit:** The LCD display is used to display the temperature and heart beat rate, current time, date and the position of the soldier.

6. **Environmental Analyzer:** The environmental analyzer is used to find the situation of an environment such as

the oxygen level and atmosphere pressure and also observe the real-time video of the soldier’s unit



Fig. 2. Expected temperature controlled trackable jacket

C. Jacket Interface

The main function of jacket interface is to provide the high thermal efficiency and comfort to user. Jacket interface consists of internal layer, Peltier plate, and external layer. Internal layer is the first subcomponent of vest interface which has to be kept tight and comfortable to fit the user. The Peltier Plate was sewn on internal layer. The second sub component of vest interface . The Peltier Plate in vest extracts heat from body and transfer to heat moving through it. External layer is the final subcomponent of the vest interface use to provide insulation to device. External layer is used to increase thermal efficiency.

III. PELTIER PLATE

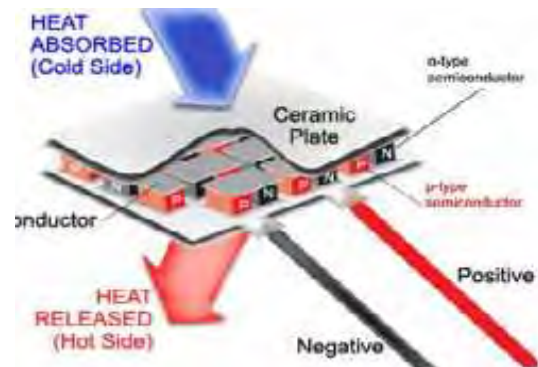


Fig. 3. Peltier effect in expected temperature controlled trackable jacket.

Peltier effect thermoelectric coolers operate according to the Peltier effect. The effect creates a temperature difference by transferring heat between two electrical junctions. A voltage is applied across the joined conductors to create an electric current. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs. Heat is deposited at the other junction. The main application of the Peltier effect is cooling. However the Peltier effect can also be used for heating or control of temperature. In every case, a DC voltage is required [3]. Peltier found that,

$$Q \propto I \quad (1)$$

Where,

Q = rate of heating or cooling

I = current passing through the junction

IV. GSM TRACKING

GPS tracking system is a device uses the Global Positioning System GPS -to determine and track its precise location, and hence that of its carrier, -at intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location database [4].



Fig. 4. GPS Tracking Module in temperature controlled trackable jacket.

This is a complete GPS module that is based on the Ublox NEO-6M. This unit uses the latest technology from Ublox to give the best possible positioning information and includes a larger built-in 25 x 25mm active GPS antenna with a UART TTL socket. A battery is also included so that you can obtain a GPS lock faster. This GPS module gives the best possible position information, allowing for better performance with your Ardupilot or other Multirotor control platform. The Ublox NEO-6M GPS engine on this board is a quite good one, with the high precision binary output. It has also high sensitivity for indoor applications. UBLOX NEO-6M GPS Module has a battery for power backup and EEPROM for storing configuration settings. The antenna is connected to the module through a ufl cable which allows for flexibility in mounting the GPS such that the antenna will always see the sky for best performance. This makes it powerful to use with cars and other mobile applications [5].

V. ADVANTAGES

- Fit and forget system
- Reliable
- Compact size
- Affordable prize (Low cost)
- Low Maintenance
- The jacket can be easily controlled.
- As our electronic gadget runs on battery, it is a portable and easy to use.

- The jacket is easy to wash, as the electrical parts detachable [6]-[7].
- Suit can be used to monitor the temperature, humidity of the patients in hospitals.
- Suit can also be used to for the old people who are susceptible to temperature change.
- Soldiers generally face extreme Cold and Hot conditions, the suit can be used to comfort the soldiers in these regions.

VI. APPLICATIONS

- Used in military applications.
- This can be used for Old people
- Soldiers can work in extreme climatic applications.
- Battle Ground of Siachen Glacier
- Hypothermia Patients
- The jacket can be easily controlled.
- As our electronic gadget runs on battery, it is a portable and easy to use [6]-[7].

VII. CONCLUSION

The final design of the project was an arduous journey that required repeated brainstorming and research. However, the design process provided a learning experience that augmented the authors' knowledge of Computer and Electrical Engineering.

In this project, the complexity and practicality behind the embedded system design was learned and understood to create a system that would maximize the functionality of the TECs through the thermoelectric effect.

VIII. FUTURE SCOPE

Heating Pad: Apply 5-12VDC and the stainless steel fibers in this heating fabric will warm up, creating a little heating pad. On one hand, it's just a gigantic resistor. On the other hand, it's flexible, light, and can be wrapped around a project.

Originally designed for portable wearable heating pads, this fabric can be used for wear able, weather balloons, thermal cycling for materials testing, etc. The temperature reached varies with voltage. This piece is ~ 10cm long, so look in the spec sheets in the Technical Details tab for a table of voltage/current/temperature outputs.

The future scope of our paper is to make it washable, light weight. Decrease the weight of the equipment's and jackets much further adding pulse monitoring system and GPS location system to the implement. Decreasing the cost of equipment used and make it affordable to the common users.

IX. RESULTS

The results is taken by using Peltier in the heating jacket for both cooling and heating depending on the side and the number of trials is taken to provide proper heating to the person who wears the jacket after all the testing is conducted.

The results shows that the heating jacket is able to deliver a heating air temperature of according to the required atmosphere; these results are obtained in the period of 20 minute. This may vary depending on further changes. The specially designed E-uniforms are very much useful for military applications especially, in unlike climatic conditions for soldiers and other civilian people.

ACKNOWLEDGMENT

The authors are grateful to Mrs. Sonal Barvey, Dr.S.C.Patil, and Department of Electronics Engineering for their constant support and guidance along the way.

REFERENCES

- [1] "7805 Datasheet - 5V DC Voltage Regulator Data Sheet / Specs." 7805 Datasheet 5V DC Voltage Regulator Data Sheet / Specs.N.p.,n.d.Web.13Dec.2013..
- [2] "ATmega16 Datasheet." Atmel.N.p.,n.d. Web.10Dec.2013..
- [3] "Cool Vest with 3 portable reservoir options for hot and humid days-stay dry & keep cool!." Veskimo Personal Cooling Systems.N.p.,n.d. Web.13Dec.2013.
- [4] Goldsmid, H. J. .*"Timeliness in the development of thermoelectric cooling."* IEEE Xplore. N.p., 18 Aug. 1998. Web. 13 Dec. 2013..
- [5] McManis, Chuck. "H-Bridge Theory & Practice -- Chuck's Robotics Notebook.N.p.,n.d.Web.13Dec.2013..
- [6] "Milwaukee Heated Jacket." Review.N.p.,n.d. Web.13Dec.2013..
- [7] "Peltier effect (physics)." Encyclopedia Britannica Online.Encyclopedia Britannica, n.d.Web.13Dec.2013..

Design of Reduced Graphene Oxide based Piezo-Resistive Acoustic Sensor on flexible Kapton for Underwater Applications

Smitha Pai B
Department of ECE
Nitte Meenakshi Institute of
Technology
Bangalore-560064, India
smitha.prabhu@nmit.ac.in

Goutham M. A
Department of ECE
Adichunchanagiri Institute of
Technology
Chikmagalur-577102, India
magoutham@yahoo.co.in

Veera Pandin
Centre for NanoScience and
Engineering
Indian Institute of Science (IISc)
Bengaluru-560012, India
veerapandin89@gmail.com

Abstract— Micro Electro Mechanical Systems (MEMS) vector sensor is a recent advancement in the field of underwater acoustic sensors. The major incentive provided by this acoustic vector sensor is that it provides the direction of the incoming acoustic source signal in addition to the measurement of the pressure associated with the acoustic signal. We are reporting, a design of a MEMS type acoustic vector sensor using reduced graphene oxide (RGO) based piezoresistive thin film realized on kapton (polyimide) film as the starting material for under water applications. The sensor is designed and fabricated by deposition of RGO on a Flexible kapton substrate by drop casting method making the process simple, low-cost and scalable. The application of the piezoresistive transduction principle and ingenious structure of the vector sensor improves the low-frequency sensitivity as well as its miniaturization. The structure of acoustic sensor consists of two parts: Simple four-beam micro-structure and rigid plastic rod which is fixed at the center of the microstructure. The four beam microstructure consists of four horizontal cantilever beams, and the whole structure has complete axial symmetry in the xyz plane. When the plastic rod is stimulated by acoustic signal in a particular direction, the flexible kapton substrate undergoes deformation which results in generation of strain and the piezoresistor transforms the resultant strain into an electrical output signal. As the fabricated acoustic sensor undergoes piezoresistive behavior due to the acoustic signal in a given direction, its output resistance changes and the variations in the corresponding electrical output voltages are observed in both static and dynamic conditions. The fabricated sensor shows a repeatable response to the applied strain in both the conditions. The experimental results show that fabricated sensor based on theory of piezoresistive effect and MEMS technology is feasible. The fabricated device has given good response for the low frequency acoustic signals and resonance frequency of the device is found to be around 80Hz.

Keywords— MEMS, RGO, Piezoresistive, Acoustic vector sensor, plastic rod, 4-beam microstructure

I. INTRODUCTION

As the level of radiated noise of submarines become lower and lower each year, the application of vector acoustic sensor effectively suffices the requirement of submarine sound detection. Acoustic wave refers to sound wave in any medium. Water being an elastic medium any disturbance in water propagates away from its origin as a

wave. When water or air molecules are pushed or pulled apart, they exert a restoring force that resists the motion. The force will be felt locally as pressure or force per unit area. The fundamental parameter of an acoustic wave is pressure and frequency. Hydrophone detects the pressure variations of acoustic signal and noise in the water and produces an output voltage proportional to the pressure. A single vector acoustic sensor based on piezoresistive transduction principle can work at low frequencies with relatively small dimensions and it possesses intrinsic two-dimensional directivity. The advantage of piezoresistive effect is that it can be used to detect the low frequency signal even at zero Hz. Therefore combining the advantage of both MEMS technology and piezoresistive effect of RGO with unique electronic properties has great significance as it results in simple, low cost and scalable process. In this paper, MEMS-based piezoresistive acoustic vector sensor will be presented with respect to the design, simulation, fabrication and preliminary characterization.

II. SENSOR DESIGN

The structure of acoustic vector sensor consists of two parts: Four-beam micro-structure (175 μ m thickness) and rigid plastic rod which has the same density as water and is fixed at the center of the microstructure. “Fig.1” shows the actual design of the structure. This four beam micro-structure consists of four horizontal cantilever beams. The rigid plastic rod is fixed on the central block of the four beam microstructure. Both the center block and the beams have same thickness and the whole structure has the complete axial symmetry.

The plastic rod will have a horizontal displacement and an angular rotation, when it is subjected to axial or radial stress. When the structure is subjected to deformation, an amplified and concentrated strain is generated on the slim sensing beams. The piezoresistors convert the stresses induced in the beam by the applied pressure into a change of electrical resistance, which is then converted into voltage output by a Wheatstone bridge circuit as shown in the “Fig.2”. The Wheatstone bridge is logically formed by locating eight piezoresistors which is used to sense the deformation of the beams. The resistance of the piezoresistors will be changed when the acoustic signal

transmitted to it and results in corresponding electrical output voltage.

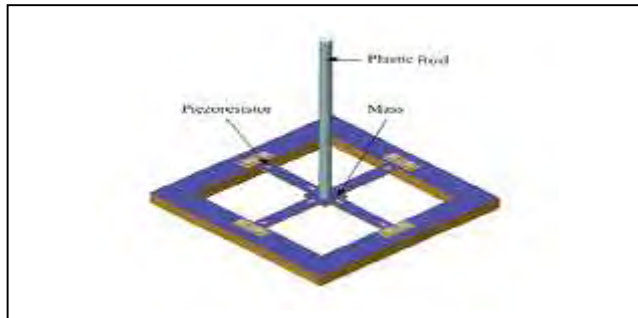
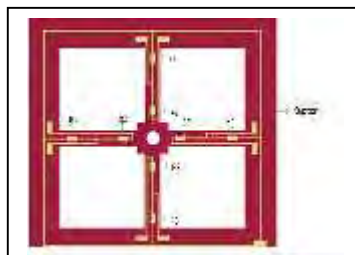


Fig. 1. Structure of Acoustic Sensor



R1,R2,R3,R4,R5,R6,R7,R8:Piezoresistors

Fig. 2. Wheatstone bridge formation by Piezoresistors

III. MODELLING USING COMSOL MULTIPHYSICS

The sensor geometry is modeled using Comsol Multiphysics 5.0, Solid mechanics physics and stationary study has been used. The 3D geometry comprises three main components including a 4 beam microstructure, Central block and a cylinder (as depicted in Figure 2). The materials used to form 4 beam microstructure and central block is Kapton with density of 1300 Kg/m³, relative permittivity of 2.9, young's modulus of 3.1Gpa and Poisson's ratio of 0.34 and Nylon for cylinder whose density is closer to the value of density of water and with Poisson's ratio of 0.4. The Parametric analysis is carried out as shown in Figure 3 in order to determine the design parameters of the structure such as length, width, thickness of 4 beam microstructure and central block, length and diameter of plastic rod which yields good sensitivity of the structure. As per parametric study the length, width, thickness of 4 beams are 10mm, 2mm and 0.175 mm respectively and square central block is 6mm with rod dimensions being 25mm length and 2mm in diameter. One of the ends of all four cantilever beams of 4beam microstructure are attached to the central block and the other end are made fixed by attaching them to the support frame. The pressure and force in axial and radial directions are applied as boundary load to the plastic rod which is attached to the central block. During simulation, when the pressure corresponding to the underwater acoustic particle motion is applied to the rod then the central block will have angular displacement. Therefore the structure will be

subjected to deformation as shown in Figure4, and hence an amplified and concentrated strain is generated. The maximum stress is located at the beam –mass interface and near the support frame as shown in Figure5. The piezoresistors of the structure can be located at these places of the beam where the stress profile is optimal as shown in Figure 6. The dynamic characteristics of the designed structure are studied to determine its vibration characteristics. The dynamic analysis uses the overall mass and stiffness of the device to find the various periods at which it will naturally resonate. The first natural frequency of the device for different cylinder length is as shown in Figure 7. For the mentioned cylinder dimension, the first natural frequency is 70.474Hz and the second is 70.519Hz, both of them are the operating frequency of the structure .They are far away from the other eigen frequencies which will have little effect under a relatively low driving frequency.

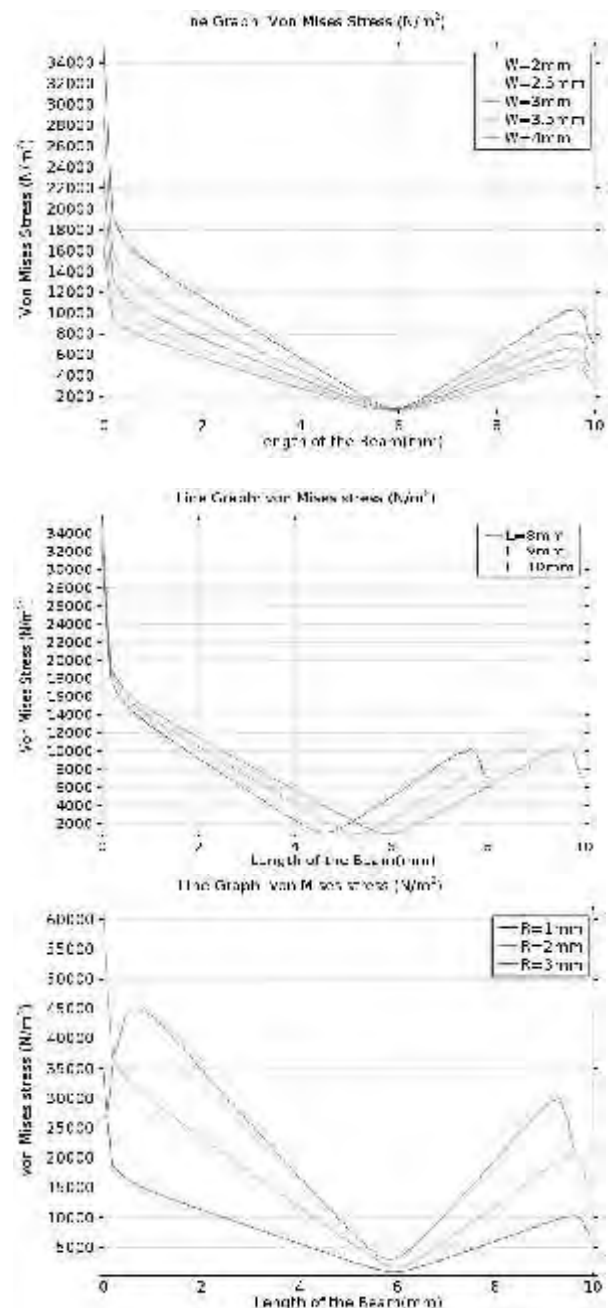


Figure3: Von Mises stress along the length of the beam for parametric analysis of a) width of the beam b) length of the beam, c) radius of the cylinder

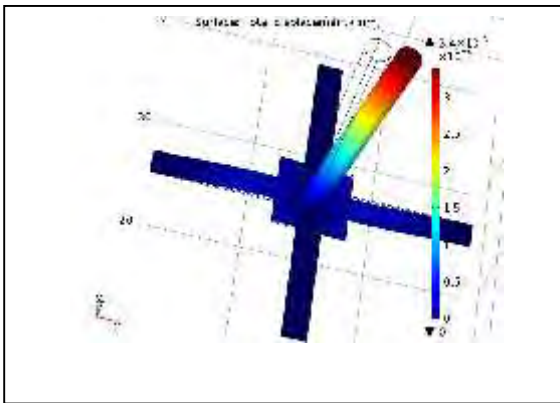


Fig.4 Displacement and deformation for 120 Pa Pressure

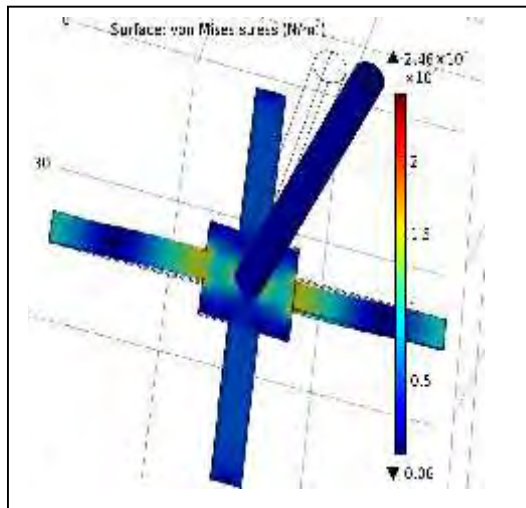


Fig. 5. Stress Profile along the length of the Beam

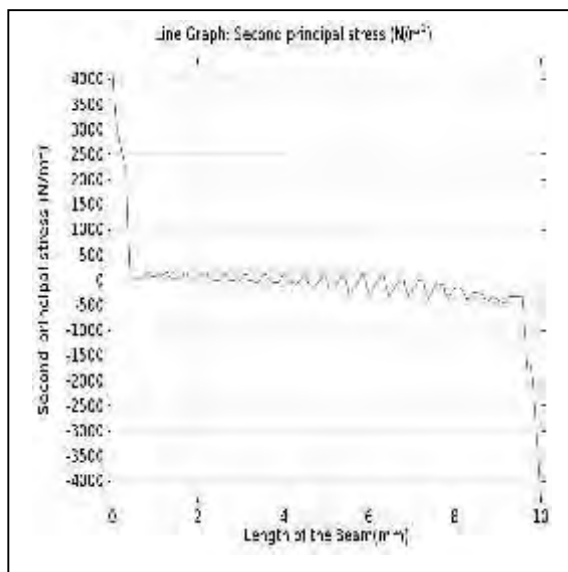


Fig. 6. Piezoresistor location at the optimal stress on the beam

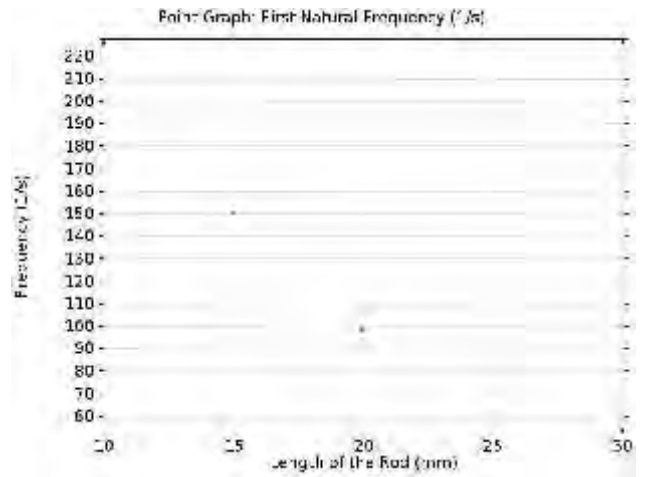


Figure 7: First Eigen frequency for different length of cylinder

IV. FABRICATION

The fabrication of the device consists of the processing of four-beam microstructure and the rigid plastic rod as shown in “Fig. 8”. The 4 beam microstructure is realised on a square Kapton (polyimide) flexible substrate of thickness 175 μ m and 50mm diameter, by processing it through laser cutting procedure as per the required dimensions “Fig. 8a”.

The reduced graphene oxide(RGO) based piezoresistive thin film sensor is realised on 4 beams of the flexible microstructure by drop casting method for strain sensing and further, it is annealed in oven at 120 degree Celsius for 1 hour “Fig. 8b”. This result in coating of RGO on the four beams of diaphragm whose resistivity can be measured. To establish electrical connections with the device the leads are taken out by forming contact using silver paste “Fig. 8c”.

Device is then coated with perylene (polymer)to provide protection to the device from external environment like moisture and it reduces breaking of coating of RGO during vibration and the device is ready for calibration. After the four-beam micro-structure being fabricated, a plastic rod is fixed at the center of the micro-structure using Araldite adhesive and is as shown in “Fig.8d”.



Fig. 8a. 4-Beam Microstructure

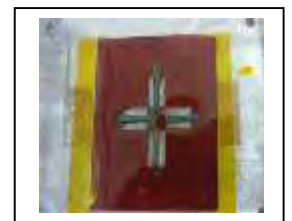


Fig. 8b Deposition of RGO



Fig. 8c Formation of electrical

Fig. 8d Fixing Plastic Rod

Fig. 8. Fabrication process of the device

V. CALIBRATION

The characterization of an acoustic vector sensor mainly refers to the sensitivity and directivity. For sensitivity analysis, two Wheatstone bridges were formed on beams along X-axis and Y-axis respectively as shown in "Fig. 9".

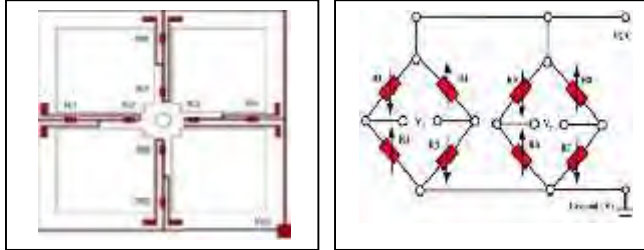
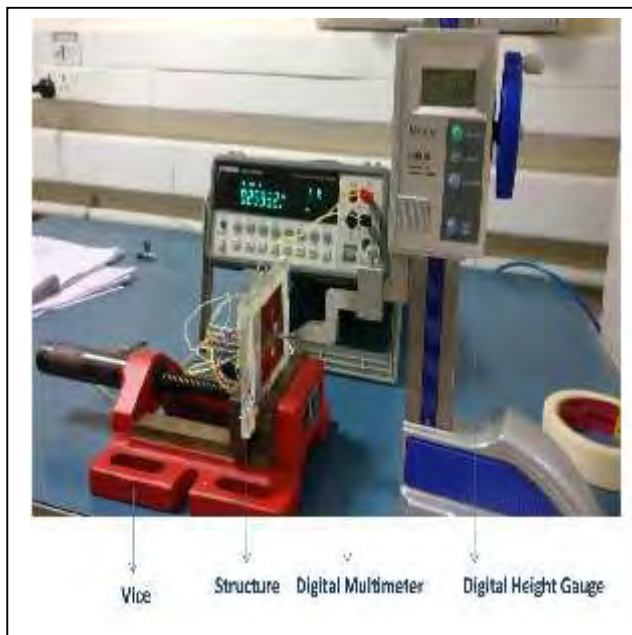


Fig. 9 Two Wheatstone bridge with eight piezoresistors

Piezoresistors R1, R2, R3 and R4 forms the first Wheatstone bridge and R5, R6, R7 and R8 forms the second Wheatstone bridge along X axis and Y axis respectively. The device was calibrated by using both static and dynamic calibration methods.

A. Static Calibration

In order to study the performance of the device, it was fixed on vice and plastic rod was used in cantilever configuration as shown in "Fig. 10". As can be observed, the plastic rod was subjected to movement by applying force at its free end using a digital height gauge. The photograph of the complete experimental setup used is shown in "Fig. 10". The electrical leads of the strain sensor were connected to digital multimeter. The sensor was subjected to strain by applying the force at the free end of the plastic rod. The deflection of the free end of the rod was measured using the digital height gauge and the corresponding resistance variation of the gauge was noted from the digital multimeter.



When the plastic rod was applied radial force in the Y direction, the beams which are situated along the Y direction will undergo deformation due to the compressive and tensile stresses acting along the beam, which results in corresponding resistance variation of the beam and the Wheatstone bridge formed along the Y axis will give the equivalent electrical output voltage and indicates the direction of applied force as radial direction i.e as +Y direction. The opposite will happen for force in negative radial direction. Similarly when the plastic rod was applied force in the X direction, the beams which are situated along the X direction will undergo deformation due to the compressive and tensile stresses acting along the beam, which results in corresponding resistance variation of the beam and the Wheatstone bridge formed along the X axis will give the equivalent electrical output voltage and indicates the direction of applied force as axial direction i.e as +X direction. The opposite will happen for force in negative X direction.

Output Voltage of Y axis Wheatstone bridge with the applied excitation voltage of 3V for various displacements of plastic rod in negative Y direction is shown in Table 1.

TABLE I. ELECTRICAL OUTPUT VOLTAGE OF Y AXIS WHEATSTONE BRIDGE

Displacement (mm)	Electrical Output Voltage (mV)	Differential Output Voltage ΔV (mV)
0	356.60	0
0.5	355.50	1.1
1	354.53	2.07
1.5	353.57	3.03
2	352.52	4.08

The sensitivity shown by the corresponding Y axis Wheatstone bridge = 2mV/mm. Here the offset output voltage was found to be 356.60mV. When the plastic rod was subjected to displacement (mm) by applying force in negative Y direction, the electrical output voltage of the corresponding bridge was found to be decreasing as mentioned in table 1 and opposite was observed for force when it was applied to the rod in positive Y direction.

The similar effect was observed when the plastic rod was subjected to displacement by applying force in X direction and the sensitivity of x Axis Bridge was found to be around 3mV/mm.

During the operation, electrical output voltage of Wheatstone bridge was found to be in milliVolts and the same was strengthened using instrumentation amplifier LT 1167 which was designed to give a gain of 100, after minimizing the offset voltage and the entire experimental set up as shown in Fig. 11

B. Dynamic Calibration:

The dynamic characterization of the device is measured by vibration platform. The device is fixed on the vice and the plastic rod was vibrated by using the vibration given by vibration platform in vertical motion, and the output voltage of the device changed with the frequency. "Fig. 12" shows the entire experimental set up of dynamic

calibration. With the help of vibration platform, the sensor was subjected to various frequencies ranging from 10Hz to 500 Hz for $g=0.5$ and $g=0.2$. The output response of the sensor at 50 Hz and 100Hz for $g=0.5$ are as shown in “Fig. 13”. The measurement on vibration platform gives a frequency response in the range of 5Hz to 500 Hz and the measured resonance frequency is around 80Hz.



Figure11: Experimental set up to amplify the electrical output voltage

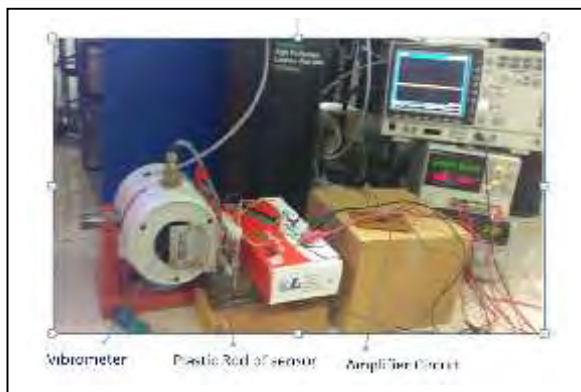
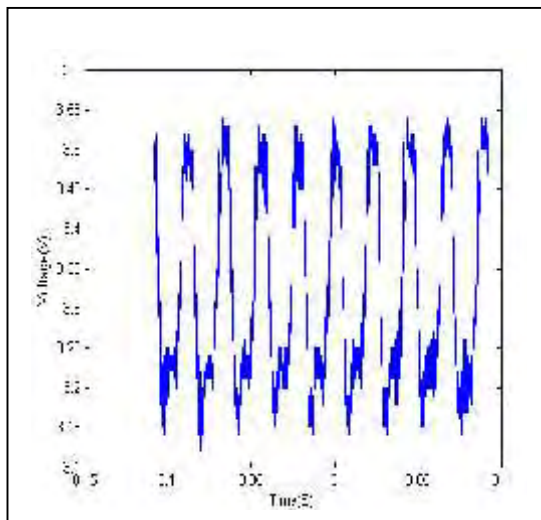


Fig. 12 Dynamic calibration using vibration platform

13a)



13b)

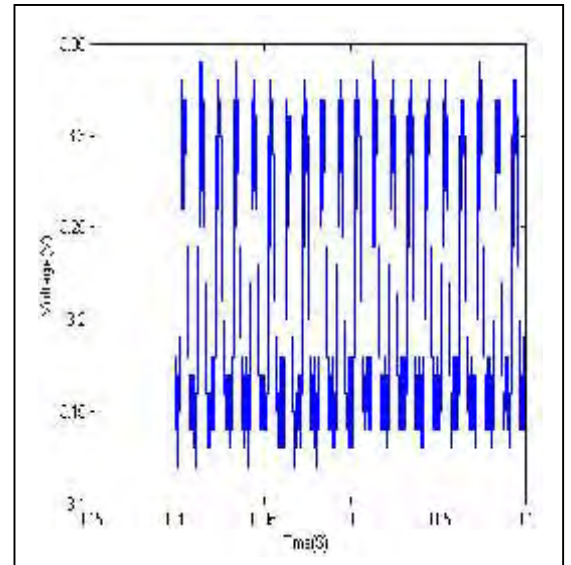


Fig. 13. Dynamic response for a) 50Hz b) 100Hz

VI. CONCLUSION

We have proposed design, simulation, fabrication and preliminary characterization of the two-dimensional reduced graphene oxide based acoustic vector sensor which is suitable for underwater applications. It is observed that the property of graphene is suitable for detection of the sound, when realized on uniform layer of Kapton sensing membrane and also results in simple, low-cost and scalable process. Because of the application of piezoresistive transduction principle, this sensor was found to be best suitable for detection of low frequency acoustic signals. This acoustic vector sensor not only has several advantages such as small volume, simple structure, and simple process and low cost but also has good low-frequency characteristics. So it can be used to estimate the horizontal azimuth of the underwater targets and satisfies the requirements for low-frequency submarine sound detection.

ACKNOWLEDGEMENT

The authors are grateful to the Instrumentation and Applied Physics Department (IAP) and Center for Nano Science and Engineering (CENSE), IISc, Bangalore, for providing fabrication and characterization facilities and valuable guidance. Also would like to thank Mr.Sankaran and Ms.Pavitra for their kind help in testing of the device as well for supporting necessary electronic circuitry.

REFERENCES

- [1] Shang Chen, Chenyang Xue, Binzhen Zhang, Bin Xie and Hui Qiao," A Novel MEMS Based Piezoresistive Vector Hydrophone for Low Frequency Detection," Proceedings of the IEEE 2007, 1839-1844.
- [2] ChenyangXue, Shang Chen,Wendong Zhang,Binzhen Zhang,Guojun Zhang, Hui Qiao,"Design,fabrication,and preliminary characterization of a novel MEMS bionic vector hydrophone," Microelectronics Journal 38(2007) 1021-1026.
- [3] Mengran Liu, Guojun Zhang, Zeming Jian, Hong Liu, Xiaopeng Song, Wendong Zhang," Design of Array MEMS Vector Vibration Sensor in the Location of Pipeline Internal Inspector," TELKOMNIKA Indonesian Journal of Electrical Engineering, Vol. 12, No. 9, September 2014, pp. 6651 ~ 6657.
- [4] T Chu Duc,J F Creemer and P M Sarro," Lateral nano-Newton force sensing piezoresistive cantilever for microparticle handling," Journal of Micromechanics and Microengineering,16(2006)S102-S106.
- [5] Nagarjuna Nella,V Gaddam,M.M Nayak, K.Rajanna, T.Srinivas,"Highly flexible and sensitive graphene-silver nanocomposite strain sensor," Proceedings of the IEEE 2015.
- [6] Kaihua Cao,Xiaodong Ye,Xinhua Guo,"Design and Simulation of Two-Dimensional Graphene-Based Acoustic Sensor Arrays," Proceedings of the IEEE 2017

Making Paver Blocks using Plastic Waste

Narpinder Singh Pannu
Electronics &
Telecommunication
Saraswati College of
Engineering
Navi Mumbai, India
narpindersingh59@gmail.com

Saurabh Subhash Amburle
Electronics &
Telecommunication
Saraswati College of
Engineering
Navi Mumbai, India
saurabhamburle@gmail.com

Divya Praveen Pawar
Electronics &
Telecommunication
Saraswati College of
Engineering
Navi Mumbai, India
pawardivya50@gmail.com

Divya Praveen Pawar
Electronics &
Telecommunication
Saraswati College of
Engineering
Navi Mumbai, India
pawardivya50@gmail.com

Abstract— People in India throws away 2.5 million of plastic bottles per hour. The degradation rate of plastic is very slow process. Hence, we propose to reduce plastic waste. We propose to make a reverse vending machine for collection of plastic bottles. This is a multidisciplinary project and our system consist of standard recycle bin that is equipped with microcontroller and collection of sensors. Throughout the process, the sensors responsible to identifying user information, count the bottles and eventually convert the count to the corresponding points automatically. Once the process completed, the user can claim their points by using RFID point card. All the mentioned process will be controlled by a microcontroller. Then plastic bottles will be used for making paver blocks.

Keywords— Arduino, NFC, Plastic Waste, Reverse Vending Machine, Tachogenerator.

I. INTRODUCTION

Plastics have become a vital asset for humanity. Though extensive research and new technologies have led to invent of newer and safer plastics, but drawbacks and challenges of plastics have never been resolved and impact is on the rise. The proposed project serves the need for plastic waste management by building a machine which makes a paver block from waste plastic. The paver block paving is a commonly used decorative method of creating a pavement or hard standing.

II. LIETRATURE SURVEY

The method proposed by Razali Tomari, Aeslina Abdul Kadir(2016) an automated recycle bin with a reward feature is proposed that derived from a reverse vending machine (RVM) concept. Basically, the system is implemented in a standard recycle bin provided by local municipal that equipped with microcontroller and collection of sensors. Throughout the process, the sensors responsible to identifying user information, weight the scale and eventually convert the weight to the corresponding points automatically. Once the process completed, the user can claim their points by using RFID point card[1].

B. Shanmugavalli K. Gowtham(2017) mainly studies to replace cement with plastic waste in paver block and to reduce the cost of paver block when compared to that of convention concrete paver

blocks. The degradation rate of plastic waste is also a very slow process. Hence this study is helpful in reducing plastic waste in a useful way. In this study they have used plastic waste in different proportions with quarry dust, coarse aggregate and ceramic waste. The paver blocks were prepared and tested and the results were discussed[2].

Govind Pandey(2013) discusses prospects of plastic waste management schemes. It is concluded that the existing rate of environmental worsening is likely to continue unless long term remedial measures are adopted for plastic wastes management in the country[3].

C. Balaji(2018) propped that Paver Blocks are the precast blocks that are used in the construction of various types of pavements. Cement, Coarse Aggregate and Fine Aggregate are majorly used in manufacturing of paver blocks. Due to the scarcity of raw materials cost of the raw materials also increasing rapidly. To overcome the issue they have incorporated an idea of partially replacing the coarse aggregate with plastic wastes. Plastic wastes are also increasing in the environment very rapidly and recycling of these plastic wastes are very tedious process so for effectively reusing it they have partially replacing the coarse aggregates with shredded plastic waste. Paver blocks are then casted and cured in the laboratory. Various strength parameters are tested and results have been arrived[4].

III. OBJECTIVE

The main objective of this paper is to reduce plastic waste. This can be done by recycling or reusing plastic waste. In this paper our idea is to reuse plastic. The paver block made of cement can be replaced with plastic paver blocks.

IV. PROCESS FLOW

The plastics waste will be collected and the appropriate reward of money (points) will be given to the depositor. The waste plastic bottle will be collected with the help of reverse vending machine. As the user throw bottle, the user will be given a RFID card and the redeemable points will be stored in card. The waste

plastic will be drawn in to Hooper of machine to shred for conversion of plastic in to fine form. The muffle furnace heated this plastic in the liquid state by using the heating coil. The sand, coarse aggregate, cement and water are added increased the strength properties of paver block. This block after testing initially can be used to serve society by providing solid solution for plastic waste management. But in above steps Arduino will be used to detect some technical issues. Consider plastic waste got stuck in shredder so we will get an indication with the help of buzzer.

Recycling of plastic has advantage since it has a long service life and good binding property. Waste material like bottles which are shredded and melted may be used as ingredient for the manufacture of paver block. The melted plastic can be added with coarse aggregate replacing of by 20% the coarse aggregate, recycled aggregate, plastic aggregate, sand, cement and water may be mixed together in the mixing chamber of machine to get a uniform consistent mix of concrete. This can be reflected in the molds of paver block placed on vibratory box after curing the block may tested for compressive strength.

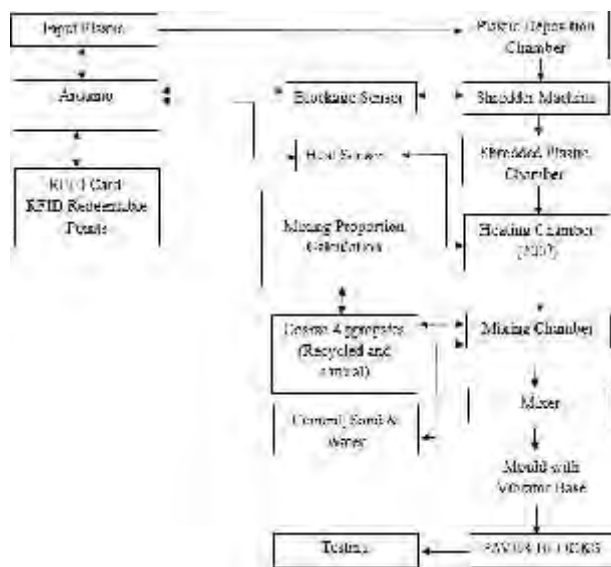


Fig 1: Flow Chart of Process

V. SYSTEM OVERVIEW

We are controlling the reverse vending machine using ATMEGA 328 microcontroller. Since NFC codes are easily available in Arduino library, we are using microcontroller ATMEGA328 instead of Arduino. To redeem the points based on bottles inserted we require read-writeable card as well as reader. Thus, we will be using NFC card and NFC reader. Operating voltage of NFC reader is 3.3V. Output of NFC will be displayed on LCD.

To insert the bottles there will be flap/door which will be controlled by motor. For these two transistors will be used, through relay mechanism. Relay mechanism will be helping in opening or closing of flap/door. Shredder will be used to shred the plastic bottles. Due to any

reason if shredder stop working, tachogenerator will be used to detect cause. Similarly, to maintain the temperature in the heating chamber thermistor will be used. If tachogenerator or thermistor detects any problem in process then it will give an indication with the help of buzzer. Main power supply is of 230V, thus stepdown transformer will be used to reduce voltage.

Table1: Power Consumption by Different Components

Component	Operating Voltage
Buzzer	12V
LCD	5V
Microcontroller	5V
Motor	12V
NFC Reader	3.3V
Thermistor	5V

VI.CONCLUSION

In this paper, a reverse vending machine which will be useful to reduce and recycle the plastic waste will be constructed. This reverse vending machine can be installed at public places such as shopping malls, airports, railway station, etc. For this project we have constructed the PCB. We are planning to finish this project soon.

REFERENCES

- [1] Razali Tomari, Aeslina Abdul Kadir, 2016, "Development of Reverse Vending Machine (RVM) Framework for Implementation to a Standard Recycle Bin", IEEE International Symposium on Robotics and Intelligent.
- [2] B. Shanmugavalli K. Gowtham, Vol. 6 Issue 02, Feb-2017, "Reuse of Plastic Waste in Paver Blocks", International Journal of Engineering Research & Technology.
- [3] Govind Pandey, Vol. 2(12), 84-88, December-2013, "A Review on Plastic Waste Management Strategies", International Research Journal of Environment Sciences.
- [4] C. Balaji, Vol. 10, 06-Special Issue, 2018, "Experimental Investigation on Paver Blocks with Partial Replacement of Coarse Aggregates with Plastic Waste", Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology

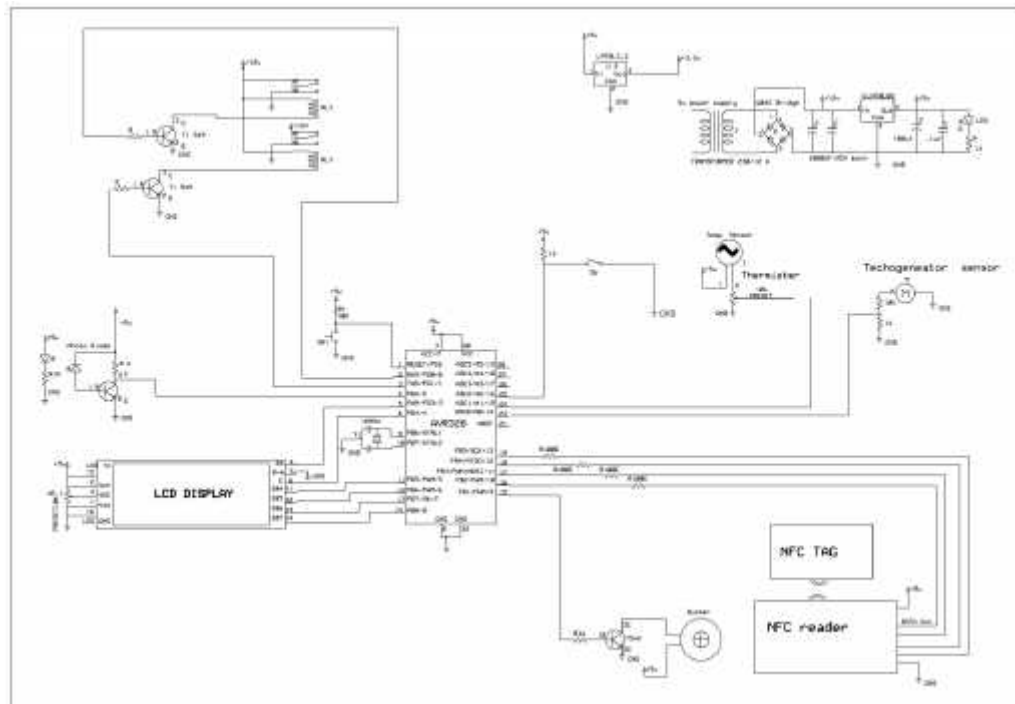


Fig2:Circuit Diagram of System for Reverse Vending Machine

This page is kept blank intentionally

Proposed High Performance Subtle Light Intensity Variation UV Photodetectors

Jaya V. Gaitonde
Electronics and Telecommunication Dept.
Goa Engineering College
(Goa University)
Farmagudi-Ponda-Goa-India, 403401
jayagaitonde46@gmail.com

R. B. Lohani
Electronics and Telecommunication Dept.
Goa Engineering College
(Goa University)
Farmagudi-Ponda-Goa-India, 403401
rblohani@gec.ac.in

Abstract—We present the simulation studies on GaN-based OPFET (Optical Field-Effect Transistor) UV (Ultraviolet) photodetectors with complete parameter estimation and analysis. The generalized model and the front-illuminated model of OPFET have been considered for the proposed study. We adopt a semi-analytical approach for modeling the OPFET photodetectors. Both the models exhibit enhanced photoresponse, high sensitivity to slight variations in light intensity, low switching times, and high detectivity. The devices are also evaluated as detector-cum-amplifiers showing high bandwidths and high unity-gain cut-off frequencies at the lower intensities whereas the bandwidths drop at the higher intensity. The results have been explained by the photovoltaic and the photoconductive effects, and the series resistance effects. The devices will greatly contribute towards single photon counting, high resolution imaging, and UV communication applications.

Keywords—UV, OPFET, GaN, high dynamic range, imaging, photon counting, communication.

I. INTRODUCTION

Ultraviolet (UV) photodetectors are useful in applications such as chemical, environmental, and biological analysis and monitoring, flame and radiation detection, astronomical studies, missile detection, and optical communication. UV high dynamic range imaging and single photon counting applications require photodetectors capable of resolving slight variations in light intensity without much compromising the responsivity, response time, bandwidth, and detectivity. Different types of photodetectors investigated by numerous researchers have attained sensitivity or dynamic range varying between 60 dB to 120 dB [1]-[8] along with substantial values for other parameters. OPFET (Optical Field Effect Transistor) photodetector has been widely known over the past several decades as a highly sensitive photodetector [9]-[16]. Our previous work on GaN-based buried-gate OPFET UV detectors showed excellent photoresponse, fast response times, high detectivity along with enhanced bandwidth [17]. However, the sensitivity or dynamic range of the buried-gate device was in the lower range. This calls for the employment of alternative structures or models to cater to the subtle variations in the light intensity. Thus, in this paper, we explored the two other illumination models of OPFET (generalized model and front-illuminated model) for perceiving high contrast imaging or sensing and observed that the devices can resolve subtle variations in light intensity better than the buried-gate devices and comparable to the reported literature without much compromising the other detector

parameters which are also superior than the existing detectors.

The rest of the paper is organized as follows: We begin with a brief theory followed by the results and discussion, and finally the conclusion of the work done.

II. THEORY

The two models considered in this work (front-illuminated OPFET and generalized model of OPFET) are schematically shown in Fig. 1 and Fig. 2 respectively. In the 1st case, only the transparent Au gate is illuminated whereas in the 2nd case, the spacings between the gate and source, and the gate and drain are illuminated in addition to the gate area. The absorption of photons with energy greater than the bandgap of GaN in the regions below the gate (1st case and 2nd case) and the sidewalls of the gate depletion region (2nd case) creates electron-hole pairs in the respective regions. The photogenerated holes travel toward the junction while the electrons move toward the channel. A forward photovoltage is developed when the holes cross the junctions, reducing the depletion width and increasing the drain to source current (photovoltaic effect). On the other hand, the electrons move along the longitudinal area of the channel when the drain to source voltage is applied and contribute to the conductivity of the channel (photoconductive effect). The series resistances present in the area between the gate and source, and the gate and drain, limit the total current through voltage drops developed across these resistances. Thus, the photovoltaic and the photoconductive effects, and the series resistances effect can provide a complete explanation of the performance of these detectors.

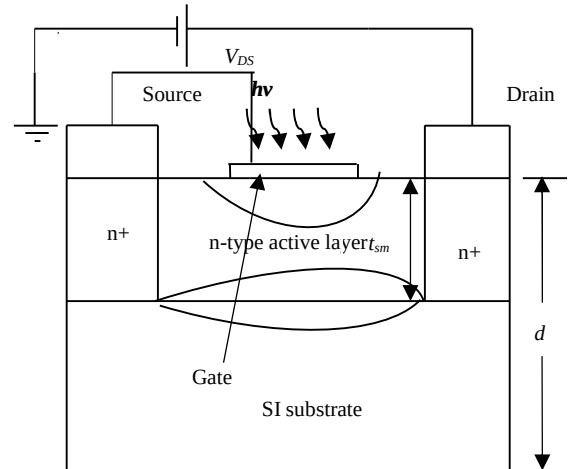


Fig. 1. Schematic of the front-illuminated OPFET.

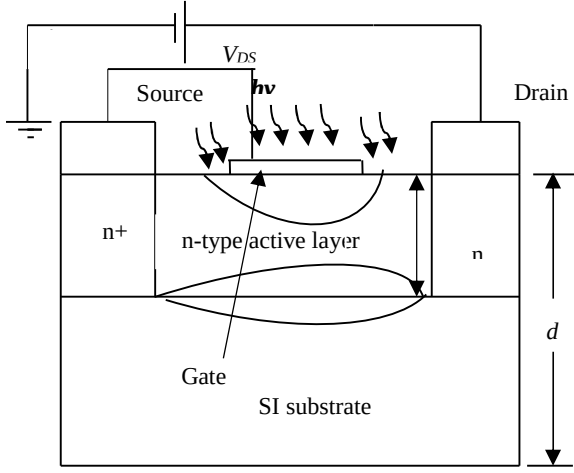


Fig. 2. Schematic of the generalized model of OPFET.

In the practical devices, only the gate depletion region exists in the channel. The p-n junction depletion region extension in the channel ceases to exist owing to the combined effect of moderate channel doping concentration ($5 \times 10^{22} / \text{m}^3$) and low substrate impurity concentration ($\sim 10^{13} / \text{m}^3$) substrate being semi-insulating. This also results in the complete depletion of the substrate region. The reader is advised to refer to [11], [14]-[16] for the analytical modeling of the devices (solutions of the continuity equations). In the following equations, which will be useful for explaining some of the results, the symbols have the same meaning as provided in [11], [14]-[16]. The trap effects are neglected in this work.

The space charge region extension in the channel measured from the surface is written as,

$$y_{dg} = \left[\frac{2e}{qN_{dr}} (\Phi_B - \Delta + v(x) - v_{gs} - V_{OP1}) \right]^{\frac{1}{2}}. \quad (1)$$

A. The effect of illumination on the minority carrier lifetime

The lifetime of minority carriers under illumination is calculated from [12],

$$t_L = \frac{\left[1 + \frac{4(1-r_m)(1-r_s)P_{opt}t_p(1-\exp(-at_{sm}))}{t_{sm}N_{dr}hn} \right]^{-1/2} - 1}{\frac{2(1-r_m)(1-r_s)P_{opt}(1-\exp(-at_{sm}))}{t_{sm}N_{dr}hn}}, \quad (2)$$

where t_{sm} is the active layer thickness.

B. Modulated Carrier Lifetimes

When the optical radiation is modulated by a small signal of frequency, ω , the carrier lifetimes are also modulated. The ac electron and the hole lifetimes are respectively given by:

$$t_{wn} = \frac{t_n}{1 + j\omega t_n}, \quad (3)$$

$$t_{wl} = \frac{t_L}{1 + j\omega t_L}. \quad (4)$$

Similarly the electron density, hole density, radiation flux density, and the volume generation rate of carriers have the ac and the dc parts.

C. Calculation of photovoltage

The hole continuity equation in the depletion region is represented by

$$\frac{\partial p}{\partial y} + \frac{p}{v_y t_{wl}} - \frac{a\Phi \exp(-ay)}{v_y} = 0. \quad (5)$$

The analytical solution can be given as:

$$p(y) = a\Phi t_{wl} \exp \left[- \left(a - \frac{1}{v_y t_{wl}} \right) y_{dg} \right] \left[\frac{av_y t_{wl}}{(av_y t_{wl} - 1)} \right], \quad (6)$$

$$\exp \left[- \frac{y}{v_y t_{wl}} \right] + \left[\frac{a\Phi t_{wl} \exp(-ay)}{(1 - av_y t_{wl})} \right]$$

using the boundary condition at $y=y_{dg}$,

$$p = a\Phi t_{wl} \exp(-ay_{dg}) \quad (7)$$

in the case of the front-illuminated OPFET.

For the generalized model of OPFET, the additional hole densities exist in the sidewalls of the gate depletion region. These can be obtained using (6) by replacing y_{dg} with y_{dgs} or y_{dgd} for the source and the drain sidewall depletion region extensions in the channel respectively. y_{dgs} and y_{dgd} can be estimated by treating the sidewalls as the semi-circular arcs of radius y_{dg} with $v(x)=0$ at the source end and y_{dg} with $v(x)=V_{ds}$ at the drain end and following the laws of circle theory (circle equation). The acquired hole densities reaching the surface (put $y=0$ in the respective equations) are integrated from 0 to y_{dg} with $v(x)=0$ at the source end and from 0 to y_{dg} with $v(x)=V_{ds}$ at the drain end multiplied with the gate width to give the net respective sidewall hole current per meter crossing the Schottky junction and contributing to the photovoltage.

For comparison with the buried-gate technology, we also discuss this model here. In this case, the hole density in the gate depletion region is given by (6) by using y_{dg} expressed as [16]

$$y_{dg} = t_{sm} - \left[\frac{2e}{qN_{dr}} (\Phi_B - \Delta + v(x) - v_{gs} - V_{OP1}) \right]^{\frac{1}{2}} \quad (8)$$

Then the photovoltage can be calculated as,

$$V_{OP1} = \frac{kT}{q} \ln \left[1 + \frac{qv_y p(0)}{J_{s1}} \right]. \quad (9)$$

in the case of the front-illuminated OPFET.

$$V_{OP1} = \frac{kT}{q} \ln \left[1 + \frac{qv_y p(0)}{J_{s1}} \right] + \dots \quad (10)$$

$$\frac{kT}{q} \ln \left[1 + \frac{qv_y p_{1s}}{ZLJ_{s1}} \right] + \frac{kT}{q} \ln \left[1 + \frac{qv_y p_{1d}}{ZLJ_{s1}} \right]$$

for the generalized model of OPFET, where p_{1s} and p_{1d} are the net hole currents per meter crossing the Schottky junction due to contributions from the source and the drain sidewall regions respectively.

Whereas the photovoltage in the case of the buried-gate model is obtained as

$$V_{OP1} = \frac{kT}{q} \ln \left[1 + \frac{qv_y p(t_{sm})}{J_{s1}} \right] \quad (11)$$

D. Drain to source current calculation

The total conducting charge is expressed as,

$$Q_n = Q_d + Q_{ch} + Q_{dep1} + Q_{dep2}. \quad (12)$$

Here Q_d is the charge due to doping; Q_{ch} , Q_{dep1} and Q_{dep2} are the charges due to photogeneration in the channel, Schottky junction depletion region and the substrate depletion region respectively.

Then Q_n can be evaluated as:

$$Q_n = \int_{y_{dg}}^{t_{sm}} N_{dr} dy + \int_{y_{dg}}^{t_{sm}} n_{ch} dy + \int_0^{y_{dg}} n_{dep1} dy + \int_{t_{sm}}^d n_{dep2} dy \quad (13)$$

where n_{ch} , n_{dep1} and n_{dep2} are the photogenerated electron densities in the channel, Schottky junction depletion region and substrate depletion region respectively.

All the integrations concerned with the computation of charge are performed numerically using the Trapezoidal method.

The total drain to source current is then calculated using the model described in [18]:

$$I_{ds} = I_{dss} (1 + |V_{DS}|) \tanh(hV_{DS}) + V_{DS} / R_{sh}. \quad (14)$$

The parasitic series source and drain resistances involved in the calculation are obtained following a similar procedure as given in [19]. The above current is applicable to the front-illuminated OPFET. In the case of the generalized model of the OPFET, the additional components of the current due to the contributions from the sidewalls of the gate depletion region are provided in [15].

III. RESULTS AND DISCUSSION

The simulations have been performed using MATLAB Software with MEX coding feature. We set the gate-source voltage to 0 V and the drain-to-source voltage to 10 V (saturation region). The wavelength of operation is 350 nm. The photon flux densities used in the simulations (10^{16} , 10^{19} , and 10^{22} /m²-s) correspond to optical power densities of 0.575 μ W/cm², 0.575 mW/cm², and 0.575 W/cm² respectively. The performance evaluation of the two illumination OPFET models considered in this work (generalized model and front-illuminated model) with respect to the performance metrics along with the other two models studied in our previous work [17] as reference is

provided in Table I. The comparison of our simulations with the reported work is presented in Table II. The parameters employed in calculation are listed in Table III. The definition of the different detector parameters are notified in [17]. Apart from that, one more parameter of interest signifying the extent of high resolution imaging or sensing or the linearity of the photocurrent is the *LDR* (Linear and Dynamic Range) expressed in dB. It is given as

$$LDR = 20 \log \left(\frac{J_{ph}}{J_d} \right) \quad (15)$$

where J_{ph} is the photocurrent density obtained at an optical power density of 1 mW/cm² and J_d is the dark current density.

As seen from Table I, the buried-gate structures record photovoltages of (0.346 V, 0.525 V, and 0.7 V) and (0.2 V, 0.38 V, and 0.56 V) respectively in the case of front-illumination and back-illumination. These are modest photovoltages and produce significantly high photoresponses. The detailed reasons and principles behind the attained responses of the two models are explained in [17]. In this paper, we will only provide the relative comparison and analysis of the devices with respect to the present models considered in this work. Although the responses achieved are high, the buried-gate structure suffers from low sensitivity in response to slightly variations in light intensity. This feature pulls back the device from being used in high dynamic range sensing or single photon counting applications. This limitation of the buried-gate structure is due to the low series resistance and moderate photovoltage resulting in reasonable current, hence, modest voltage drop across the series resistance which lowers the depletion width. It is known from the device physics that the sensitivity to illumination is higher when the depletion width is more. As such, the buried-gate structure exhibits reduced sensitivity. The low series resistance is attributed to the gate being buried in the channel which evades the possibility of development of the free surface depletion region as in the case of the surface gate OPFET wherein the depletion region is formed in the free surface between the gate and source, and the gate and drain apart from the depletion region developed at the sidewalls of the Schottky junction depletion region. Thus, comparing the surface gate and buried-gate devices, the total depletion width in the area between the source and gate, and the gate and drain, is more in the case of surface gate devices, reducing the current in this area and raising the series resistance. In contrast, the since the gate is buried in the channel, the gate is in contact with the substrate. The region near the interface between the channel and the substrate in the gate-source spacing and the gate-drain spacing produces zero depletion width in the channel owing to the semi-insulating nature of the substrate and the moderate doping concentration in the channel. This reduces the overall depletion width in the spacings decreasing the series resistance. Owing to the reduced sensitivity, the *LDR* in the buried-gate front-illuminated

OPFET is only around 14 dB. To improve this sensitivity, we suggest in this work, two models with surface gate (the generalized model and the front-illuminated model). The series resistance is higher in these cases as explained earlier. The depletion width sensitivity is higher owing to the modest photovoltages (0.269 V, 0.45 V, and 0.63 V) generated in the case of the front-illuminated OPFET and high photovoltages (0.65 V, 1.2 V, and 1.72 V) for the generalized model of OPFET, thus, drawing modest and significantly high current respectively, and developing large voltage drops across the high series resistances maintaining wider depletion widths. The LDRs so obtained are 24 dB and 55 dB for the front-illuminated and the generalized models of OPFET which are comparable to the various detectors reported in the literature [1]-[8] (Table II). The principle behind the modest photovoltages developed in the case of the front-illuminated OPFET is that the GaN absorption coefficient is moderate (8×10^5 /m) corresponding to the absorption depth of 1.25 μm resulting in the significant photogeneration throughout the device surface to substrate thickness of 1 μm . This enables a significant number of holes within the depletion region to cross the gate junction and develop a substantial photovoltage. This photovoltage is lower than the buried-gate structure with front-illumination and higher than that with back-illumination. This is because, the term with the additional factor ($\alpha \times v_y \times \tau_{\omega L}$) as discussed in [17] in the equation for hole density (6) is less in the surface-gate front-illuminated OPFET model owing to the generation being starting from the surface of the device and experiencing exponential decrease of the carriers until it reaches the edge of the depletion region. This doesn't occur in the buried-gate structure with front-illumination since the photogeneration begins from the channel side whereas in the buried-gate back-illuminated model, the additional factor ceases to exist as explained in [17]. Also, refer to [17] on how to treat the factors $((\alpha \times v_y \times \tau_{\omega L}) - 1)$ and $(1 - (\alpha \times v_y \times \tau_{\omega L}))$ in the denominator. On the other hand, the photovoltages are considerably high in the generalized model of OPFET due to the contribution from the sidewalls of the gate depletion region in addition to the gate depletion region itself.

It would be worthwhile to mention here that the sensitivity being discussed in the previous paragraph with respect to the buried-gate structure is low only at the lower intensities. At the higher intensity, both the buried-gate devices show significant sensitivity. This is because the device sensitivity being described was with respect to the depletion width sensitivity or photovoltaic sensitivity at the lower intensities. At the higher intensity of 10^{22} /m²-s, the photoconductive effect dominates the photocurrent owing to the high power levels involved. This photoconductive current is independent of the depletion width since the carriers generated in both the depletion region and the neutral channel region contribute to the photocurrent due to almost uniform photogeneration throughout the device thickness. If the depletion width is more, the depletion current contributes considerably or if the channel width is more, the channel current contributes substantially. One more reason for the enhanced photosensitivity at the higher

flux density is that the previous photocurrent response to the lower flux density is low due to the reasons discussed earlier since the sensitivity at a particular flux density is given by the difference between two successive responses divided by the response at the higher flux density. In the case of the surface gate models, the sensitivity of the front-illuminated model is lesser at the lower intensities and boosted at the higher intensity as compared to the generalized model. This can be explained as follows: Due to the significantly high photovoltages in the generalized model at the lower intensities along with the reasons stated earlier, the sensitivity is higher in this model. At the flux density of 10^{22} /m²-s, the depletion width sensitivity is zero on account of the large voltage drop incurred by the photoconductive current which is greatly enhanced at this intensity and adds substantially to the photocurrent. This photocurrent is more in the case of the generalized OPFET model. However, since the lower intensity photocurrent response being higher than that of the front-illuminated model, the effect of the photoconductive current sensitivity is felt more in the front-illuminated OPFET model. The buried-gate structure, due to its low series resistance, produces higher dark current. This also limits the sensitivity of the device. Higher dark current also adversely affects the Signal-to-Noise Ratio. Thus, the surface-gate devices take advantage of the lower dark current to improve the sensitivity as well as the Signal-to-Noise Ratio.

The modest and high photovoltages in the front-illuminated and the generalized model of OPFET respectively produce excellent photoresponses comparable to the buried gate devices. The generalized model offers superior performance at the lower intensities whereas the response is better in the front-illuminated OPFET at the higher flux density. This is because, at the higher intensity, the photovoltaic response is zero and the photoconductive effect alone contributes. Although, the photoconductive current is slightly greater in the generalized model owing to the additional contribution from the sidewalls of the gate depletion region, this comes at the cost of higher optical power to illuminate the spacings of the device. Since the responsivity is given by the ratio of the photocurrent to the incident optical power, the response is greater in the front-illuminated model. The photocurrent gain and the external quantum efficiency are related to the responsivity or the photocurrent and follow the similar explanation. High gains and efficiencies are obtained in all cases (Table I). This suggests that no external amplifying stages are required.

One of more important parameters, the switching time, signifies how fast the detector responds to changes in the optical signals and is given by the ratio of the depletion charge below the gate and its sidewalls to the total current flowing through the device thickness. All the four models exhibit reduced switching times in the nanoseconds to picoseconds range. The buried-gate structures show lower response times than the surface gate devices. This is attributed to the depletion width being smaller in buried-gate devices due to the small series resistance reducing the space charge below the gate while the current is reasonably high. In the surface-gate devices, the current is significantly high

but the depletion width is also large increasing the space charge owing to the large series resistance, thus, limiting the response speed. The generalized OPFET model exhibit lower switching times than the front-illuminated model owing to the higher current. The switching time decreases with the increase in optical power due to increase in the current.

The maximum amount of data in communication that can be detected is quantified by the bandwidth of the detector. The buried-gate structure shows better frequency response than the surface-gate structure. The rationale behind the significantly high frequency response in the buried-gate structures is explained in detail in [17]. The inferiority of the surface-gate devices' bandwidth performance is due to the dominant term bearing the additional factor of $(\alpha \times V_g \times \tau_{ol})$ is of lower magnitude than that in the buried-gate devices since the photogeneration in the surface-gate devices begins from the surface side whereas that in the buried-gate structures starts from the channel side. This creates the difference in magnitudes in the terms depending upon the density of the carriers that are photogenerated at the edge of the depletion region and in turn, the variation with modulation frequency. The bandwidth performance of the front-illuminated OPFET is enhanced compared to the generalized model at the lower intensities and vice versa at the higher intensities. This is because, in the generalized model, the photovoltage or the photogenerated hole density is due to the combined contribution of the individual parts due to the gate-depletion region and its sidewalls. Since a single part i.e. the gate-depletion region produces lower magnitude of hole density with the buried-gate device response as a reference which also implies that the frequency response is reduced, adding two more components of the same nature to the said response will further deteriorate the frequency response as in the generalized model at the lower intensities. At the higher flux density, the photoconductive component of current is the sole contributor wherein the generalized model with its additional contribution from the sidewalls as compared to the front-illuminated model exhibits better frequency response. The bandwidth is in the GHz range at the lower flux densities and in the MHz range at the higher flux density due to the dominance of the photovoltaic effects and the photoconductive effects at the lower and higher intensities respectively. The photovoltaic bandwidth is large due to the lower lifetime of holes (0.9 ns), bandwidth being inversely proportional to lifetime. The photoconductive bandwidth is small due to the dependence on the lifetime of electrons which is of the order of microseconds.

One more crucial parameter showing the ability to detect weak signals in the presence of noise is the detectivity. It depends upon the responsivity, the bandwidth, the detector area, and the noise parameters (various resistances). All the models show significantly high detectivities at all intensities. The detectivities are higher in the generalized OPFET model at the lower flux densities owing to the considerably high responsivities. At the higher flux density, the detectivity is superior in the front-illuminated model due

to the higher responsivity.

Another figure of merit depicting the highest frequency at which the device can amplify signals is the unity-gain cut-off frequency (f_T). All the models show comparable f_T values and in the gigahertz range which in combination with the detection bandwidth determine the detection-cum-amplification bandwidth of the detectors. The f_T increases with the increase in illumination as is understood from basic theory. However, in this study, an anomalous behavior is observed at the highest intensity i.e. decrease in the f_T value. This can be explained by the zero photovoltaic response and the enhanced photoconductive effect which is almost insensitive to the change in the gate to source voltage.

The substantial sensitivity of the generalized model of OPFET to slight changes in the light intensity is depicted in Fig. 3.

The devices' comparison with literature (Table II) shows that the devices' responses are better than the existing detectors with comparable *LDR* value of the generalized model to the reported work.

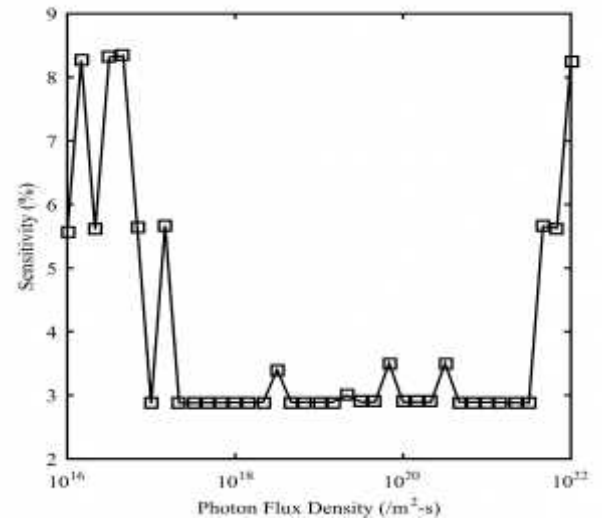


Fig. 3. Sensitivity versus photon flux density in the generalized model of OPFET.

IV. CONCLUSION

We studied the UV photoresponses of the two surface-gate OPFET illumination models (generalized model and front-illuminated model) in terms of photoresponse, bandwidth, response time, sensitivity, *LDR*, detectivity, and f_T . The detectors were proposed to be employed in high contrast imaging, sensing or single photon counting applications based upon their high *LDR* values. This was an improvement over our previous work on the buried-gate structures exhibiting rather poor sensitivities and dynamic range. However, the bandwidth performance of the buried-gate devices was superior to the surface gate devices. The other parameters were fairly comparable to each other. The switching times were lower in the buried-gate devices. The two models investigated exhibited excellent photoresponse, high bandwidth, low response times, high detectivity, and high f_T . The obtained results were analyzed in detail based on the photovoltaic and the photoconductive effects and the series resistance effects. A maximum

detection-cum-amplification bandwidth of 7.6 GHz at the flux density of 10^{19} /m²-s is achieved with the generalized model, thus, showing its potential in high data rate UV

communication applications. The devices' responses can be further improved through optimization.

TABLE I. PERFORMANCE COMPARISON OF GAN OPFET ILLUMINATION MODELS.

GaN buried-gate front illuminated OPFET with Au gate ($v_{gs}=0$ V, $V_{ds}=10$ V, $\lambda=350$ nm) [17]									
Photon Flux Density (/m ² -s)	Photovoltage (V)	Responsivity (A/W)	Photo-current Gain	EQE (%)	Sensitivity (%)	Switching time (s)	Bandwidth (Hz)	Detectivity (cmHz ^{1/2} W ⁻¹)	f_r (Hz)
0	0	-----	-----	-----	-----	67 ps	-----		7.37 GHz
10^{16}	0.346 V	1.1×10^9	2×10^{10}	3.86×10^{11}	15.06	53.6 ps	10.1 GHz	7.73×10^{16}	6.1 GHz
10^{19}	0.525 V	1.6×10^6	3.1×10^7	5.8×10^8	7.13	48 ps	33.4 GHz	1.17×10^{14}	5.8 GHz
10^{22}	0.7 V	3.69×10^3	6.92×10^4	1.31×10^6	20.85	34 ps	4.87 MHz	2.6×10^{11}	11.8 GHz
GaN buried-gate back illuminated OPFET with Au gate ($v_{gs}=0$ V, $V_{ds}=10$ V, $\lambda=350$ nm) [17]									
Photon Flux Density (/m ² -s)	Photovoltage (V)	Responsivity (A/W)	Photo-current Gain	EQE (%)	Sensitivity (%)	Switching time (s)	Bandwidth (Hz)	Detectivity (cmHz ^{1/2} W ⁻¹)	f_r (Hz)
0	0	-----	-----	-----	-----	67 ps	-----		7.37 GHz
10^{16}	0.2 V	5.6×10^8	1.06×10^{10}	2×10^{11}	8.7	60 ps	16.34 GHz	3.95×10^{16}	7.25 GHz
10^{19}	0.38 V	1.2×10^6	2.2×10^7	4.2×10^8	8.63	54 ps	28.5 GHz	8.2×10^{13}	7.1 GHz
10^{22}	0.56 V	1.57×10^4	2.94×10^5	5.56×10^6	67.1	4 ps	0.846 MHz	9.97×10^{11}	16.2 GHz
GaN front illuminated OPFET with Au gate ($v_{gs}=0$ V, $V_{ds}=10$ V, $\lambda=350$ nm) [This work]									
Photon Flux Density (/m ² -s)	Photovoltage (V)	Responsivity (A/W)	Photo-current Gain	EQE (%)	Sensitivity (%)	Switching time (s)	Bandwidth (Hz)	Detectivity (cmHz ^{1/2} W ⁻¹)	f_r (Hz)
0	0	-----	-----	-----	-----	1.25 ns	-----		5.2 GHz
10^{16}	0.2696 V	2.9×10^8	1.916×10^9	1.03×10^{11}	62.31	0.45 ns	5.8 GHz	6.57×10^{16}	6.2 GHz
10^{19}	0.4483 V	5.8×10^5	3.9×10^6	2.1×10^8	38.66	0.268 ns	12.87 GHz	1.17×10^{14}	6.7 GHz
10^{22}	0.6271 V	4.42×10^3	2.9×10^4	1.57×10^6	83.5	38 ps	0.78 MHz	7.55×10^{11}	4.95 GHz
GaN generalized model of OPFET with Au gate ($v_{gs}=0$ V, $V_{ds}=10$ V, $\lambda=350$ nm) [This work]									
Photon Flux Density (/m ² -s)	Photovoltage (V)	Responsivity (A/W)	Photo-current Gain	EQE (%)	Sensitivity (%)	Switching time (s)	Bandwidth (Hz)	Detectivity (cmHz ^{1/2} W ⁻¹)	f_r (Hz)
0	0	-----	-----	-----	-----	1.25 ns	-----		5.2 GHz
10^{16}	0.65 V	5.25×10^8	6.94×10^9	3.73×10^{11}	85.7	0.16 ns	2.836 GHz	9.145×10^{16}	7.6 GHz
10^{19}	1.2 V	1.29×10^6	1.71×10^7	9.2×10^8	55.67	58 ps	10.97 GHz	1.78×10^{14}	7.76 GHz
10^{22}	1.724 V	2.91×10^3	3.85×10^4	2.068×10^6	53.94	22 ps	3.27 MHz	3.9×10^{11}	74.4 MHz

TABLE II.

THE COMPARISON OF SIMULATIONS WITH THE LITERATURE.

Hybrid Perovskite [1]	<i>EQE</i> of 47%, detectivity of $2 \times 10^{13} \text{ cmHz}^{1/2}\text{W}^{-1}$, bandwidth of 3 MHz, and <i>LDR</i> of 100 dB at an optical power density of 1 mW/cm^2 at 0.1 V reverse bias at 350 nm wavelength
Solution processed ZnO nanoparticles [2]	Responsivity of 721 A/W, <i>EQE</i> of 2,45,300%, detectivity of $3.4 \times 10^{15} \text{ cmHz}^{1/2}\text{W}^{-1}$, and <i>LDR</i> of 80 dB -----at a power density of $1\text{-}1.25 \text{ }\mu\text{W/cm}^2$ and a bias of -9 V Responsivity of 1001 A/W, <i>EQE</i> of 3,40,600%, rise time (25 μs), fall time (142 μs -fast, 558 μs -slow), bandwidth of 9 kHz, and detectivity of $2.5 \times 10^{14} \text{ cmHz}^{1/2}\text{W}^{-1}$
Organic-Inorganic hybrid [3]	Responsivity of 240 A/W, <i>EQE</i> of $8.5 \times 10^4\%$, detectivity of $3.72 \times 10^{14} \text{ cmHz}^{1/2}\text{W}^{-1}$, and <i>LDR</i> of 60 dB at a bias of -10 V
Fullerene-based [4]	Responsivity of 1.28 A/W, <i>EQE</i> of 408%, and <i>LDR</i> of 120 dB under 0.1 W/cm^2 illumination at a bias of -8 V Detectivity of $6.5 \times 10^{12} \text{ cmHz}^{1/2}\text{W}^{-1}$ at a power density of $1 \text{ }\mu\text{W/cm}^2$ at a bias of -6 V
All-graphene p-n vertical junction [5]	Responsivity of 0.2 A/W, detectivity of $2 \times 10^{11} \text{ cmHz}^{1/2}\text{W}^{-1}$ at a bias of 1 V, and <i>LDR</i> of 93 dB
Se/ZnO p-n heterojunction [6]	Responsivity of 3 mA/W, on/off ratio of $\sim 10^4$ at 0 V bias under 370 nm illumination at an optical power density of 0.85 mW/cm^2 , rise and decay times of 0.69 ms and 13.5 ms respectively, and <i>LDR</i> of 80 dB
Solution processed ZnO/Au nanoparticle composite films [7]	Responsivity of $1.51 \times 10^5 \text{ A/W}$, detectivity of $2.05 \times 10^{15} \text{ cmHz}^{1/2}\text{W}^{-1}$, and <i>LDR</i> of 60 dB at 350 nm at an optical power density of $10.6 \text{ }\mu\text{W/cm}^2$
ZnO/Ag nanowires/ZnO composite film [8]	Responsivity of 2.4 A/W, detectivity of $6.8 \times 10^{12} \text{ cmHz}^{1/2}\text{W}^{-1}$ at 1 V bias at an optical power density of $10 \text{ }\mu\text{W/cm}^2$, response and recovery times of 3.53 s and 3.67 s respectively at 4.9 mW/cm^2 optical power density, and <i>LDR</i> of 64 dB

TABLE III.

PARAMETERS USED IN CALCULATION.

Dimensions and other parameters				
Parameter	Name	Value	Ref	Unit
Z	Channel Width	100×10^{-6}	[13]	(m)
L	Channel Length	3×10^{-6}	[13]	(m)
a	Active layer thickness	0.15×10^{-6}	[13]	(m)
N_{dr}	Ionized impurity concentration	4.95×10^{22}		(/m ³)
GaN parameters				
μ	Low field electron mobility	0.1	[20]	(m ² /V.s)
Φ_B	Schottky Barrier Height (Au-GaN)	0.88	[21]	(eV)
v_y	Carrier velocity in the y direction	2×10^5	[22]	(m/s)
τ_p	Lifetime of holes	0.9×10^{-9}	[23]	(s)
τ_n	Lifetime of electrons	1.15×10^{-6}	[24]	(s)
ϵ	Permittivity	9.21×10^{-11}	[24]	(F/m)
α	Absorption Coefficient @ 350 nm	8×10^5	[25]	(/m)

REFERENCES

- [1] L. Dou, Y. Micheal, J. You, Z. Hong, W. Chang, G. Li, and Y. Yang, "Solution-processed hybrid perovskite photodetectors with high detectivity," *Nature communications*, vol. 5, Nov. 2014.
- [2] F. Guo, B. Yang, Y. Yuan, Z. Xiao, Q. Dong, Y. Bi, and J. Huang, "A nanocomposite ultraviolet photodetector based on interfacial trap-controlled charge injection," *Nature nanotechnology*, vol. 7, pp. 798-802, Dec. 2012.
- [3] D. Shao, M. Yu, H. Sun, G. Xin, J. Lian, and S. Sawyer, "High-performance ultraviolet photodetector based on organic-inorganic hybrid structure," *ACS applied materials & interfaces*, vol. 6, pp. 14690-14694, July 2014.
- [4] Y. Fang, F. Guo, Z. Xiao, and J. Huang, "Large gain, low noise nanocomposite ultraviolet photodetectors with a linear dynamic range of 120 dB," *Advanced Optical Materials*, vol. 2, pp. 348-353, April 2014.
- [5] C. Kim, S. Kim, D. Shin, S. Kang, J. Kim, C. Jang, S. Joo et al., "High photoresponsivity in an all-graphene p-n vertical junction photodetector," *Nature communications*, vol. 5, Feb. 2014.
- [6] K. Hu, F. Teng, L. Zheng, P. Yu, Z. Zhang, H. Chen, and X. Fang, "Binary response Se/ZnO p-n heterojunction UV photodetector with high on/off ratio and fast speed," *Laser & Photonics Reviews*, vol. 11, pp. (1600257-1)- (1600257-7), Jan 2017.
- [7] Z. Jin, L. Gao, Q. Zhou, and J. Wang, "High-performance flexible ultraviolet photoconductors based on solution-processed ultrathin ZnO/Au nanoparticle composite films," *Scientific reports*, vol. 4, March 2014.
- [8] Z. Yang, M. Wang, X. Song, G. Yan, Y. Ding, and J. Bai, "High-performance ZnO/Ag Nanowire/ZnO composite film UV photodetectors with large area and low operating voltage," *Journal of Materials Chemistry C*, vol. 2, pp. 4312-4319, April 2014.
- [9] C. Baack, G. Elze, and G. Walf, "GaAs MESFET: A high-speed optical detector," *Electronics Letters*, vol. 13, pp. 193-193, March 1977.
- [10] A. A. A. De Salles, "Optical control of GaAs MESFETs," *IEEE Trans. on Microwave Theory and Techniques*, vol. 31, pp. 812-820, Oct. 1983.
- [11] S. R. Saxena, R. B. Lohani, R. U. Khan, and B. B. Pal, "Generalized dc model of GaAs optical field effect transistor considering ion-implanted profile," *Optical Engineering*, vol. 37, pp. 1343-1352, April 1998.
- [12] P. Chakrabarti, S. K. Shrestha, A. Srivastava, and D. Saxena, "Switching characteristics of an optically controlled GaAs-

- MESFET," IEEE Trans. on Microwave Theory and Techniques, vol. 42, pp. 365-375, March 1994.
- [13] N. S. Roy and B. B. Pal, "Frequency-dependent OPFET characteristics with improved absorption under back illumination," Journal of lightwave technology, vol. 18, pp. 604-613, April 2000.
 - [14] J. Gaitonde and R. B. Lohani, "GaAs Optical Field Effect Transistor (OPFET): A High Performance Photodetector for Automotive Applications," SAE International Journal of Passenger Cars-Electronic and Electrical Systems, vol. 9, pp. 204-211, April 2016.
 - [15] N. S. Roy, B. B. Pal, and R. U. Khan, "Frequency-dependent characteristics of an ion-implanted GaAs MESFET with opaque gate under illumination," Journal of Lightwave Technology, vol. 18, pp. 221-229, Feb. 2000.
 - [16] M. K. Verma and B. B. Pal, "Analysis of buried gate MESFET under dark and illumination," IEEE Trans. on Electron Devices, vol. 48, pp. 2138-2142, Sep. 2001.
 - [17] J. V. Gaitonde, S. P. S. Rawat, and R. B. Lohani, "Comparative Analysis of Buried-Gate GaN OPFET Models for UV Photodetector Applications," In 2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON), IEEE, pp. 1-8, Nov. 2018.
 - [18] T. Chen and M. S. Shur, "Analytical models of ion-implanted GaAs FET's," IEEE Trans. on Electron Devices, vol. 32, pp. 18-28, Jan. 1985.
 - [19] Y. H. Byun, M. S. Shur, A. Peczalski, and F. L. Schuermeyer, "Gate-voltage dependence of source and drain series resistances and effective gate length in GaAs MESFETs," IEEE Transactions on Electron Devices, vol. 35, pp. 1241-1246, Aug. 1988.
 - [20] V. W. L. Chin, T. L. Tansley, and T. Osotchan, "Electron mobilities in gallium, indium, and aluminium nitrides," Journal of Applied Physics, vol. 75, pp. 7365-7372, June 1994.
 - [21] Y. Kribes, I. Harrison, B. Tuck, T. S. Cheng, and C. T. Foxon, "Investigation of Au Schottky contacts on GaN grown by molecular beam epitaxy," Semiconductor science and technology, vol.12, pp. 913-916, 1997.
 - [22] J. Kolnik, İ. H. Oğuzman, K. F. Brennan, R. Wang, P. P. Ruden, and Y. Wang, "Electronic transport studies of bulk zincblende and wurtzite phases of GaN based on an ensemble Monte Carlo calculation including a full zone band structure," Journal of Applied Physics, vol. 78, pp. 1033-1038, July 1995.
 - [23] K. Kumakura, T. Makimoto, N. Kobayashi, T. Hashizume, T. Fukui, and H. Hasegawa, "Minority carrier diffusion length in GaN: Dislocation density and doping concentration dependence," Applied Physics Letters, vol. 86, pp. (052105-1)-(052105-3), Jan. 2005.
 - [24] S. Bose, M. Gupta, and R. S. Gupta. (2001, Dec.). Analytical model for DC characteristics of GaN MESFET under dark and illuminated conditions. In Microwave Conference, APMC, Asia-Pacific, Taipei, Taiwan, 2001.
 - [25] O. Ambacher, W. Rieger, P. Ansmann, H. Angerer, T. D. Moustakas, and M. Stutzmann, "Sub-bandgap absorption of gallium nitride determined by photothermal deflection spectroscopy," Solid state communications, vol. 97, pp. 365-370, Feb. 1996.

A 3D SIMULATION OF DGCNTFET MORPHOLOGICAL ANALYSIS

Pooja Shimpi,
Student,
Technische Universität Chemnitz,
Saxony, Germany
pooja0708shimpi@gmail.com

Deepak Singh,
Assistant Professor,
Thakur College of Engineering and
Technology, Mumbai, India
d.singhh91@gmail.com

Deepak Kumar Sinha,
Assistant Professor,
Thakur College of Engineering and
Technology, Mumbai, India
deepksinha.extc@gmail.com

Abstract—The study of Carbon nanotube field effect transistor extensively in the past few years and have developed applications in CMOS devices, because of the capability of ballistic transport mechanism below the 200nm. In this article exhibited device performance and scaling perspectives of Double gate carbon nanotube field effect transistors (DGCNTFET) with doped source and drain extensions. The simulations results achieved in the current paper follows self-consistent solution of 3-D Poisson–Schrodinger equation considering open boundary conditions, for non-equilibrium Green function methodology, where arbitrary gate dimensions and device architecture is considered. The investigation of short channel effects for different gate structure and the geometrical parameters expresses that double gate devices presents quasi-ideal threshold voltage, Transconductance without extremely lowering the gate dielectrics medium. Exploration of devices expresses that ON currents per unit width are predominant in the range of 10^7 - 10^8 , whereas high-frequency performance is in the order of tera hertz.

Keywords: Ballistic transport, carbon nanotubes (CNTs), non-equilibrium Green's function (NEGF), technology computer aided design (CAD).

I. Introduction

In relation to ITRS field gap [12], Silicon based As technology scaling has improved over the years to the nanometer range, technology is anticipated to accomplish its resizing limit at the extend of 5nm [12].

The scaling edge of the semiconductor industries has reached maximum limit, the problem occur due this punch through, hot carrier effect, mobility degradation that limit the CMOS technology for further scaling down. Industry has tried with different variation in structural change in device for improvement in scaling so now the search has been increased for novel material such as carbon nanotube, single electron tunneling, Quantum cellular automata. Compared to other material CNT has same operating principle and structure so the current infrastructure of Si-based technology can be reused using CNT.

Carbon Nanotubes is the graphene sheets which is rolled into cylindrical tubes along with associate axis. The microscopic morphological chirality that defines the basic Properties of CNT like diameter, channel length. Depending upon the angle of the orientation of carbon rolls CNT behavior change depending upon the chiral vector (n,m) If (n-m) is divisible by three, the tube is metallic else it will be semiconductor. The chiral vector (n,m) which define CNT where n is correlated with diameter, m define the total length of CNT.

The majority of the CNTFETs made-up are of planer type as a consequence of their relative plainness and temperate compatibility with obtainable producing technologies. In planer technology the

top gate morphology offers the paramount performance [4]. But coaxial is most well-liked as a consequence of it increases the capacitive coupling sandwiched in the midst of the gate along with CNT surface, thereby causing additional charge in channel at a known gate potential than alternative geometries. For our simulations there have a affinity to be development double gate planer geometry.

We have simulated double gate CNTFETs for channel length (L) 30-80nm and diameter (d) 0.5-1nm for various dielectric medium to examine the majority proficient device morphology. We have investigated and compared completely different structure on the foundation of a diversity of parameters i.e.

ION/IOFF ratio, transconductance (gm), inverse sub threshold slope (S) in extension to threshold voltage (Vth). Simulations are engaged in NanoTCAD Vides. Double Gate CNT FETs are determined, where Poisson equation in three dimensions in like manner electrostatic potential and source-electron transport is evaluated by using Landauer formalism.

The structure is been adopted for the Poisson equation that's at the equivalent instance involved the non equilibrium Green's function (NEGF) formalism exploitation the mode space approach, which empower the computation of transport for a little range of electron sub bands with a less computational cost. This paper includes morphological and through empirical observation relevant Double gate CNT-FETs with doped wells extensions, and evaluates their performance with the necessity of the ITRS. During this case, code is developed that is able to enumerate full band Schrodinger equations by using open boundary conditions.

The code is referred in NANOTCAD ViDES [6], which be capable of be used for general structures, since it doesn't take prevalence of specific symmetries and can take into account structures within which the couple CNTs along with traditional semiconductors are as one given. Our sane duplicate spectacle that Double gate CNT-FETs are pleasant for 1) driving high ON currents per unit length; 2) providing Ion/Ioff ratio with 20-nm gate length II. "BASICS OF DOUBLE GATE CARBON NANOTUBES", The Carbon nanotubes, discovered by S. Iijima in 1991 while found out that molecular framework incorporate of carbonium.

This may be looked into as the results of layers of folding graphite into carbon cylinders and maybe self-possessed of one shell-single wall nanotubes (SWNTs), or of many shells-multi-wall nanotubes (MWNTs) as exhibited in fig.1. Looking on the folding angle and the diameter, nanotubes may be metallic in nature or semiconducting which depends on on the chiral vector, the circular

vector that is at right angles to the axis of the tube [1].



Figure 1: Structural view of Double gate carbon nanotube field effect transistor

II. SIMULATION APPROACH

The Simulation performed in 3-D obeys Poisson equation

$$\nabla \cdot [\epsilon(\vec{r}) \nabla \phi(\vec{r})] = -q [p(\vec{r}) - n(\vec{r}) + N_D^+(\vec{r}) - N_A^-(\vec{r}) + \rho f_{\text{fix}}]$$

Where $\phi(\vec{r})$ electrostatic potential, $\epsilon(\vec{r})$ dielectric constant, $N_D^+(\vec{r})$ and $N_A^-(\vec{r})$ are the concentrations of ionized donors and acceptors, respectively, and ρf_{fix} is the fixed charge. The electron and hole concentrations (n and p , respectively) are classified by dealing with the Schrodinger equation and its open boundary conditions by virtue of the NEGF formalism [7]. A closed binded Hamiltonian with an atomistic (pz orbitals) real-space basis [8] applied with a hopping parameter $t = 2.7$ eV.

The Green's function is described as

$$G(E) = [EI - H - \sum S - \sum D]^{-1}$$

Where E is energy, I identity matrix, H Hamiltonian of the CNT, and $\sum S$ and $\sum D$ are the self-energies of the source and drain, respectively. As exhibits complete ballistic transit is assumed as working below 200nm.

The considered CNTs are all zigzag nanotubes, but the contemplated approach can be easily derive to nanotubes with a generic chirality since the required changes associate only the Hamiltonian matrix. As the length and chirality of the tube is known then the co-ordinates of the individual carbon atom can be figure out [9]. After that, the 3-D domain is discretized so that a grid point is defined in correspondence with each atom, while a user-specified grid is defined in area not including the CNT.

Let us consider the point charge approximation i.e., all free charge around each carbon atom are spread equally in each elementary cell along with atom. Assume that chemical potential of the reservoirs is co-ordinated at equilibrium state of Fermi level in CNT. The CNT is inclined with no confined states, where the electron concentration is given by the following equation:

$$n(\vec{r}) = 2 \int_{-\infty}^{+\infty} dE [|\psi_1(\vec{r}, E)|^2 f(E - E_F) + |\psi_2(\vec{r}, E)|^2 f(E - E_F)]$$

The hole Concentration is given by:

$$p(\vec{r}) = 2 \int_{-\infty}^{+\infty} dE [|\psi_1(\vec{r}, E)|^2 [1 - f(E - E_F)] + |\psi_2(\vec{r}, E)|^2 [1 - f(E - E_F)]]$$

Where $\vec{r}$ is coordinate of the carbon site, f is Fermi-Dirac occupation factor, $|\psi_1|^2$ ($|\psi_2|^2$) is probability that states implant by the source (drain) reach the carbon site ($\vec{r}$), and E_F (E_{FD}) are the Fermi level of the source (drain).

The current has been enumerate as

$$I = \frac{2q}{h} \int_{-\infty}^{+\infty} dE T(E) [f(E - E_F) - f(E - E_{FD})]$$

Where q is electron charge, h is Planck's constant, and $T(E)$ is transmission coefficient computed as [7].

$$T = -\text{Tr} [(\Sigma_S - \Sigma_D) G (\Sigma_D - \Sigma_S) G^*]$$

Where Tr is trace operator. We have to point out that with current model, the one-dimensional (1-D) transit between source and drain reservoirs, although leakage gate current is not considered. On considering the devices with channel length of minor nanometers, it can be shown that the gate current is negligible with respect to the drain current. From a mathematical point of view, Green's function is computed using the recursive Green's function (RGF) technique [10], [11]. To articulate and explain the context of self-energy matrix, which can be interpreted as a boundary condition of the Schrodinger equation. In particular, the simulation analysis depicts about a self-energy for semi infinite edge tested for boundary conditions that results to consider CNT to be connected for infinite length at its ends.

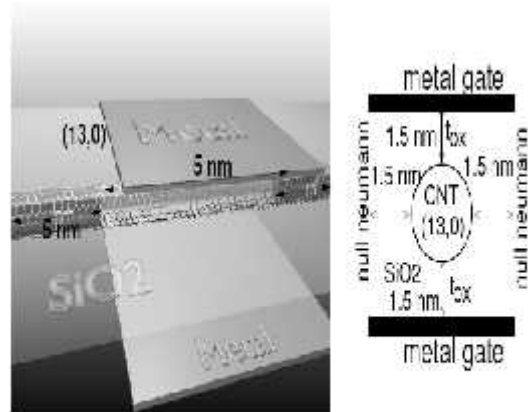


Figure 2: the defined DG-CNTFET in the input deck CNT file.

I. SIMULATION ANALYSIS AND RESULT

In this work, we consider a (13, 0) CNT channel with a 1.5nm-thick oxide as the gate insulator. The height of each SB is assumed to be half of the CNT energy band-gap (mid-gap SB). We assume a ballistic channel length of 60nm, which is divided into three regions. Without loss of generality, it is assumed that the gate in each region has the same length (20nm). The gate current is assumed to be negligible, and the drain current of the transistor is evaluated using the Landauer formula.

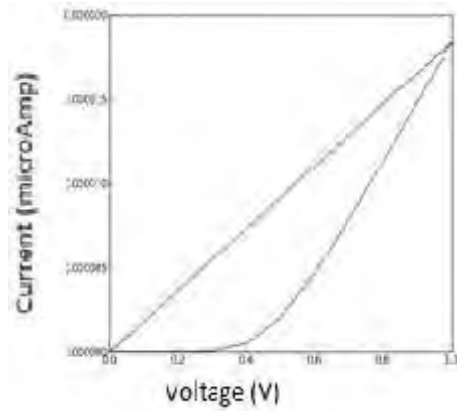


Figure 3: Transfer characteristic of double gate carbon nanotube field effect transistor.

Case 1 : 13,60			
Currents(Ids)	Ion/Ioff	Transconductance	
0.00E+000	8.53E-011	4.227*10 ⁻⁹	
1.00E-001	5.08E-010	4.350*10 ⁻⁸	
2.00E-001	4.86E-009	5.55*10 ⁻⁷	
3.00E-001	6.04E-008	4.456*10 ⁻⁶	
4.00E-001	5.06E-007	1.594*10 ⁻⁵	
5.00E-001	2.10E-006	2.61*10 ⁻⁵	
6.00E-001	4.71E-006	3.2*10 ⁻⁵	
7.00E-001	7.91E-006	3.39*10 ⁻⁵	
8.00E-001	1.13E-005	3.5*10 ⁻⁵	
9.00E-001	1.48E-005	3.6*10 ⁻⁵	
1.00E+000	1.84E-005		

Table 2: Transconductance with respect to chiral vector (19,60)

Case 2 : 19,60			
Voltages	Current	Ion/Ioff	Transconductance
0.00E+000	1.92E-009	6.1*10 ⁻³	7.9*10 ⁻⁷
1.00E-001	8.12E-008		1.09*10 ⁻⁵
2.00E-001	1.18E-006		3.23*10 ⁻⁵
3.00E-001	4.41E-006		3.26*10 ⁻⁵
4.00E-001	7.67E-006		1.19*10 ⁻⁵
5.00E-001	8.86E-006		2.74*10 ⁻⁵
6.00E-001	1.16E-005		3.7*10 ⁻⁵
7.00E-001	1.53E-005		4.4*10 ⁻⁵
8.00E-001	1.97E-005		4.8*10 ⁻⁵
9.00E-001	2.45E-005		5*10 ⁻⁵
1.00E+000	2.95E-005		

Table 3: Transconductance with respect to chiral vector (26,60)

Case 3 : 26,60			
Voltages	Current	Ion/Ioff	Transconductance
0.00E+000	1.01E-007	1.2*10 ⁻²	1.31*10 ⁻⁵
1.00E-001	1.41E-006		5.34*10 ⁻⁵
2.00E-001	6.75E-006		5.95*10 ⁻⁵
3.00E-001	1.27E-005		4.1*10 ⁻⁵
4.00E-001	1.68E-005		1*10 ⁻⁵
5.00E-001	1.78E-005		2.9*10 ⁻⁵
6.00E-001	2.07E-005		4.3*10 ⁻⁵
7.00E-001	2.50E-005		4.6*10 ⁻⁵
8.00E-001	2.96E-005		4.9*10 ⁻⁵
9.00E-001	3.45E-005		5.4*10 ⁻⁵
1.00E+000	3.99E-005		

Table 4: Transconductance with respect to chiral vector (10,60)

Case 4: 10,60			
Voltages	Current	Ion/Ioff	Transconductance
0.00E+000	3.61E-014	3.8*10 ⁻⁸	1.64*10 ⁻¹¹
1.00E-001	1.68E-012		4.21*10 ⁻¹⁰
2.00E-001	4.38E-011		1.36*10 ⁻⁸
3.00E-001	1.41E-009		3.33*10 ⁻⁷
4.00E-001	3.47E-008		3.85*10 ⁻⁶
5.00E-001	4.20E-007		1.4*10 ⁻⁵
6.00E-001	1.82E-006		2.2*10 ⁻⁵
7.00E-001	4.02E-006		2.6*10 ⁻⁵
8.00E-001	6.62E-006		2.7*10 ⁻⁵
9.00E-001	9.32E-006		2.88*10 ⁻⁵
1.00E+000	1.22E-005		

A. Variations of chiral vector on threshold voltage

A carbon nano tube can behave not only as semiconductor but also as conductor. The orientations of carbon atom depend on the angle of CNT tube. This is considered as chirality vector and is represented by the integer pair (m, n). The circumference of a carbon nanotube is expressed as,

$$C = na_1 + ma_2 \quad (1)$$

semiconducting is judged by its indices (m, n). The nanotube is metallic if $n = m$ or $n - m = 3i$, where i is an integer. Otherwise, the tube is semiconducting [12]. The geometry of graphene lattice and chiral vector of the tube determines the structural parameters such as the diameter of CNT, unit cell, carbon atoms, along with its size and shape which are covered by Brillouin zone. The diameter calculation of CNT is based on the following equation:

$$D_{CNT} = \frac{\sqrt{3} a_0}{\pi} \sqrt{n^2 + m^2 + mn} \quad (2)$$

Where,

$a_0 = 0.142$ nm is the inter-atomic distance between each carbon atom and its neighbor.

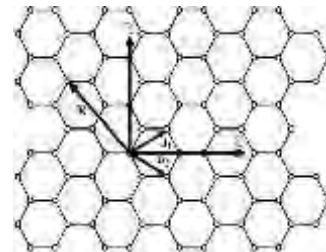


Figure 4: Graphene atomic structure with chiral vector.

$$V_{th} = \frac{u v_E}{\sqrt{3} q D_{CNT}} \quad (3)$$

Where q is electronic charge, a is lattice constant with dimension of 2.49 Å with carbon π to π bond energy. CNTFETs provide unique prevalence to control threshold voltage by varying the chirality vector, or the diameter of the tube.



The V_{gs} voltage that generates reference current is considered as the threshold voltage for transistor with varying chirality. The chiral vector plays vital role in deciding the diameter of carbon nanotube. Through the simulation result shown below, it is expressed with reference to threshold voltage controlled by varying the chiral vector. In Table 1, we have considered 12 different combinations of chiral vector and analyzed them to evaluate the threshold voltage respectively.

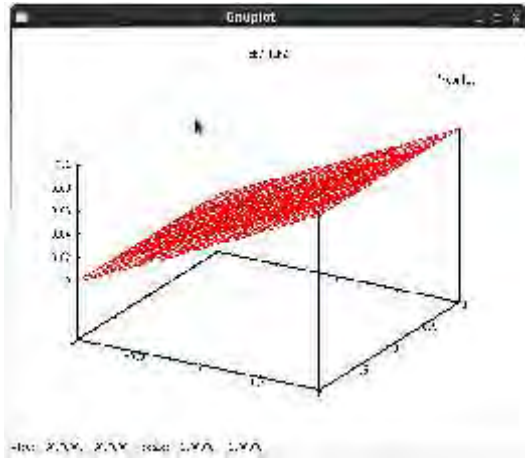


Figure 7: Two dimensional view of Poisson model for current calculation.

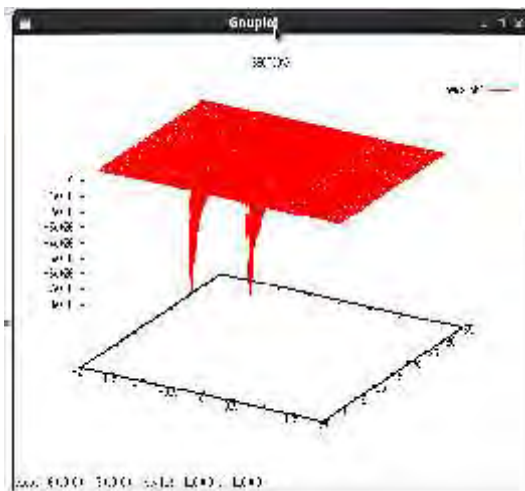


Figure 8: Two dimensional view of Poisson equation model for current calculation.

Table 5: Threshold voltage with respect to different chiral vector.

Chiral Vector(m,n)	Threshold voltage(V)
(4,0)	1.392
(6,2)	0.7719
(16,12)	0.2288
(8,0)	0.6958
(9,1)	0.535
(17,9)	0.2434
(11,0)	0.506
(13,2)	0.3946
(24,13)	0.1712
(14,0)	0.3976
(17,3)	0.298
(19,60)	0.293
(26,12)	0.1654

III. cONCLUSION

In the current work a novel 3-D NEGF-based simulation results for DG - CNTFET architecture is proposed which has enabled to investigate the performance perspectives of CNT-FETs. In principle, the random distribution of dopants in the reservoirs is significantly observed with device performance which degrades the current in the OFF state by several orders of magnitude by 10^{-2} . It is observed that DG structures exhibit a narrow short channel effects even with thick silicon oxide gate dielectric (1 nm). This is an acceptable threshold voltage for devices with the channel length up to 20 nm.

The driving currents and transconductance measured are compared as per ITRS requirements. The I_{off} results in few problems due to the presence of localized hole states in the channel. However, good I_{on}/I_{off} in the range of 10^7 to 10^8 is achieved by reducing the tube density in the CNT-FET array, still satisfying ITRS requirements.

REFERENCES

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

- [1] R. Martel, H.-S. P. Wong, K. Chan, and P. Avouris, “Carbon nanotube field-effect transistors for logic applications,” in IEDM Tech. Dig., 2001, pp. 159–162 (2004).
- [2] The International Technology Roadmap for Semiconductor 2004 Update, ITRS Handbook. [Online]. Available: <http://public.itrs.net>
- [3] S. Iijima, “Helical microtubules of graphite carbon,” Nature, vol. 354, no. 6348, pp. 56–58, Nov. 1991.
- [4] S. Heinze, J. Tersoff, R. Martel, V. Derycke, J. Appenzeller, and P. Avouris, “Carbon nanotubes as schottky barrier transistors,” Phys. Rev. Lett., vol. 89, no. 10, pp. 106801–106803, Aug. 2002.
- [5] J. Appenzeller, J. Knoch, R. Martel, V. Derycke, S. Wind, and P. Avouris, “Short-channel like effects in schottky barrier carbon nanotube field-effect transistors,” in IEDM Tech. Dig., 2002, pp. 285–288.
- [6] G. Fiori and G. Iannaccone, “Code for the 3-D simulation of nanoscale semiconductor devices, including drift-diffusion and ballistic transport in 1-D and 2-D subbands, and 3-D tunneling,” J. Comput. Electron., vol. 4, no. 1, pp. 63–66, Sep. 2005.

- [7] S. Datta, "Nanoscale device modeling: Green's function method," *Superlattices Microstruct.*, vol. 28, no. 4, pp. 253–277, Jul. 2000.
- [8] J. Guo et al., "Performance analysis and design optimization of near ballistic carbon nanotube field-effect transistors," in *IEDM Tech. Dig.*, 2004, pp. 703–706.
- [9] R. Saito, G. Dresselhaus, and M. S. Dresselhaus, *Physical Properties of Carbon Nanotubes*. London, U.K.: Imperial College Press, 2003, pp. 35–58.
- [10] R. Lake, G. Klimeck, R.C. Bowen, and D. Jovanovic, "Single and multiband modeling of quantum electron transport through layered semiconductor devices," *J. Appl. Phys.*, vol. 81, no. 12, pp. 7845–7869, Feb. 1997.
- [11] A. Svizhenko, M. P. Anantram, T. R. Govindam, and B. Biegel, "Two-dimensional quantum mechanical modeling of nanotransistors," *J. Appl. Phys.*, vol. 91, no. 14, pp. 2343–2354, Nov. 2001.
- [12] Dresselhaus M S, Dresselhaus G, Riichiro S. Carbon fibers based on C60 and their symmetry. *Phys Rev B*, 1992, 45(11): 6234

This page is kept blank intentionally

IoT for Agricultural India – A Case Study

Karunesh Loke
M.Tech. (EXTC),
EED, VJTI, Mumbai, India
karuneshloke@gmail.com

Imran Tamboli
M.Tech. (Power),
EED, VJTI, Mumbai, India
imrantamboli1993@gmail.com

Dr. Surendra Bhosale
Associate Professor,
EED, VJTI, Mumbai, India
sjbhosale@ee.vjti.ac.in

Abstract– There is vast enhancement in agriculture sector worldwide i.e. different tools and technologies are being used in agriculture now a days. New technology called Internet of Things (IoT) is used to improve efficiency, productivity, global market and to reduce human intercession, time and cost. IoT is the network of devices which transfer the information without human involvement. Hence, to gain high efficiency, IoT works in synergy with agriculture to obtain smart farming. This paper focuses on use of IoT for agricultural benefits in rural India and also involve one experiment carried out in lab for fertilizer content detection using near infrared laser absorption with its appropriate results.

Keywords–IoT, Smart Agriculture, Sensor Technology, Digital world, Mobile Apps

I. INTRODUCTION

Development of farming in different phases like survival farming in 18th century, barns farming in 19th century, animal-powered farming in early 20th century and machine powered farming in late 20th century. Now a days an age of data powered farming is coming into picture, via open statistical data sets on climate condition and crop yields, Internet of Things (IoT), smart technologies and drones.

IoT in an agricultural context refers to the use of sensors, cameras, and other devices to turn every element and action involved in farming into data. Remote sensing & IoT are part of new innovations. For example, Science-based analytic tools like FieldScript uses for recommendations on planting, accurate seeding and inherent gain. Monsanto's Integrated Farming System (IFS) used to map and forecast potato yields, farm imagery has been used by GroundCover, With the help of smartphones, CanopyCheck app offers an extra data about geo-location statistics to farmers. To locate the movement and healthiness of cattle as well as for detection of diseases and their prevention, GrowSafe System uses sensors.

A. Use of IoT in Indian Agriculture:

India's startup ecology is the 3rd largest technical startup ecology in the world,. 60–65 percent startups are of the Indian IoT system, and 70 percent of them are not more than seven years old. These startups are aiming to the customer as well as agricultural and industrial areas [1].

For small crofters who use sprinkler or drip systems, one of the biggest challenges is to irrigate feild, where water is a limited resource. Contribution of Indian agriculture is 17 percent to the GDP of india and 61.5 percent of Indian population depend on agriculture for their source of income. Drought, lack of reliable labour, and poor frame of infrastructure gives rise to in reduced yield of crop. By combining IoT sensors and activators, can be used to control it remotely by means of mobile applications. To irrigate fields and helping farmers to save water. Solution oriented IoT based Startups like Avanijal has been developed in India to help farmer in irrigation.

Several 24 Indian IoT Startups for agriculture sector has been tracked by India Electronics and Semiconductor Association (IESA), which receive financial help are Wifinity, Nimble Wireless, GOQii, Ducere, SensGiz, Connovate, Systemantics, Ray IT, Ineda Covaccis, ConnectM Eravaku, Altizon, GreyOrange, iIdeaForge, LogiNext, Silvan Innovation, Entrib, Altiux Stellapps, Ecozen , CardiacDesign Labs ,iBoT, and Embrace [2].

B. Enter the digital twins:

An exact replica of a physical system which is continuously monitored is nothing but a digital twin. Gartner has identified this digital twin in 2017 as one of the top five trending technologies To monitor agronomic machine efficiency and decrease downtimes, digital models offer deep perceptions on physical asset by continuous learning, For well development of farming machinery digital twins offer very useful competencies.

There are many companies functioning to use IoT in agricultural India, Financial safety to farmers are provided by 12 percent of all IoT startups in India. Agritech company is one of them, SatSure uses IoT to report information irregularity, Gramophone uses IoT technology. Avanijal's app help farmers to save water by irrigating their fields, Smart farm machineries are build by Green Robot with the help of robotics and 3D vision technology. In Indian agriculture IoT Program Green Robot and Avanijal are front-runners in Qualcomm Design, which combine Qualcomm technologies and it's platforms and inspires Indian companies to produce inventive hardware designs [3].

Nowadays application of IoT is a global demand and it is very beneficial for the country like India

where agriculture is the main source of income and overall development of country. IoT can reinforce the capability of rural populations to become financial carterers and worth makers and generate new employment and opportunities. IoT is renovating the farming industry through most innovative and practical applications.

Summary of applications and their benefits are given in following Table 1.

TABLE I. IoT Applications and Benefits

Sector	Mobile Application	Benefits
Agriculture	1. GIS system for planning 2. Teleeducation, Scientific databases 3. Telecentres, information services for pricing	1. More awareness of innovative approaches 2. Improved food production 3. Seasonal planning risk mitigation
Animal Healthcare	1. Telemedicine (Audio/Image transmission, Collaboration) 2. Digital publication of medical research 3. Outsourcing of services	1. Increased productivity, reduced travel costs 2. Broader service reach for experts 3. More responsive healthcare

II. THEORY

Things to be Considered Before Developing Agricultural IoT Apps: Farm's performance and revenue can be increased with the help of some smart IoT devices. However, it is not an easy task to develop IoT apps for agriculture. There are certain challenges one should consider before endowing money in IoT operated farming [4].

1. Hardware

To construct an IoT operated app for farming, you require to select the suitable sensors for your device or you have to generate a custom one depend upon your device constraint. The data or info or statistics you want to gather and the motive of your results are the key constraints for your choice. In any circumstance, the decisive parameter is sensors quality for success of IoT product, it depends on the correctness of the gathered data and its dependability [5]

2. The Brain

For each IoT operated agriculture solution Data analysis is at the center. If you cannot make perceptiveness of the collected data it will not be helpful for you. Thus, you require to have dominant data analytics capabilities. In order to obtain actionable perceptions based on the gathered data, apply forecasting algorithms and machine learning.

3. Maintenance

For agricultural IoT products, maintenance of hardware is a task that is of significant importance, as sensors used in farming field can be broken easily.

Hence, you need your hardware which is robust and easy to maintain else, you will in effect change sensors used in farming field more frequently.

4. Mobility

IoT operated farming apps should be personalized for usage in the farming land. A farm manager or business owner must be capable to access and control the statistics on site or remotely via desktop computer or a smartphone. Plus, each associated equipments or devices must be self-sufficient and have plentiful broadcast range to converse with the other equipments or devices for sending records and data statistics to the central server.

5. Infrastructure

You need a firm central infrastructure to confirm that your IoT operated farming app executes thriving and to making sure about its data handling capability. Moreover, security of central infrastructure is also a main concern. Failing of the security system of central infrastructure can cause burglarise your data, or someone can also take control of your self-governing system.[6]

III. TECHNICAL WORK

Due to overfertilization of agricultural soil, subterrestrial water also began to become contaminated with fertilizers. It is important to reduce this underground water pollution by increasing the quality of fertilizers and improving the efficiency with which they are applied. An experiment is carried out to verify this

A. Tools Required:

Hardware:

Near IR Laser Module
BPW34 Photo Diode
Potassium Dichromate ($K_2Cr_2O_7$)
Arduino UNO

Software:

LabVIEW

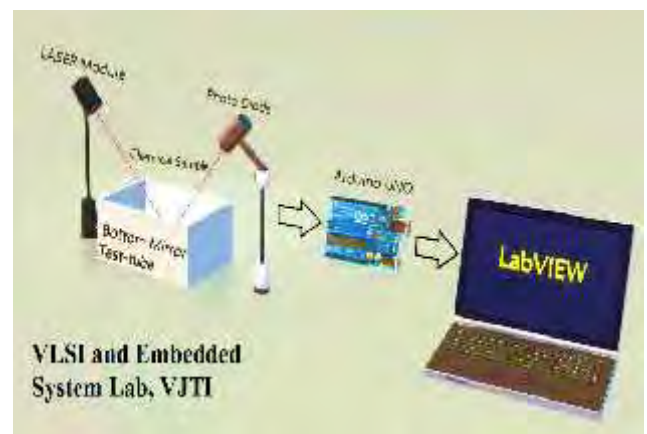


Fig.1 Procedural setup of experiment

B. Experimental setup:

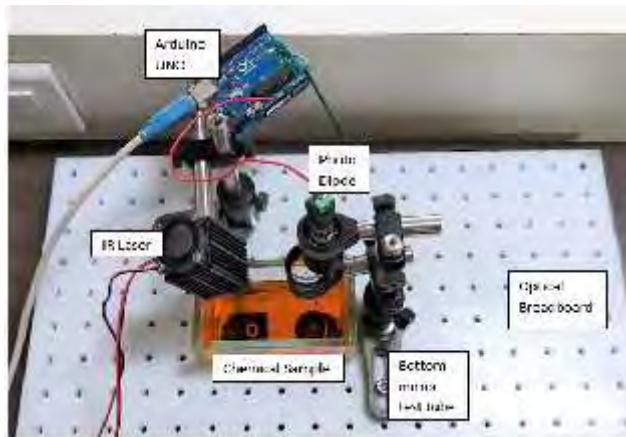


Fig. 2 Top view of experimental setup

When IR beam interacts with test sample, the scattered light is detected at photo diode. The amount of photon absorption by a sample can be easily found out by calculating transmitted light intensity at photo diode. [7]

C. Procedure

1. Arrange the components as shown in experimental setup.
2. Design experimental block diagram in LabVIEW.
3. Load the graphical program of LabVIEW in Arduino.
4. Select proper serial port and analog channel in LabVIEW.
5. Run the program.
6. Then pass the IR laser through pure water sample (100ml) for some time.
7. Add 10 g of Potassium Dichromate in pure water sample.
8. Observe and record the voltage reading using LabVIEW.
9. Export recorded data in Excel Sheet using LabVIEW.

D. Simulation:

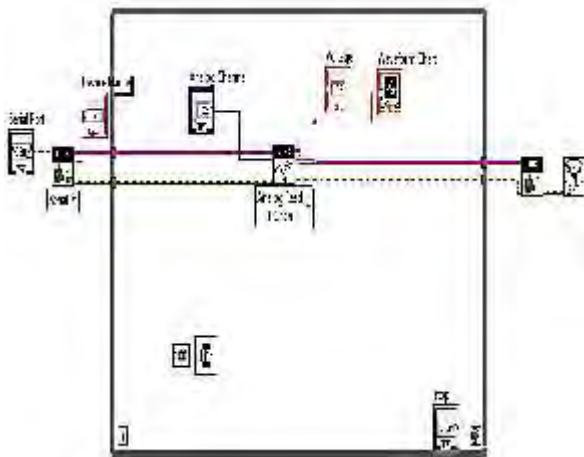


Fig 3 Block diagram design in LabVIEW

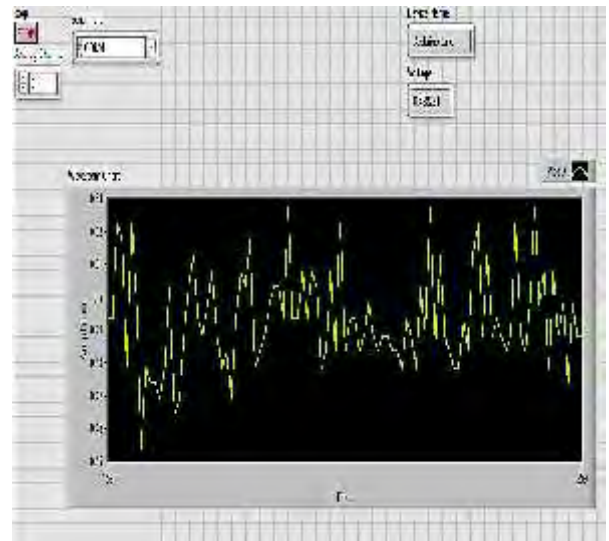


Fig.4 Front Panel in LabVIEW

IV. RESULT AND DISCUSSION

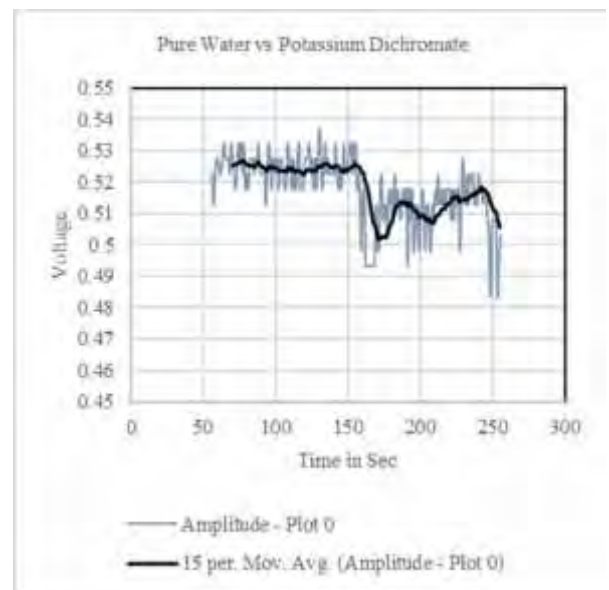


Fig. 5 Obtained Graph from experimental setup

The molecules in the sample will start increasing their vibration, when laser beam of specific wavelength is focused on a test sample. For this experiment we have used IR laser module operating at 808 nm having output power of 500mw. We have used potassium dichromate which is use in fertilizer as a sample for this particular test.[8]

We have added potassium dichromate in pure water sample at an instant of 150 sec, and then the graph is drawn from the data obtained by LabVIEW. From the above graph it is clear that there is a voltage drop after 150 sec, which indicate that the certain amount of IR light is absorbed by potassium dichromate

molecules.[9] From the potential difference perceived in the graph it is possible to determine the content of specific fertilizer in the soil-water sample. Thus, using the same experimental setup we can find different fertilizer content in soil-water by looking at its photon absorption characteristics.

NI LabVIEW software connected with internet are used to analyze this type of experimental results remotely.[10]

V. CONCLUSION

There are numerous benefits of using IoT in agricultural India such as better control over the internal processes, cost management, waste reduction, increased business efficiency through process automation, enhanced product quality and volumes. As well as all these factors eventually lead to higher revenue. There are many types of IoT applications and IoT sensors which can be used in agriculture to monitor Climate Conditions, Crop Management, Greenhouse Automation, Cattle management and it's monitoring and End-to-End Farm Management Systems.

In upcoming years, we need to do the following things technology should be designed such that which can save water, labour and electricity. Preset schedules can be used to optimise use of water in different seasons. Also, we can design system for fine-tuning water distribution depending on the soil quality. IoT in agriculture can unleash a range of benefits. Productivity of agricultural workers can be increased by automating processes such as remote farming equipment. Remote farming equipment also reduces travel costs in agriculture. For cattle, more receptive healthcare services can be provided which can indicate their health and can be tracked via wireless sensors. In today's era providing the necessary training in the regional language to farmers is call of hour.

REFERENCES

- [1] Ayush Sharma et al., "From idea to IoT: the wearables and industrial internet outlook for India", 2017.
- [2] Madanmohan Rao, "IoT in the rural sector: agriculture, dairy and energy", 2018.
- [3] Shruti Kedia, "How Precision Agriculture can transform the agritech sector and improve the lot of every Indian farmer", 2018.
- [4] Maria Aleksandrova, "IoT in Agriculture: Five Technology Uses for Smart Farming and Challenges to Consider", 2018.
- [5] V. Malavade et al., "Role of IoT in Agriculture", IOSR Journal of Computer Engineering, vol. 2016, e-ISSN: 2278-0661,p-ISSN: 2278-8727, PP 56-57.
- [6] Dr.N.L.Balasudarsun and Pranavaraj M (2018); Application of Internet of Things in Agriculture; International Journal of Scientific and Research Publications, 8(4) (ISSN: 2250-3153)
- [7] A. Rawankar et al., "Detection of N, P, K fertilizers in agricultural soil with NIR laser absorption technique," 2018 3rd International Conference on Microwave and Photonics (ICMAP), Dhanbad, 2018, pp. 1-2.doi: 10.1109/ICMAP.2018.8354625

- [8] Dheeba, B et al. "Fertilizers and Mixed Crop Cultivation of Chromium Tolerant and Sensitive Plants under Chromium Toxicity" Journal of toxicology vol. 2015 (2015): 367217.
- [9] Open Chemistry Database, PubChem, Forensic Spectral Research, Compound Summary for Potassium dichromate.
- [10] National Instruments White Paper on "Taking Your Measurements to the Web with LabVIEW", 2018.

Mobile Border Surveillance Robot

Rutvi Thakar
Thakur College of Engineering and
Technology
rutvi.panchal@thakureducation.org

Pooja Gohil
Thakur College of
Engineering and Technology
pooja.gohil2808@gmail.com

Ram Makwana
Thakur College of
Engineering and Technology
makwanaram007@gmail.com

Khushboo Mourya
Thakur College of Engineering
and Technology
khushboomourya143@gmail.com

Abstract— Country borders are required to be protected from enemies or intruders. The soldiers on duty have a heavy risk of their lives. To minimize this risk, a robot can be placed ahead of the army. After some distance the army will be deployed. A distance of 500m is enough to know if the robot is in action or if there is any harm to it. This will reduce the chances of human loss in case of any attack. An Intelligence based unit is designed which can identify human being and take necessary action on them as commanded. The systems can provide a capability increase to forces through expanded surveillance capabilities. The robot will be placed on the borders and as soon as it will detect presence of human it will immediately send an alert to control room. At the control room live video streaming of the area will be visible. An option to communicate with person through cordless microphone and speakers is given if the person is not the attacker. If the robot is hit or anything happens to the robot, an alarm will ring at the control room. This paper presents the examination which is considered important to ensure security and safety. Study of motion detection and other sensor has been conducted in order to make a mobile robot with surveillance capability.

Keywords- PIR sensor, Wi-Fi, Robot, Surveillance, Zigbee, control room, speaker, ultrasonic sensor, camera.

I. INTRODUCTION

Now a day's robotics research focused mainly on design and development of autonomous and compliant movable robots for unstructured and natural environments such as planet surfaces rather than for structured industrial environments. These robots can be used to accomplish tasks like rescue, security, surveillance in unstructured and natural environments. This class of robots can be utilized for tasks in the hazardous environments where human is not capable of doing it. Here the focus is on locomotion and choice of particular locomotion mechanism which is best when compared to its substitutes. Webster defines a robot as "An autonomous device that performs functions normally recognized to humans or a machine in the form

human." Generally, it is a machine that functions in spite of a living person.

Robots are used for special applications like handling hazardous situations and tasks that need high accuracy and speed. A danger event normally occurs by the negligence of humans. To implement real time inspection and surveillance of the border security, Border Safety Robot (BSR) system is developed. Wireless sensor network is used to monitor physical or environment conditions such as temperature, gases, humans, metals etc. Our system consists of Wi-Fi module, embedded system, microphone, speaker, ultrasonic sensor, PIR sensor, wireless camera, laptop, buzzer and intelligent program on the robot vehicle. There are two main units in our system. One is Control unit and other is Robot unit.

II. PROBLEM DEFENATION

A soldier serves the armed forces of a country. The importance of soldiers in India is very high in defending and protecting its borders. Every country has its own soldiers for its defence. Soldiers play the most significant task in defending and protecting the borders of India. A soldier is the most disciplined and faithful person in a nation. A soldier sacrifices his life bravely for his motherland. It is he who has to live miles away from his family. While defending his country he goes into the jaws of death. His life is not a bed of roses; it is a bed of thorns. For him, defence of country is most important in his duties and responsibilities. The life of soldier is very important for our nation. To overcome this problem we have come across this idea "Border Safety Robot". The already existing robot can only detect the obstacle. The robot is using ZigBee module for wireless communication which is of low data rate. Also, the existing robots do not have the property to shoot after the victim is detected by the command given through the command room. This all problem are been taken care in this project.

III. WORKING

An Intelligence based Unit is designed which will identify human being and shoot them if commanded. Since we are using a machine, it is fast enough to identify humans and shoot them.

It is designed by using wireless battery, ATMEGA89c51 micro controller, laser, gun, speakers, cordless microphone, wireless camera, accelerometer, ultrasonic and PIR sensors. Robot systems can be replaceable to a human in the case of any situational issues.

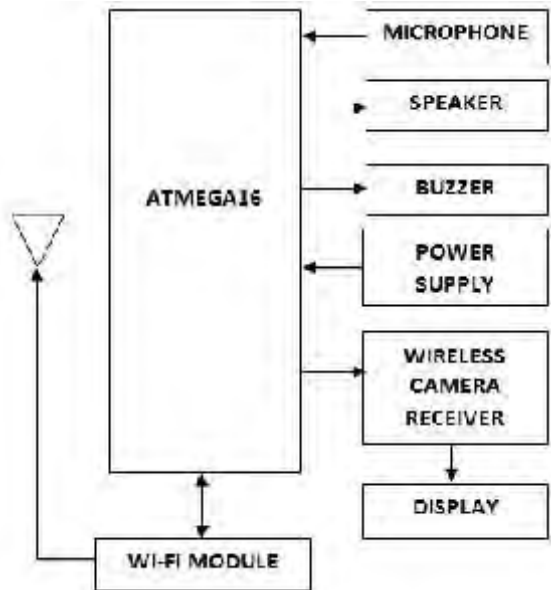


Figure 1: CONTROL UNIT

1. Controller unit: Its Function is to receive inputs from the sensors and transmit the required data to the master controller. It receives the control signals from master controller and moves the robot. It receives the video signals from the camera encodes it and transmits it to display section at control site. It also generates PWM control signals for the motion of robotics control signals Wi-Fi unit. It receives the encoded data from the controller and transmits through Wi-Fi module.
2. Wi-Fi module: It used as transmitter and receiver to transfer control data from control unit to robot unit and vice versa through internet.
3. Display unit: It is used to display the received video information which is used for robot navigation.

4. Robot driving motors: It has 4 high torque DC motors for driving the robot. L293D Motor driver is interfaced with microcontroller to control the robot.
5. Wireless camera unit: It consists of an IP camera with Wi- Fi hotspot connectivity. It may consist of a camera with Wi- Fi router whose IP address is known to us. Also it can be an android smart phone running Wi-Fi live stream software.

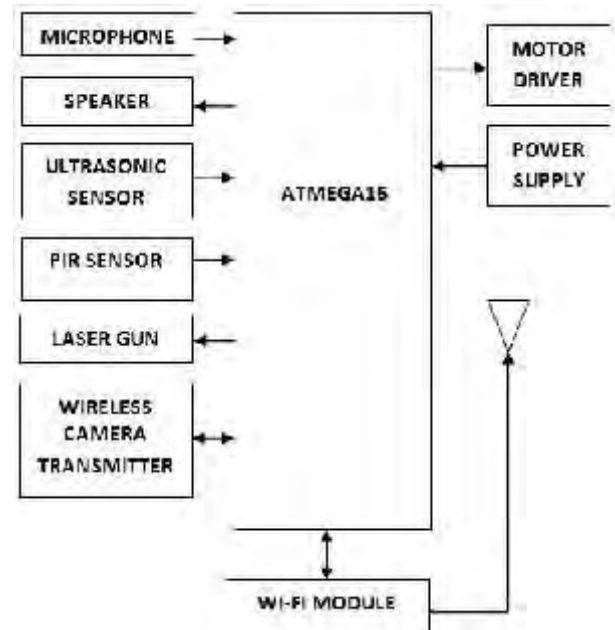


Figure 2: ROBOT UNIT

In the proposed system we have implemented a new technique to for overcoming the human loss. We have planned of implementing a Robot in the place of humans. It means that the military fully will not as Robot. Only in the borders we will place the Robots. We use camera, DC motor, laser, Wi-Fi module, PIR sensor, Ultrasonic Sensor, PC, and Robot. The camera will be placed in all the border lines and also along with the robots. The camera will be monitoring all the places. If the person is victim then the Wi- Fi which is connected to the controller will send the information to another side of the Wi-Fi then the DC motor is initialized and make the Robot to move towards the person and attack them using the LASER. If the person is victim the microcontroller sends information to Wi-Fi, the Wi-Fi sends information to the other side microcontroller then Robot is initiated and the Robot will get the command from the commander and act according to the command. This robotic technology will be very useful for army of every country so that the lives of many army men/women's are protected. The remote control

station and the robot play very important role in the future military operations.

IV. COMPONENT DESCRIPTION

1. Hardware Technology

There are various types of methodologies by which the Robot can be carried on. They are listed below:

- ESP 8266 WI-FI module
- Wireless CCTV
- USB TV tuner
- PIR sensor
- Ultra sonic sensor (SRHC 04)
- Servo motor
- DC motor
- AVR atmega 16
- Motor Driver

i. ESP 8266 WI-FI module

The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (microcontroller unit) capability produced by Shanghai-based Chinese manufacturer. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections. It support IEEE 802.11 b/g/n Wi-Fi, WEP or WPA/WPA2 authentication, or open networks. [3]

ii. Wireless CCTV

Wireless security cameras are closed circuit television cameras that transmit a video and audio signal to a wireless receiver through a radio band. Many wireless security cameras require at least one cable or wire for power; "wireless" refers to the transmission of video/audio. However, some wireless security cameras are battery- powered, making the cameras truly wireless from top to bottom. Wireless cameras are proving very popular among modern security consumers due to their low installation costs (there is no need to run expensive video extension cables) and flexible mounting option wireless cameras can be mounted/installed in locations previously unavailable to standard wired cameras. In addition to the ease of use and convenience of access, wireless security camera allows users to leverage broadband wireless internet to provide seamless video streaming over-internet.[4]

iii. USB TV tuner

If the display is TV then the TV Tuner is used. A TV tuner card is a kind of television tuner that allows

television signals to be received by a computer. Most TV tuners also function as video capture cards, allowing them to record television programs onto a hard disk much like the digital video recorder (DVR) does.

The interfaces for TV tuner cards are most commonly either PCI bus expansion card or the newer PCI Express (PCIe) bus for many modern cards, but PCMCIA, Express Card, or USB devices also exist. In addition, some video cards double as TV tuners, notably the ATI All-In-Wonder series. The card contains a tuner and an analog-to-digital converter (collectively known as the analog front end) along with demodulation and interface logic. Some lower-end cards lack an onboard processor and, like a Win-modem, rely on the system's CPU for demodulation.

Analog television cards output a raw video stream, suitable for real-time viewing but ideally requiring some sort of video compression if it is to be recorded. More advanced TV tuners encode the signal to Motion JPEG or MPEG, relieving the main CPU of this load. Some cards also have analog input (composite video or S-Video) and many also provide a radio tuner. [5]

iv. PIR sensor

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. It is low cost sensor. Range is up to 20 feet (6 meters). [6]

v. Ultra sonic sensor (HC-SR04)

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non- contact range detection with high accuracy and stable readings in an easy-to-use package. It ranges from 2cm to 400cm, or 1 inch to 13 feet. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module. [14]

vi. Servo motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists

of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing. [7]

vii. DC motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. [8]

viii. AVR ATMEGA 16

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. ATmega16 can work on a maximum frequency of 16MHz. ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively. ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.

ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16. [9]

ix. Motor Driver

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-

mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high current high voltage loads in positive supply applications.

All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1, 2 EN and drivers 3 and 4 enabled by 3, 4 EN. When an enable input is high, the associated drivers are enabled. With which the driver outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. [13]

2. Software Technology

i. AVR Studio 7

AVR Studio 7 for writing c code. Atmel Studio 7 is the integrated development platform (IDP) for developing and debugging Atmel® SMART ARM®-based and Atmel AVR® microcontroller (MCU) applications. Studio 7 supports all AVR and Atmel SMART MCUs. The Atmel Studio 7 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code. It also connects seamlessly to Atmel debuggers and development kits. AVR Studio can be downloaded from Atmel homepage. [13]

ii. Flash magic

Flash magic software for burning the hex files in microcontroller. Flash Magic is a PC tool for programming flash based microcontrollers from NXP using a serial or Ethernet protocol while in the target hardware. It has some excellent features like changeable baud rate; erase all flash before programming, setting security bits etc. The HEX file created with the help of KEIL was selected through it for programming the microcontroller. [15]

iii. Proteus Design Suite

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as training or teaching tool. [12]

V. DATAFLOW

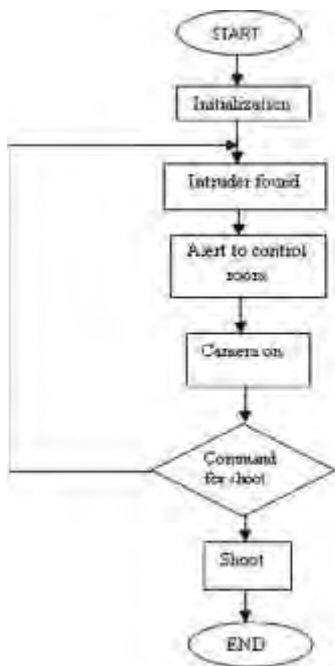


Figure 3: FLOWCHART

VI. FEATURES

- PIR detecting sensor detects motions from up to 600cms.
- Ultrasonic sensor detects the obstacle from 400cms.
- Robot can control from 200feet through remote with the help of 434 MHz RF transmitter and receiver module.

- Wireless camera sends real time audio and video signals at remote location and its range is 150feet.

VII. OUTCOME

As soon as there is some intrusion or movement in front of the camera, it captures the image; the image is forwarded to the microcontroller board. The camera is being able to cover the area around 180°. Also the servo motor has the angle of rotation around 180°. The robot is be controlled wirelessly by Wi-Fi module.



Figure 4: Model of Robot

The ESP8266 Wi-Fi module is a self contained SOC with integrated TCP/IP protocol stack that gives any controller access to the connected Wi-Fi network. With the range/distance of 400 meters the robot can be controlled. PIR SENSOR allows the motion sensing, almost always used to detect whether a human has moved in or out of the range of sensor. The range of the PIR SENSOR is up to 20 feet i.e. 6 meters.

Figure 4 shows the model designed which has ultrasonic sensor near eyes, 360° moveable camera on head, gun in hand.

VIII. APPLICATIONS

- As fighting robot with terrorist hidden inside the building.
- As suicide attack bomb if it is going to be caught by enemies.
- To minimize the casualties in terrorist attack.

- Security Purpose.

IX. CONCLUSION AND FUTURE SCOPE

In order to strengthen the security and defense of our country we desperately require robotic system which will forearm our defense system. In the recent past our world has witnessed plethora of terrorist activities and in them we had encountered tragic loss of life and property. Such humongous loss would have been avoided if we would have strong life saving robotic system in place. Hence in order to make this world a beautiful place to live we desperately require robot which will assist us in our endeavor. Using this proposed technology, it gives a helping hand to our security forces in detection of intruders. This robotic system can also be used in high altitude areas where it is difficult for humans to survive as some of our border areas fall into high altitude areas.

Using 12V dc supply DC motor rotates 180 degree on 3.5 rpm. Ultrasonic sensor detects obstacle in range of 2meter, PIR sensor range is 2 meter and there both sensor sent data wirelessly using Wi-Fi module. This Wi-Fi module range is 10 meter and sends data at rate of 9600 baud rate at speed of 13 mbps.

In future we can interface GSM module for control through mobile device. So there is no need of control room and laptops, which will save cost of the system. Bomb diffusion application can be implemented in this system. Even metal detection can be done through this system. 1. IR Sensors: IR sensors can be used to automatically detect & avoid obstacles if the robot goes beyond line of sight. This avoids damage to the system.

REFERENCES

- [1] R. Thilagavathy, J. Murali, "Intelligent Unmanned Army Robot", *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)* Volume 4 Issue 2, February 2015
- [2] C. M. Naveen Kumar, Dr. B. Ramesh et al, "Android Based Autonomous Intelligent Robot for Border Security", *IJSET-International Journal of Innovative Science, Engineering & Technology*, Vol. 1 Issue 5, pg. no. 544, July 2014
- [3] <http://esp8266.net/>
- [4] <http://makro.it.com/security-cameras>
- [5] <https://www.vskills.in/certification/tutorial/it-support/tv-tuner-cards/>
- [6] <https://learn.adafruit.com/PIR-passive-infrared-proximity-motion-sensor>
- [7] <https://www.motioncontrol.com/motors/servo-motor/>
- [8] <https://www.electrical4u.com/dc-motor-or-direct-current-motor>
- [9] <https://www.engineersgarage.com/electronic-components/atmega16-microcontroller>
- [10] <https://www.microchip.com/avr-support/atmel-studio-7>
- [11] <https://www.computer.org/cms/student-challenge/WirelessIndustrialSecurityRobot.pptx>
- [12] https://www.revolv.com/main/index.php?s=Prot_eus_Design_Suite
- [13] <https://sunrobotics.co.in/diy-electronics-parts/ics/l293d-motor-driver-ic?zenid=lqfhq58ivm0hpjtafb29e5nu35>
- [14] <https://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/>
- [15] www.flashmagictool.com
- [16] Dr. Shantanu K. Dixit, Mr. S. B. Dhayagonde, "Design and Implementation of e-Surveillance Robot for Video Monitoring and Living Body Detection", *International Journal of Scientific and Research Publications*, Volume 4, Issue 4, pg. no. 1, April 2014
- [17] Khushwant Jain, Vemu Suluchana, "Design and Development of Smart Robot Car for Border Security", *International Journal of Computer Applications* (0975 – 8887) Volume 76– No.7, August 2013
- [18] Pachlegaonkar Abhishek Vinod, "Artificial Intelligence Based Human Detection And Auto Target Knocking Over Android", *International Journal of Science, Technology & Management* Volume No 04, Special Issue No. 01, page no.310, April 2015

3D Printer using Fused Deposition Modeling

Rutvi Thakar
Assistant Professor
Dept of EXTC TCET

rutvi.panchal@thakureducation.org

Aachala Singhan
University of Maryland
aachalasinghan1995@gmail.com

Smit Mistry
Southern Methodist
University

Jinit Thakkar
Rochester
Institute of Technology

Abstract- Prototyping is a system development method which is built, tested, and then reworked as necessary until an acceptable prototype is finally achieved from which the complete system can be developed. It is this symbiosis that has brought about a revolution in the field of development in large scale manufacturing industries and at the same time given birth to precision engineering required to perform complex tasks with higher dimensional and time constraints. 3D printing is the process of being able to print any object layer by layer. To banish any disbelief we walked together through the mathematics that prove 3D printing is feasible for any real life object. 3D printers create three dimensional objects by building them up layer by layer. The current generation of 3D printers typically requires input from a CAD program in the form of an STL file, which defines a shape by a list of triangle vertices. The vast majority of 3D printers use various techniques, FDM (Fused Deposition Modelling), SLS (Selective Laser Sintering), Stereo lithography, Laminated Object Manufacturing etc. Adding to this, there is also one advanced form of 3D printing that has been an area of increasing scientific interest in the recent years is bio printing. Cell printers utilizing techniques similar to FDM were developed for bio printing. These printers give us the ability to place cells in positions that mimic their respective positions in the organs. Finally, through a series of case studies, we can use 3D printers for a massive breakthrough in the field of medicines on a large scale. We hope that this abstract will facilitate at least a basic understanding of this vast and multi-faceted branch of engineering and stimulate the reader's imagination to innovate.

Keywords- 3D printer, Fused Deposition Modeling,

I. INTRODUCTION

Technology has affected recent human history probably more than any other field. These technologies have made our lives better in many ways, opened up new avenues and possibilities, but usually it takes time, sometimes even decades, before the truly disruptive nature of the technology becomes apparent

It is widely believed that 3D printing or additive manufacturing (AM) has the vast potential to become one of these technologies. What really is this 3D printing that some have claimed will put an end to traditional manufacturing as we know it, revolutionize design and impose geopolitical,

economic, social, demographic and environmental and security implications to our everyday lives.

The most basic, differentiating principle behind 3D printing is that it is indeed a radically different manufacturing method based on advanced technology that builds up parts, additively, in layers at the sub mm scale. This is fundamentally different from any other existing traditional manufacturing techniques.

There are a number of limitations to traditional manufacturing, which has widely been based on human labour and "made by hand" ideology rooting back to the etymological origins. And so to bring a change or we can say a revolution in the traditional technology and to make it simple, we have started developing various new technologies and 3D printing is one of them, that will help to bring a change on a very large scale. 3D printing is an enabling technology that encourages and drives innovation with unprecedented design freedom while being a tool-less process that reduces prohibitive costs and lead times. Components can be designed specifically to avoid assembly requirements with intricate geometry and complex features created at no extra cost. 3D printing is also emerging as an energy efficient technology that can provide environmental efficiencies in terms of both the manufacturing process itself.

Applications of 3D printing will be emerging almost by the day, and, as this technology continues to penetrate more widely and deeply across industrial, maker and consumer sectors, this is only set to increase.

II. PROBLEM DEFINITION

Back in the 80's, there was an accepted practice of producing the physical prototype of the product that is to be mass-produced. This process has its own challenges which include financial and time losses due to flaws detection in the created prototype which led to increased scrap release. Thus, to minimise the mentioned losses and improve the accuracy and speed of creating new products, a method called "DIGITAL PROTOTYPING". This process involves the use of a 3D printer in conjunction with a 3D rendering software such as AUTOCAD or CURA and using the aid of modern electronic process devices such as Arduino. This prototyping concept reduces the amount of prototyping time and increases the accuracy of the prototype to be created. It has its application in various fields such as houses, fashion field, armaments, utensils and many more.

III. LITERATURE SURVEY

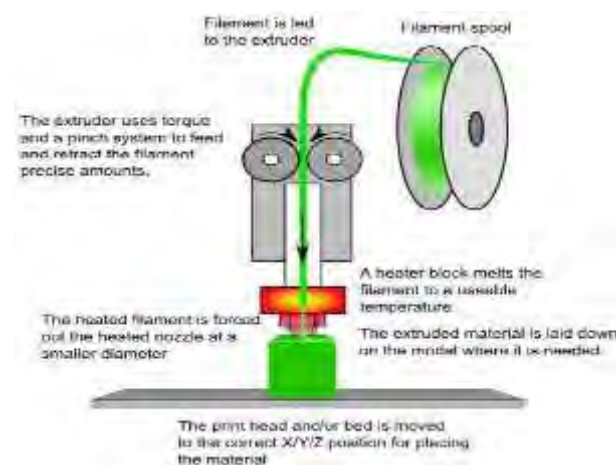
Author: Athanasios Anastasiou, Charalambos Tsirmpas, Alexandros Rompas, Kostas Giokas, Dimitris Koutsouris. [2]

Title: 3D Printing: Basic concepts Mathematics and Technologies.

Work Done: What is 3D Printing? How 3D Printing is made real by using Fubini Theorem, detailed explanation of Fused deposition modelling, Powder-Binder Printing and Bio printing. Also states a case study of 3D printing a heart. Learning from this paper: Implementation of 3D printing mathematically using Fubini Theorem and understanding the flow about Fused Deposition method. 2 Author: KaufuiV. Wong and Aldo Hernandez. [1] Title: A Review of Additive Manufacturing.

Work Done: Introduction to 3D printing, all types of 3D printing processes.

Learning from this paper: Additive manufacturing processes take the information from a computer-aided design (CAD) file that is later converted to a stereo lithography (STL) file and also the relevant additive manufacturing processes and their applications.

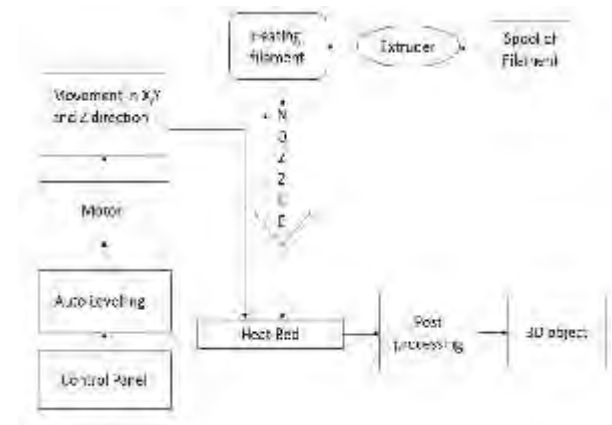


IV. FUSED DEPOSITION MODELLING

Fused Deposition Method (FDM) is the most preferred method here. This method has been modified to use a material called bio-plastic which is a nature friendly material. By using this material, the speed of prototyping can be increased and the desired prototype can be constructed in a quarter of time. It uses the “additive” principle of stacking the material in the form of layers which unwinds from a metal coil. It uses a process called stereo lithography file format (STL) which mathematically orients the model for build and slice process. The final model is formed by stacking the strings of material extruded from the nozzle followed by quick hardening. In order to push the filament through the nozzle, a worm drive is used to attain a controlled rate of fusion which facilitates easy rectification of errors.

The molten polymer used can be cooled by exposing it to low temperature in the presence of an inert gas such as argon, which significantly increases the in-layer adhesion and results in improved mechanical properties of the 3D printed objects.

1. A. Block Diagram:



2. B. Steps for printing any 3D object:

1. Develop the 3D object (AUTOCAD): It is a 3D design and rendering software which helps the user create 3D models of the possible prototypes. This helps the industry to visualize the product before its market testing and reduce the manufacturing and production cost by a large amount. This also helps in the reduction of scrap. AutoCAD is universal design software which has its application in various fields such as architecture, civil, mechanical, electronics and more. It is a very versatile design tool for manufacturing and innovation industries. These are the AutoCAD models that were prepared in order to make the design and implementation easier.
2. Conversion into STL file format: 3D prints are most commonly generated from an STL or .stl file. Standing for “stereo lithography” (what 3D printing was named when it was first invented), this file format is to 3D print the .doc file. To open and manipulate an STL file, use any computer-aided design (CAD) software. For decades, these programs have been used by everyone from architects to product designers, so there are many kinds of CAD software available. We have used AutoCAD as stated above.
3. Transfer to Cura Software to obtain the G-code: This software helps to bring any 3D creation into the real world but for doing this it needs to be converted into a G-code file, as the 3D printer can read the G-code format only and process as per the file. Cura prepares the 3D file in the blink of an eye whilst intelligently assessing any areas that need attention. Once the preparation of the 3D file is done, the powerful 3D virtual previews that the software provides allows the user to pan around the design, so one can check everything as one imagined the object to be and make the necessary changes required. This 3D data generated can be used for research purposes in domestic and military fields as per the requirement.
4. Setup the Machine: Firstly, we have to generate a code in Arduino which

commands the nozzle to move along x, y and z axis as per the requirement. Arduino is an open-source electronics platform based on efficient hardware and software. Arduino boards are able to read inputs such as light on a sensor, a finger on a button, or a Twitter message – and turning it into an output in forms such as activating a motor, turning on an LED, publishing something online. Arduino boards are completely open-source, empowering the users to build them independently and eventually adapt them to their particular needs. The things that make Arduino so special are that it is inexpensive, also provides cross-platform software, and provides simple and clear programming environment and also an open source and extensible. 5. Print: To start printing a LCD screen is used as the information screen. Pressing the knob on the information screen main menu is accessed. The menu displayed depends on the state of the printer. If it is waiting to run a job, it offers the menu “prepare” and while you are printing it offers the menu “tune”. The voices and the features available in these two modes are different and it is important to know them, to avoid losing time looking for functions that are in another mode.



Fig 3. Designing with CURA



Fig 4. LCD screen displaying the details while 3D printing. Remove the object for any post processing: After going through all the process finally the desired prototype is seen and then the necessary tests are conducted on it and as the parts are build layer by layer it gives us a brief idea about what changes are to be done while making the final product which will in turn save a lot of time and also the investment in the terms of money. The product that will be made by the use of bio-plastic will be of great help and also is very easy to dispose without causing any harm to the environment. The future of this printer is that it will be used on a very large scale

in the medical industry and will help to solve the various medical related issues related to knee, heart etc. Also in the medical studies, it is of great help for the budding students to understand the various parts in detail which will enhance the knowledge to a great scale.

V. RESULTS AND DISCUSSION

While executing the project we faced various difficulties and we proved to refine them using several solutions. The foremost problem faced was that the initial layer was not printing properly and the reason for this was that the length between the heat bed and the nozzle. The solution to this was the distance between the two should be no more or less than 0.1mm. And after all these variations and changes the problem was rectified and the proper prototyping was achieved. Secondly, when we began making the 3D object, the problem faced was that, the nozzle was not able to print the product along the desired place as anticipated and was leaping all over the heat bed. This trouble was resolved by tightening the fixed belt connected to the motor and responsible for the drift of the nozzle in X, Y and Z direction. The third problem faced was that, the PLA or the ABS material used for constructing the prototype was not securely attached to the heat bed, due to which the filament was not capable to stick properly on the heat bed and so printing was not as per expectation. We came up with two simple solutions and they are, the first by simply increasing the temperature of the heat bed, the reason for this is that, the first layer being firmly attached to the heat bed and will not leave the heat bed. And the second solution is that by creating slurry of the filament used and then applying on the heated bed. The slurry is prepared by just breaking up the PLA or ABS filament into acetone and an alternate to this is to apply glue that does not react with the filament used

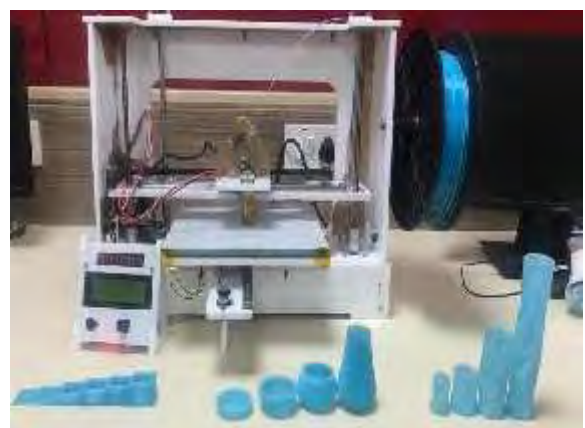


Fig 5. Objects Printer with the designed 3D Printer

VI. CONCLUSION

On a concluding note it would be great to say that the 3D printing technology could revolutionize and reshape the world. Over here the manufacturing or the design is based on the computer aided design and

then sliced up into thin layers, to prepare a 3D model. The extensive use of 3D printing technology shall result in reduced manufacturing cost, design cost; reliance on manpower, improved speed and accuracy of prototyping, less connection between parts of a product resulting in improved material properties and better life expectancy. 3D printing is a future technology that will help solve complicated engineering problems and speed up the innovation. The finishing achieved on this printer is as good as an industry standard. Table 1 shows the comparison of 3D printer available in market and the designed printer. Following are the specifications of the designed printer:

Key Specifications:

1. Build resolution: 12.5 micron
2. Linear speed: 1mm/s
3. Smart LCD Control Support.
4. Can be printed with both PLA and ABS.

Technical Specifications:

5. Build Volume: (214 x 214 x 165) mm
6. No. of Extruders: 1
7. Layer Thickness: 0.1 mm - 0.3 mm (This is optimal, but you can go below that)
8. XY Positioning Precision: 0.0125 mm
9. Nozzle Diameter: 0.4mm
10. Filament Diameter: 1.75 mm
11. Power Supply: Input 230 V / Output 12V DC 240 W
12. Electronics: Printer Board REV D (4 Layer Board, Derivative of Arduino)
13. Hot End: J head Hot End with Cartridge heater 1.75mm, 250C MAX Temperature
14. Heat Bed: MK2 PCB Heat Bed, 110C MAX Temperature
15. Printing Material: PLA and ABS
16. Build Material: Uses high quality laser cut 6mm Acrylic material
17. Motors: NEMA17 Stepper motors, 1.8 step angle (4.4 kg/cm torque)
18. Connectivity: USB, Micro SD Card using LCD Smart Controller
19. Printer Weight: 10 Kg

Table 1: Comparison of Market and Designed Printer

Parameters	Dremel 3D Idea Builder (Market)	LARNS – to create the future (Designed)
Build Resolution	100 micron	12.5 micron
Build Platform	Removable	Removable
Interface	Full colour touch screen	Smart LCD control support
Extruder	Pre installed	Pre installed
Workshop	Fully Enclosed	Fully open
Cooling Fan	Pre installed	Not installed
Warranty	One Year	
Certification	UL Certified	Not certified

REFERENCES

- [1] Athanasios Anastasiou, Charalambos Tsirmpas, Alexandros Rompas, Kostas Giokas, Dimitris Koutsouris., “3D Printing: Basic Concepts Mathematics and Technologies”, School of Electrical and Computer Engineering National Technical University of Athens, Biomedical Engineering Laboratory, Athens, Greece, 1,2, vol: 978-1-4799-3163-7/13/@IEEE, year: 2013.
- [2] Kaufui V. Wong and, Aldo Hernandez, “Kaufui V. Wong and Aldo Hernandez.”, Department of Mechanical and Aerospace Engineering, University of Miami, Coral Gables, FL 33146, USA, pg.no: 3, vol: 2012, year: 2012
- [3] Concept of Fused Deposition Modelling, Available: <http://www.stratasys.com/3D-printers/technologies/fdm-technology>
- [4] Why and what is Arduino, Available: <https://www.arduino.cc/en/Guide/Introduction>
- [5] Ways to prepare animation model for 3D Printing, Available: <http://www.shapeways.com/tutorials/how-to-prepare-your-render-animation-model-for-3D-printing>
- [6] Brief knowledge about 3D printing, Available: <http://accessinghigherground.org/wp/wp-content/uploads/2015/04/3D-Printing-Guide.pdf>

We-Care: An IoT-based Health Care System for Elderly People

Prof. R.R.Khare
Head Of The Department of Electronic &
Telecommunications,
S.G.D. College of Engineering & Technology,
Jalgaon, India.
Email Id: rajeshkhare@yahoo.com

Chetana Rajendra Kabre
Student, Electronics and Telecommunication,
S.G.D. College of Engineering & Technology,
Jalgaon, India.
Email Id: chetanakabra11093@gmail.com

Abstract—*In a world with an fast growing population day-by-day, there is a need of developing solutions for the elderly living being. The Internet of Things is a new reality that is completely changing our everyday life, and promises to revolutionize modern healthcare by enabling a more personalized, preventive and collaborative form of care. Aiming to combine these two important topics, this work presents an IoT-ready solution for the elderly living assistance which is able to monitor and register patients vital information as well as to provide mechanisms to trigger alarms in emergency situations. It is useful because it requires low power and cost. Also it has wireless characteristics. So it is the best solution to be used anywhere and by anyone, in the form of comfortable Wristband. Experiments demonstrated a good system performance for the implemented functionalities, and an average battery lifetime of 306 hours. For the working range, the system is perform well within a range of 60 meters before the out-of-range warning being triggered.*
Index Terms—*Internet of Things (IoT), Health Care, Elderly Living Assistance, Monitoring Wristband.*

I. INTRODUCTION

The world is undergoing an unprecedented technological transformation, evolving from isolated systems to ubiquitous Internet-enabled 'things' capable of generating and exchanging vast amounts of valuable data [1,2]. This novel paradigm, commonly referred as the Internet of Things (IoT), is a new reality that is enriching our everyday life, increasing business productivity, and improving government efficiency [2,3].

An important domain where IoT promises to drive significant changes and cause a huge impact is in health care systems [6]. The use of Information and Communication Technologies in healthcare scenarios have several advantages of continuously monitoring health behaviors [7], and the IoT model is enabling a more personalized, preventive and collaborative form of care, where patients are monitoring and managing their own health, and the responsibility for health care is shared between patients and the medical staff [8]. The IoT has the potential to give rise to many medical applications such as remote health monitoring, chronic diseases, private health and fitness, and pediatric and elderly care [6]. Among this wide range of applications, the health care of aging and incapacitated individuals, called ambient assisted living (AAL), is attracting specially attention, due to the expected acceleration of global population aging [9]. This kind of solutions can also be particularly helpful in rural areas, where the number and

availability of emergency teams with a proper reaction is sometimes poor and insufficient.

In the last few years, substantial research efforts have been made in IoT-driven healthcare applications, services, and prototypes. Suntiamorntut et al. [10] proposed a low-cost elderly assistive living system for private houses, while Redondi et al. proposed LAURA [11], an integrated system for patient monitoring, localization and tracking within nursing institutes. However, with the advent of the IoT, the ongoing trend is to shift from old-fashioned protocols to standardized IP-based networks. In [12], an IoT-aware smart hospital system (SHS) is presented and discussed, providing innovative services for the automatic monitoring and tracking of patients, personnel, and biomedical devices within hospitals and nursing institutes. Arboleda et al. [13] developed an IoT system for in-home health care services of elderly patients with chronic heart and respiratory diseases. The system consists of a single wireless sensor node capable of monitoring heart rate, temperature, oxygen saturation and electrocardiographic signs. The Care store platform [14] is an innovative open-source platform for seamless healthcare device marketing and configuration. The Common Recognition and Identification Platform (CRIP), a component of the Care Store project, offers a sensor-based support for seamless identification of users and health devices.

The Body Guardian Heart [15] is a monitor responsible for collecting patient mobile cardiac telemetry (MCT) and cardiac event monitoring (CEM). The patient's data is automatically detected and wirelessly delivered to a monitoring center, through a smart-phone. Wellness [16] is system that combines sensors, mobile notifications and home automation to provide a secure and cost effective option for independent living.

elderly person. The temperature sensors, used to continuously measure the ambient and body temperatures, are also used by the *Body Presence Detector* module, which is able to detect the presence of the body. If the wristband is disconnected, the system triggers an alarm to the caretaker system, alerting the situation.

B. We-Care board

The We-Care software services and cloud interface were developed using the TI SimpleLink CC3200 Launchpad [21] kit. The CC3200 System-on-Chip (SoC) consists of a powerful ARM Cortex-M4 CPU Core along with built-in Wi-Fi connectivity. For the software stack we used the TI-RTOS, a real-time operating system for TI microcontrollers. TI-RTOS enables faster development by eliminating the need for developers to write and maintain system software. The We-Care board can act either as a Wi-Fi Access Point (AP) which enables any Station device on the same network to connect and access the available services, or as a Station, which connects the We-Care system to the Internet and the cloud services. Using the Station profile on the We-Care board, any caretaker application can access and remotely monitor all the wristbands registered on the system. The We-Care board runs the web-server, listening on Port 80, for remote client connections. The web application and data files are stored in an SD Card connected to the board.

It is possible to connect each We-Watch device from the outside network for security purposes, the We-Care board acts as a firewall, as it does not run or support routing services, i.e., services that allow the devices to be reachable from any device rather than the We-Care board.

C. We-Watch gateway

Since the CC3200 only supports the IEEE 802.11 wireless protocol, the We-Care board needs to interface the 6LoWPAN network through an IEEE 802.15.4 compliant transceiver such as the CC2538/CC2650. This 6LoWPAN gateway runs a Contiki-OS UDP application which creates a socket with any wristband in the network, forwarding all the received IPv6 packets to the We-Care board. The UDP Server listens on the UDP Port 3000, accepting connections from remote clients on Port 3001.



Figure 3. We-Care system software stack

D. Wireless charging dock station

A wireless charging system was developed to integrate the We-Care system. Based on the TIDA-00881 [22] reference design, this technology makes charging easy of the We-Watch battery since it only needs a base station to wirelessly charge it when placed over the base platform. This simple charging system helps the elderly person to charge the We-Watch without the need of cables or complex connecting systems.

IV. SOFTWARE MODULES

Figure 3 illustrates the We-Care software stack. It can be represented by four simple layers: hardware, software, web-services and applications. The hardware layer represents the Board Support Packages responsible to interface the hardware. The software layer is composed by the TI-RTOS and Contiki-OS protocol stacks and OS components. They provide full IEEE 802.11 and IEEE 802.15.4 compliant software and IP-enabled stack to interface the available communication interfaces. For the services layer, on the Contiki-OS side, we simply run an UDP Client/Server application to enable the message exchange between the We-Watch and the We-Watch gateway. On the TI-RTOS side, this layer implements all the web services, protocols, databases and the IOT C API which interacts with the IoT JS API implemented on the Application Layer. The Application Layer generates the Graphical User Interface to create the local web-server, which is able to display system status and data, and also sets all the application protocol messages to communicate with the cloud services and remote applications.

A. We-Care web-server

The We-Care web-server was specially designed for running on the low-power CC3200 MCU, configured to handle four (up to eight) clients at a time. Its lightweight implementation provides two main APIs: the IoT.C and IoT.JS, written in C Language and JavaScript language, respectively. These APIs communicate with each other for dealing with the Machine-to-Machine (M2M) communication requirements.



Figure 4. We-Care web application: caretaker interface

B. We-Care web application

The We-Care web application was also designed to achieve the low-power requirements of the system. It only loads the required data and supports sleep modes which are activated when the application is not in use. This way energy efficiency is increased, thus, resulting in an increased battery lifetime. This application also implements the GUI for supporting the caretaker interaction with the We-Care system. The application files are directly accessed from the SD Card through the File System API. Figure 4 illustrates an example of the simple interface available to the caretaker, displaying the information collected from the We-Watch wristbands.

The colored lines next to the wristband identifier can tell if the device is online (green) or offline (red). The wristband IPv6 address is the name by default but it can be changed to any desired alias to ease of the wristband identification.

For the distress messages, when the Push Button is pressed the application displays (Figure 5) a warning message followed by a sound alert in order to immediately notify the caretaker. Other alerts and messages can be configured to be sent to other designed destinations such as responsible person (rather than the caretaker) and medical emergency teams if the elder requires urgent medical attention.



Figure 5. We-Care application: warning message

C. Securing the wireless communications

Protecting data from unauthorized viewers - which may intercept the IEEE 802.15.4 frames and/or inject fake data on the network, compromising the overall systems behavior, security of wireless communications is essential in the We-Care application. The 802.15.4 standard defines optional cryptographic security suites for providing either confidentiality, integrity, or both, achieved by strong cryptographic algorithms, such as the Advanced Encryption Algorithm (AES). For securing the wireless communications between the We-Watch wristband and the We-Watch gateway, we used the *link-layer encryption library for IEEE 802.15.4 compliant radios* (LLSEC) provided by Contiki-OS.

Table I
CURRENT CONSUMPTION FOR DIFFERENT POWER MODES

Power Mode	Description	Current (mA)	Time (ms)
0	Sleep Mode	NA	NA
1	Idle	0,76	-
2	Sensors ON	6,47	100
3	TX Mode	25,77	5
4	RX Mode	33,12	0,3

V. EVALUATION

A. We-Watch battery lifetime

Experimental evaluation was performed in order to measure the energy consumption of the We-Watch wristband for different operation modes. From the obtained results the battery lifetime can be predicted. The measured values, along with their maximum duration, are presented in Table I. Four operation modes were characterized:

- (1) Idle: This mode corresponds to the lowest current consumption mode and it is active for the most of the working time, helps to save energy. On the Idle mode the communications are OFF, but ready to be turned ON if the We-Watch needs to

communicate with the gateway for messages exchange or network maintenance. However, in the case of sudden movements detected by the accelerometer, the CPU is interrupted and the We-Watch immediately initiates the communications and reports to the We-Care board.

- (2) Sensors ON: This mode represents the sensors periodic sampling. It takes 100ms for reading all the sensors, with an average current consumption of 6.47mA.

- (3) TX Mode: After collecting the sensors data, the We-Watch sends it to the We-Watch gateway. This operation takes, on average, 25.77mA and lasts, at most, 5ms.

- (4) RX Mode: After sending the data to the gateway, the We-Watch stays in this mode for 0.3ms waiting for a data acknowledgment message before going to the Idle Mode again. The current consumption measured was, on average, 33.12mA. This messages is needed for detecting loss of communication with the We-Care board and trigger the out-of-range situation.

Setting a communication and sampling-rate of 30 seconds, the active mode draws, on average, 7.463mA during 0.105s and the Idle mode draws 0.760mA during 29.895s. This leads to an average current consumption of 0.784mA. With a standard rechargeable coin cell battery of 240mAh, the estimated battery lifetime is calculated as follows:

$$\text{BatteryLifeTime} = \frac{\text{BatCapacity(mAh)}}{\text{TotalConsumption(mA)}}$$

$$\text{BatteryLifeTime} = \frac{240\text{mAh}}{0.784\text{mA}}$$

$$\text{BatteryLifeTime} = 306.12\text{h}$$

The expected battery lifetime is about 306.12h, that is, around 12 days without being replaced or recharged. This gives enough time to the caretaker for replacement of the battery or the We-Watch wristband, while keeping the system services and features. If the elderly person is able to perform the replacement and recharge the We-Watch itself, it can simply do it by using the wireless charger provided with the system.

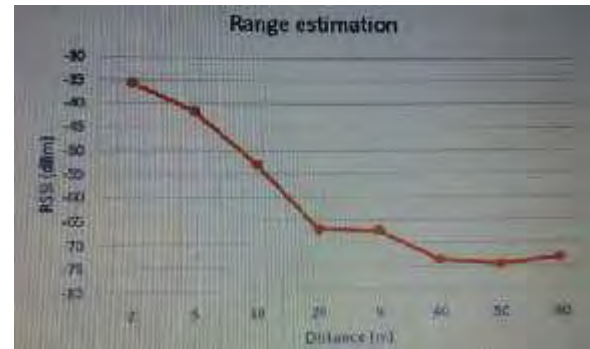


Figure 6. Range estimation test

B. Performance Checks

1) *System availability*: In order to test the system availability to operate and its ability to adapt to conditions changing on the application scenario, we conducted some tests with the presence and absence of the Internet gateway. In the first case the We-Care board started the Station profile and the caretaker can always connect directly, or if in the same network, to the system.

2) *Out of Range*: This functionality guarantees that the system is always connected and the elderly is in the range of the desired area. If the We-Watch wristband loses connection with the We-Care board, after a 60 seconds period of tries, both devices will trigger a sound alarm until the wristband returns to its range and is able to communicate again with the We-Care board.

VI. CONCLUSIONS AND FUTURE WORK

The world is adopting the new technological trend for connecting billions of devices. The Internet of Things is a new paradigm that is enriching our everyday life, and promises to drive significant changes and cause a huge impact in modern healthcare, by enabling a more personalized, preventive and collaborative form of care. In this paper we presented We-Care, an IoT-based health care system designed to monitor and collect vital data of elderly people. The system is able to detect falls, as well as the absence of vital signs, triggering alerts in case of emergency situations. The developed web application collects all the data retrieved and sent by the wristband to the server, and is also able to remotely alert the caretaker or medical staffs in the case of emergency events. The stored data can later be used for analysis, which may help medical staff to trace the evolution of their patients.

Work in the near future will focus on the addition of new sensors to the wristband in order to collect data from other vital parameters such as the blood pressure and the heart rate. The results will help in evaluating the scalability of the solution in terms of the supported number of We-Watch network nodes, as well as the capacity of the We-Care web-server application to handle such number of nodes. From a different perspective, we will after look at the privacy and security issues relating to medical data,

and as it flows from the connected 'things' to the cloud.

VII. ACKNOWLEDGMENTS

This work has been supported by COMPETE: POCI-01-0145-FEDER-007043 and FCT - *Fundação para a Ciência e Tecnologia* within the Project Scope: UID/CEC/00319/2013. Sandro Pinto is supported by FCT PhD grant SFRH/BD/91530/2012. Tiago Gomes is supported by FCT PhD grant SFRH/BD/90162/2012.

REFERENCES

- [1] G. Kortuem, F. Kawsar, V. Sundramoorthy, and D. Fitton, "Smart objects as building blocks for the Internet of things," *IEEE Internet Computing*, vol. 14, no. 1, pp. 44–51, Jan 2010.
- [2] L. Tan and N. Wang, "Future internet: The Internet of Things," in *2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE)*, vol. 5, Aug 2010, pp. V5–376–V5–380.
- [3] L. Atzori, A. Iera, and G. Morabito, "The internet of things: A survey," *Computer Networks*, vol. 54, no. 15, pp. 2787 – 2805, 2010.
- [4] A. Zanella, N. Bui, A. Castellani, L. Vangelista, and M. Zorzi, "Internet of Things for Smart Cities," *IEEE Internet of Things Journal*, vol. 1, no. 1, pp. 22–32, Feb 2014.
- [5] L. D. Xu, W. He, and S. Li, "Internet of Things in Industries: A Survey," *IEEE Transactions on Industrial Informatics*, vol. 10, no. 4, pp. 2233–2243, Nov 2014.
- [6] S. M. R. Islam, D. Kwak, M. H. Kabir, M. Hossain, and K. S. Kwak, "The Internet of Things for Health Care: A Comprehensive Survey," *IEEE Access*, vol. 3, pp. 678–708, 2015.
- [7] J. Ko, C. Lu, M. B. Srivastava, J. A. Stankovic, A. Terzis, and M. Welsh, "Wireless Sensor Networks for Healthcare," *Proceedings of the IEEE*, vol. 98, no. 11, pp. 1947–1960, Nov 2010.
- [8] D. Metcalf, S. T. J. Milliard, M. Gomez, and M. Schwartz, "Wearables and the Internet of Things for Health: Wearable, Interconnected Devices Promise More Efficient and Comprehensive Health Care," *IEEE Pulse*, vol. 7, no. 5, pp. 35–39, Sept 2016.
- [9] W. Lutz, W. Sanderson, and S. Scherbov, "The coming acceleration of global population ageing," *Nature*, vol. 451, no. 7179, pp. 716–719, 2008.
- [10] W. Suntiamorntut, S. Charoenpanyasak, and J. Ruksachum, "An elderly assisted living system with wireless sensor networks," in *2011 4th Joint IFIP Wireless and Mobile Networking Conference (WMNC 2011)*, Oct 2011, pp. 1–6.
- [11] A. Redondi, M. Chirico, L. Borsani, M. Cesana, and M. Tagliasacchi, "An integrated system based on wireless sensor networks for patient monitoring, localization and tracking," *Ad Hoc Networks*, vol. 11, no. 1, pp. 39 – 53, 2013.
- [12] L. Catarinucci, D. de Donno, L. Mainetti, L. Palano, L. Patrono, M. L. Stefanizzi, and L. Tarricone, "An IoT-Aware Architecture for Smart Healthcare Systems," *IEEE Internet of Things Journal*, vol. 2, no. 6, pp. 515–526, Dec 2015.
- [13] J. Arboleda, J. Aedo, and F. Rivera, "Wireless system for supporting home health care of chronic disease patients," in *2016 IEEE Colombian Conference on Communications and Computing (COLCOM)*, April 2016, pp. 1–5.
- [14] J. Miranda, J. Cabral, S. R. Wagner, C. Fischer Pedersen, B. Ravelo, M. Memon, and M. Mathiesen, "An Open Platform for Seamless Sensor Support in Healthcare for the Internet of Things," *Sensors*, vol. 16, no. 12, p. 2089, 2016.
- [15] P. Solutions. (2015) BodyGuardian Heart. [Online]. Available: <http://www.preventicesolutions.com/services/body-guardian-heart.html>
- [16] Alarm.com. (2015) Alarm.com Wellness. [Online]. Available: <https://www.alarm.com/productservices/wellness.aspx>
- [17] UnaliWear. (2015) UnaliWear. [Online]. Available: <http://www.unaliwear.com>
- [18] Texas Instruments. (2015) Multi-standard SensorTag. [Online]. Available: http://www.ti.com/ww/en/wireless_connectivity/sensorstag2015
- [19] A. Dunkels, B. Gronvall, and T. Voigt, "Contiki - a lightweight and flexible operating system for tiny networked sensors," in *Local Computer Networks, 2004. 29th Annual IEEE International Conference on*, Nov 2004, pp. 455–462.
- [20] Texas Instruments. (2016) Chronos: Wireless development tool in a watch. [Online]. Available: <http://www.ti.com/tool/ez430-chronos>
- [21] Texas Instruments. (2015) SimpleLink Wi-Fi CC3200 LaunchPad. [Online]. Available: <http://www.ti.com/tool/cc3200-launchpad>
- [22] Texas Instruments. (2016) 50mA Wireless Charger with 19mm Coil BoosterPack Reference Design. [Online]. Available: <http://www.ti.com/lit/ug/tiduba1/tiduba1.pdf>
- [23] K.-F. Krentz, H. Rafiee, and C. Meinel, "6LoWPAN Security: Adding Compromise Resilience to the 802.15.4 Security Sublayer," in *Proceedings of the International Workshop on Adaptive Security*, ser. ASPI '13. New York, NY, USA: ACM, 2013, pp. 1:1–1:10.
- [24] S. Pinto, T. Gomes, J. Pereira, J. Cabral, and A. Tavares, "IIoTEED: An Enhanced, Trusted Execution Environment for Industrial IoT Edge Devices," *IEEE Internet Computing*, vol. 21, no. 1, pp. 40–47, Jan 2017.

Intellisense Food Dispenser (IFD)

Mr. Hari N. Khatavkar
Student,
Electronics Engineering,
Thakur College of
Engineering &
Technology, Mumbai,
India.
hari.khatavkar@gmail.com

Mr. Rahul S. Kini
Student,
Electronics Engineering,
Thakur College of
Engineering &
Technology, Mumbai,
India.
kini.rahul6@gmail.com

Mr. Suyash K. Pandey
Student,
Electronics Engineering,
Thakur College of
Engineering &
Technology, Mumbai,
India.
psuyash17.sp@gmail.com

Mr. Vaibhav V. Gijare
Assistant Professor,
Electronics Engineering,
Thakur College of
Engineering &
Technology, Mumbai,
India.
vaibhav.gijare@thakureduc
ation.org

Abstract - The purpose of this paper is to make use of automated feeders to maintain a particular amount of food for pets which suits their requirements and giving them access to all the necessary proteins and fibers for their healthy growth thus preventing obesity and various other diseases related to it. It offers new and developed way of feeding pets without the need of human intervention with low food alert and feeding alert.

Keywords –pets, smart system, dispenser, feeder

I. INTRODUCTION

The idea of automatic food dispenser has developed from the thought of feeding pets when the owners are not in proximity or are busy with work thus losing track of time which causes irregularities in the feeding patterns. The purpose of this paper is to make use of automated feeders to maintain a particular amount of food for pets which suits their requirements and giving them access to all the necessary proteins and fibers for their healthy growth thus preventing obesity and various other diseases related to it. This project offers a new and developed way of feeding pets without the need of human intervention with low food alert and feeding alert.

II. IMPORTANCE AND REQUIREMENT

The paper is concentrated on the health and weight management of domestic pets thus causing less problems to the owners. Automatic pet feeders allow to feed a pet without the owner being present and this is one of the best features that allows the owners to get over their lack of sleep in case they suffer any, due to their pets. About 56% of pets are overweight, which can cause serious health risks including heart and respiratory disease, kidney disease, and diabetes. Automatic feeders help provide proper weight management by giving the pet the portioned feedings they need. This intellisense food dispenser is designed to store food for a number of servings. This automatic feeder will serve the pet meals for 24 hours exactly when you want it to. This is how you can be sure that the pet has the food for the entire day portioned as the owner wants it to be.

III. PROPOSED ARCHITECTURE

Considering the various scenarios and hurdles related to hospitality of pets, it is very much necessary to address

this issue. The Project is focused on management of domestic pets. Given the big demand there is a huge scope of innovation both in terms of improving the hardware and software aspects, we have implemented the same using the latest FRDM KL25Z board, ESP8266 module and a cloud based system that is a software as a service (SaaS) which is free to use to design, debug and compile. The wifi module being implemented here is the ESP8266 which is used by the FRDM KL25Z board to communicate to the user via a secure wireless connection via standard IEEE networking protocols. The old models still require remote control but can be easily automated thus completely removing human intervention.

IV. BLOCK DIAGRAM

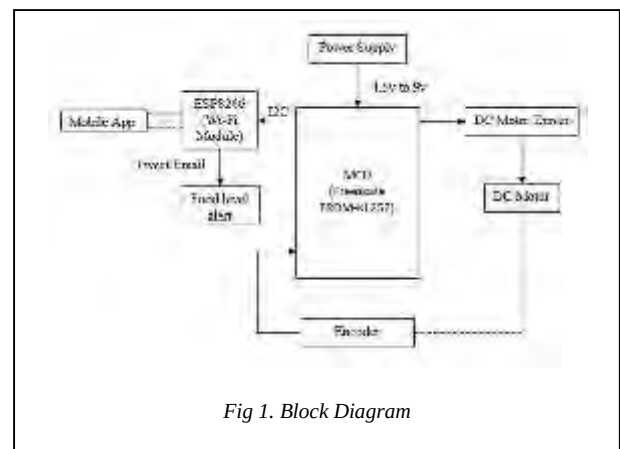


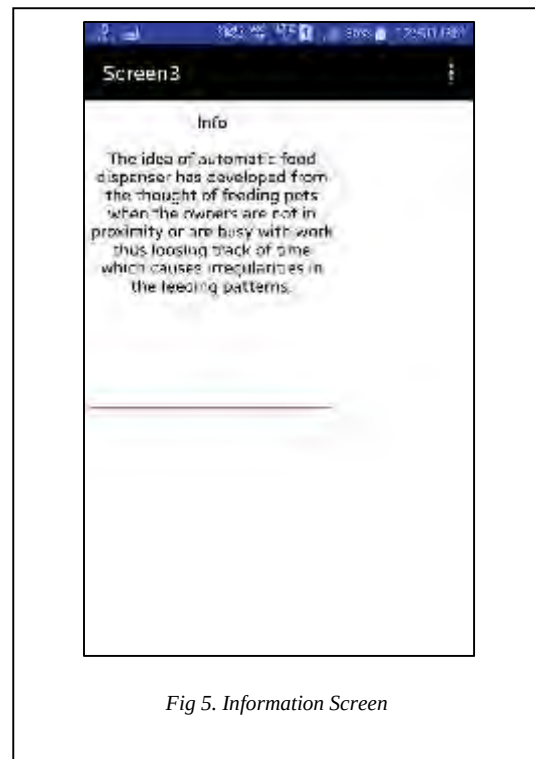
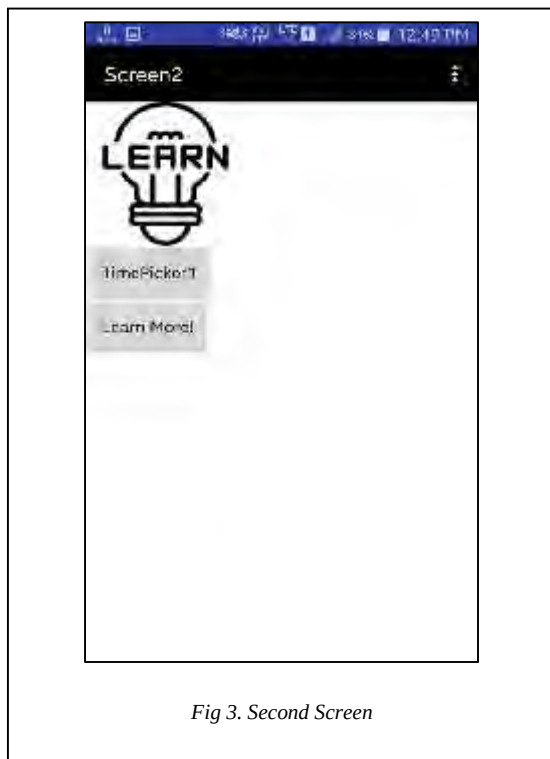
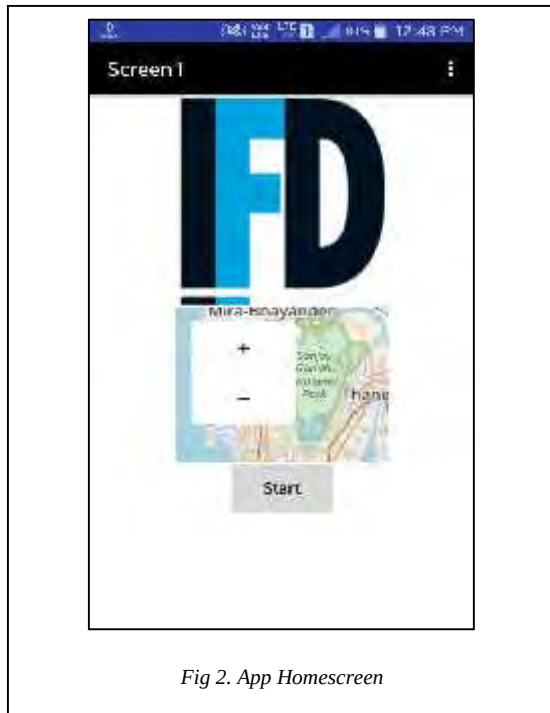
Fig 1. Block Diagram

V. IMPLEMENTATION & OPERATION

The food dispenser is controlled using an android app which gives the control to the device through a wi-fi module (ESP8266) for dispensing the food. The microcontroller FRDM KL25Z is programmed in such a way that it sets the motor working. There are two basic functional parts for dispensing of the food. The storage box used for storing the food will have an opening with hole on the storage. The storage box will have a lid beneath it. This lid will be attached to a DC motor which will be interfaced with the FRDM board. The amount of time the openings of both lid and storage box coincide will decide the amount of food dispensed. After the food is dispensed, the motor will be programmed to rotate anticlockwise, closing the lid. The android application

proves helpful in this case. It can control the time for how long the motor stays in the opening position.

Following is the implementation of the android app:



VII. FLOW DIAGRAM

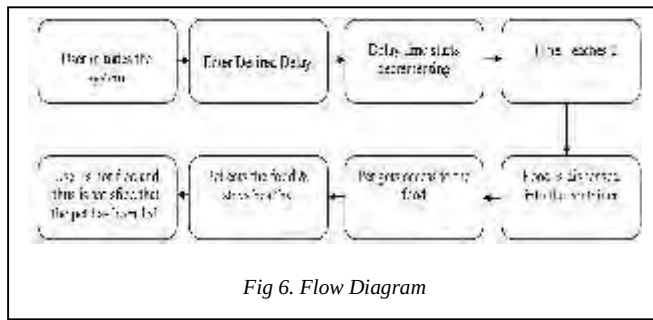


Fig 6. Flow Diagram

Step 1: System will be powered up by the user.

Step 2: Desired delay time will be entered by the user, after which dispensing will take place.

Step 3: Now the delay time will start decrementing and will finally reach termination.

Step 4: When the delay timer reaches 0, food will be dispensed into the container.

Step 5: Pet gets access to the food

Step 6: User is notified and thus is satisfied that the pet has been fed.

VIII. RESULT & FUTURE SCOPE

Given the big demand there is a huge scope of innovation both in terms of improving the hardware and software aspects. Further innovations would comprise of a product in which all the features are included in a modernized machine with low maintenance. Water also being a requirement, future developments can be done. The water bowl often stays on the floor filled with stagnant water and thus collects dirt and grime that the pets may drink. Automated pet fountains can be installed thus not allowing the water to be stagnant and preventing contamination. The old models still require remote control but can be easily automated thus completely removing human intervention. More upgrades can be made to the model by improving sanity levels due to constant food storage, the food may get spoiled, so sensors can be added to alert the owner about change of food also the material of the dispenser can be chosen accordingly.

IX. APPLICATIONS

Food intake Monitoring: The main intent of the project is to dispense food and take care of the daily intake of the food of the pets. So, it can monitor the amount of the food the pet takes in a day and helps you decide the amount so that the obesity is kept in check.

Medicine Dispensing: The food dispenser can also be used as a means to dispense medicine to the bedridden patient who need to consume medicine from time to time. The timer can be adjusted according to the medicine schedule of the patient.

Pet Care: When the owners of the pets are away, the intellisenseFood Dispenser can be set by a timer and amount can be decided so that it gives the food to pets timely.

Pet Medications: The pets that are on medications can be easily given the medicine by dispensing it with the food.

X. CONCLUSION

This paper primarily intends to provide a solution to pet care. It has demonstrated a cost-efficient method that makes use of a popular development board, the 'ARM FRDM KL25Z', an android application and some other standard peripheral devices. The usage of the device has been simplified due to its modular design & providing an app interface. Thus, it can be concluded that when this system is developed further ahead at a later stage, it can be easily enhanced by incorporating GSM module, RF id tags and many more.

REFERENCES

- [1] Automatic Pet Feeding and Monitoring System, Sowmiyalaxmi, Rajsekaran, vol. 10 No. 14, International journal of ChemTech, Aug 2017
- [2] Pill dispenser with alarm via smart phone notification, Nurmiza Binti Othman, Ong PekEk, 29 December 2016
- [3] Smart dog feeder design using wireless communication, MQTT and android client, Vania, KanisiusKaryono, Hargyo Tri Nugroho, Oct-16, international conference on computer control, informatics and its applications.
- [4] Automatic pet feeder, Manoj M, sept-15, International journal of advances in science engineering and technology, vol. 3, issue 3
- [5] The Study and Application of the IoT in Pet Systems Chung-Ming Own, Haw-Yun Shin, Chen-Ya Teng, Jan-13, Contract No. NSC 101-2221-E-129-014.
- [6] Remote controlled and GSM based automated feeder, Prashant Singh, Payalsood, April 2005, IJEEE vol. 2, issue 2
- [7] Smart Medicine Dispenser (SMD), Wissam Antoun, Ali Abdo, Suleiman Al-Yaman, Abdallah Kassem, Mustapha Hamad, Chady El-Moucarry, 2018 IEEE 4th Middle East Conference on Biomedical Engineering (MECBME), Year: 2018
- [8] Smart Medication Dispenser: Design, Architecture and Implementation, Pei-Hsuan Tsai ; Tsung-Yen Chen ; Chi-Ren Yu ; Chi-Sheng Shih ; Jane W. S. Liu, IEEE Systems Journal, Year: 2011 , Volume: 5 , Issue: 1
- [9] The real time hardware of Smart Medicine Dispenser to Reduce the Adverse Drugs Reactions, Purnendu Shekhar Pandey ; Sanjeev Kumar Raghuvanshi ; Geetam Singh Tomar, 2018 International Conference on Advances in Computing and Communication Engineering (ICACCE), Year: 2018
- [10] Pushing Boundaries of RE: Requirement Elicitation for Non-human Users by Anna Zamansky ; Dirk van der Linden ; Sofya Baskin published Sept 2017.
- [11] The Smart Pet Feeder, Rachel Heil, Kristine McCarthy, Filip Rege, Alexis Rodriguez-Carlson, May 2, 2008 WENTWORTH INSTITUTE OF TECHNOLOGY ELMC 461-03/04-ELECTROMECHANICAL DESIGN
- [12] Automatic Pet Feeder Using Arduino, MritunjaySubhashchandra Tiwari, Sahil ManojHawal, Nikhil Navanath Mhatre, Akshay Ramesh Bhosale, MainakBhaumik, Vol. 7, Issue 3, March 2018, International Journal of Innovative Research in Science, Engineering and Technology

This page is kept blank intentionally

Co-relational Analysis by using Different Modeling Techniques in Robotics Application

Mr. Navneet Sharma
Dept of Electronics
Thakur college of
engineering and technology
Email: nvtstrm@gmail.com

Ms. Aboli Sawant
Dept of Electronics
Thakur college of engineering
and technology
Email: abolisawant@yahoo.in

Mr. Shubham Shukla
Dept of Electronics
Thakur college of
engineering and technology
Email: shubham.basant@gmail.com

Mr. Hemant Kasturiwale
Dept of Electronics
Thakur college of engineering
and technology
Email: hemantkasturiwale@gmail.com

Abstract—The word ‘robot’ was first used by Czech playwright Karel Capek in the year 1921. The first industrial robot was made in 1961, which was a welding robot named ‘Unimate’. Commands were given to Unimate by means of magnetic drums and it moved automatically. These commands are given to a microcontroller in today’s world which has brought an ease in robotic motion so that they can be used for a number of applications. By using a microcontroller we can efficiently control the motor characteristics which will controls the robotic motion. For this paper we have considered three microcontrollers namely: MSP430, Raspberry Pi and Intel Galileo Gen 2. All these microcontrollers came out in different time periods and they have their own pros and cons. So the basis of this paper is the comparative study of the mentioned microcontrollers to find out how these microcontrollers affect robotic parameters.

Keywords Robot, Microcontroller, Industrial robots.

I. INTRODUCTION

At first robots were restricted to fixed automation and fully structured assembly lines but due to advancement in technology robots are being used in unstructured and unpredictable environments like underwater, on ground, in air and even in space. In the world today there is a need of robots having autonomy an excellent instance of an autonomous robot would be Mars Rover which is helping us to learn about our red neighbor. We have used servo motors in our robot and hence it is important to study the control of these motors which is the purpose of microcontrollers. There a number of applications where control of motor is required like cranes, elevators, rolling mills, machine tools, etc.

II. HISTORICAL BACKGROUND

The first industrial robot arm was based on George Devol’s patent which was later sublicensed around the world. The Japanese Robot Association (JIRA, later JARA) was the first robot association. The first robot which was fully electric and controlled by microcontroller was IRB 6 from ASAE, Sweden. It mimicked human arm movement with 6kg payload and 5 axes. The SCARA (Selective Compliance Assembly Robot Arm) Robot was developed by Hiroshi Makino, University of Yamanashi, Japan in 1981. After that Germany introduced first lightweight robot named KUKA which was made of aluminium and achieved total flexibility with three translational and three rotational movements. Fanuc,

Japan, launched the first “Learning Control Robot “in 2010. Due to Learning Vibration Control (LVC) FANUC could learn its vibration characteristics for higher accelerations and speeds.

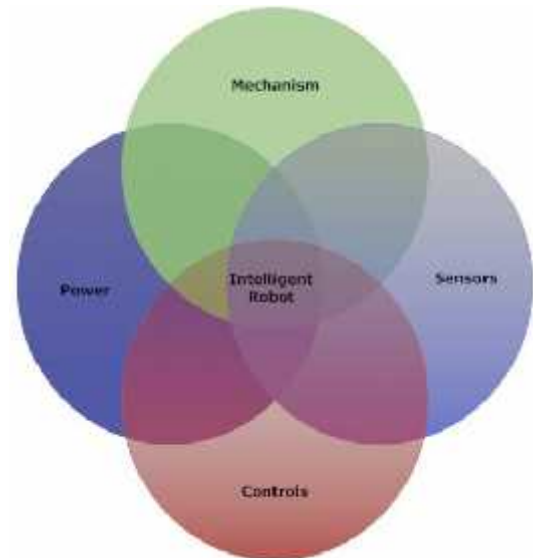


Fig. 1 Intelligent Robot

III. ROBOTIC PARAMETERS

A. Axis

Axis plays a major role in movement indication, one axis is used for a line, two axes are used for a plane and three axes are used for a point anywhere in space. Till 1987 robots were working in 2-axis and 3-axis only but now 4-axis, 5-axis, 6-axis and in multi-axis robots are present. A higher number of axis means that the robot can move in three dimensional spaces more freely as compared to a robot having lower number of axis.

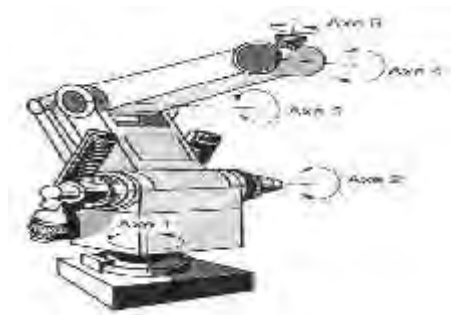


Fig. 2. Robot with 5 axis

B. Degrees of Freedom

A robot controls all points directionally by using its degrees of freedom. A human arm has seven degrees of freedom while a robotic arm can have up to six degrees of freedom. A robot is made of different mechanical parts joined together by n number of joints, each joint having one degree of freedom which means that the number of joints is equal to degrees of freedom.



Fig. 3. A KUKA arm with 7 degrees of freedom

C. Working Envelope and Working Space

The area which the robot can reach is called the working envelope of that robot. Envelope, here, means the range the robot can cover or the range of its movement. A robot can move in any direction (forward, backward, up and down) depending on its application and the number of axis. Meaning each three dimensional shape becomes an envelope for the robot in that space. A robot can work in its working envelope only but it is possible to design a more flexible robot to increase its working envelope. The region in which the robot can fully operate without any obstacle becomes its working space. For example a robotic arm mounted on a table has a working envelope on half sphere with its radius equal to the length of the arm.

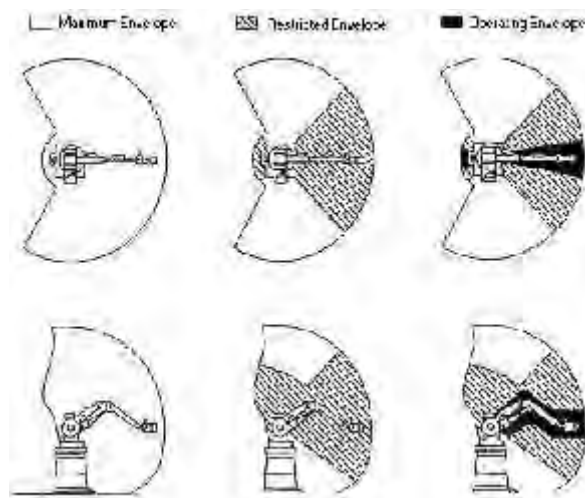


Fig. 4. working envelope of a robotic arm

D. Payload

The payload of a robot is defined as the weight it can operate with without any setbacks. It also includes the weight of the robot itself because the motors in the robot have to carry the physical weight of the robot as well. The payload is one of the most important parameter we consider when we make the robot as it directly affects its application. In industries the robot has to do a number of heavy tasks so the payload must be high for such robots. For normal use the payload of a robot ranges from 1 kg to 10 kg.

E. Accuracy and Repeatability

Accuracy and repeatability are the most important factors for a robot as the performance of the robot depend on them. Accuracy is required to perform the given task in the intent time and in a single attempt and repeatability is the measure of getting the same result if the robot performs the same task a number of time. Figure 5 shows accuracy and repeatability in terms of error. In order to achieve high accuracy and repeatability in a robot a large number of sensors for measuring different parameters like distance, shape, etc.

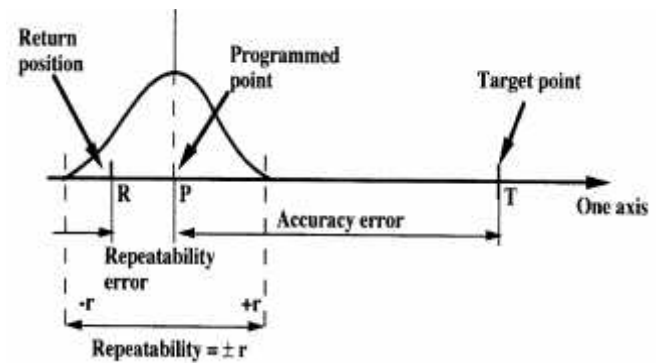


Fig. 5. Accuracy and Repeatability graph

IV. MODELING ASPECT

Robot kinematics studies the relationship between the dimensions and connectivity of kinematic chains and the position, velocity and acceleration of each of the links in the robotic system, in order to plan and control movement and to compute actuator forces and torques.

A. Direct Kinematics

Direct Kinematics, also known as Forward kinematics is the use of the kinematic equations of a robot to compute the position of the end-effector from specified values for the joint parameters. The positions of particular parts of the model at a specified time are calculated from the position and orientation of the object, together with any information on the joints of an articulated model. For example, in this project, the object to be animated is the robot body. The location of the tip of the arm is calculated from

the angles of the shoulder, elbow, wrist, thumb and knuckle joints.

B. In-direct Kinematics

Indirect Kinematics, also known as Inverse Kinematics is the mathematical process of recovering the movements of an object in the world from some other data. It computes the joint parameters that achieve a specified position of the end-effector. The orientation of the robot parts is calculated from the desired position of certain points on the model.

V. SIMULATION SOFTWARE

- V- Rep
- Proteus Simulator

VI. RESULTS

Intel Galileo proved to be better than its counter parts in the fields of Repeatability, Accuracy and IP rating and is used in our project.

VII. APPLICATION

- Military robots.
- Industrial purposes.
- Construction robots.
- Agricultural robots
- Medical robots
- Automation
- Cleanup of contaminated areas, e.g.: toxic waste of nuclear facilities.
- Nanorobots.
- Automotive Industry

VIII. CO-RELATIONAL ANALYSIS

Correlation analysis is a method of statistical evaluation used to study the strength of a relationship between two variables (micro-controller and robot parameters). It helps to establish if there are possible connections between variables. If correlation is found between two variables it means that when there is a systematic change in one variable, there is also a systematic change in the other. The co-relation can be either positive (increase in one variable increases the other) or negative (increase in one variable reduces other).

The co-relational analysis in our project is between the two variables, micro-controller and the robot parameters. We studied the change in the different parameters with respect to a micro-controller, and change in a particular parameter with change in different micro-controllers to find the best controller for our project.

IX. COMPONENTS USED

A. Servo Motor

The servo motor we used is MG995 servo motor because it was economical, easily controllable and has good

torque. For a servo motor which would prove to be useful in our study we had to consider certain specifications which are given in the table below

I. MG995 SERVOSPECIFICATIONS:

Modulation	Digital
Torque	4.8V: 130.54 (9.40 kg-cm). 6.0V: 152.76 (11.00 kg-cm).
Speed	At 4.8V: 0.19 sec/60° at 6.0V: 0.15 sec/60°
Weight	1.94 (55.0g).
Dimensions	Length: 1.60 in (40.7 mm). Width: 0.78 in (19.7 mm). Height: 1.69 in (42.9 mm).
Gear Type	Metal
Rotation/Support	Dual Bearings
Pulse Cycle	1 ms

B. Intel Galileo



Fig. 7. Intel Galileo

The Galileo boards have a real time clock, requiring only a 3V coin cell battery. The boards can therefore keep accurate time without being connected to either a power source or internet. Intel Galileo Gen 2 has the following features due to which it proved to be the best microcontroller for our project needs.

- 1x6-pin 3.3V USB TTL UART header

- 12-bit pulse-width modulation (PWM)
- Console UART1 redirection to Arduino headers
- Power over Ethernet (PoE) capability
- A power regulation system that accepts power supplies from 7V to 15V.
- Improved PWM control line means finer resolution for movement control.

C. MSP430

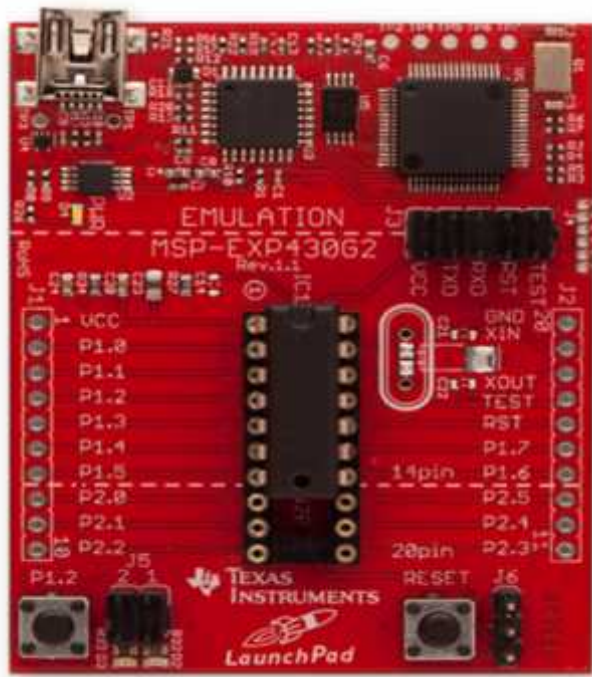


Fig. 8. MSP430

The MSP430 is a mixed-signal microcontroller family from Texas Instruments. The following are the features of MSP430:

- It is equipped with 16-bit CPU which is designed for low cost and, specifically, low power consumption embedded applications.
- The current drawn in idle mode can be less than 1 μ A. The top CPU speed is 25 MHz. It can be throttled back for lower power consumption.
- It has six different low-power modes for power saving, which can disable unneeded clocks and CPU.
- An internal oscillator
- Timer including PWM, watchdog, USART
- SPI, I²C
- 10/12/14/16/24-bit ADCs
- Brownout reset circuitry.

C. RASPBERRY PI

The Raspberry Pi is a series of small single-board computers developed in the United

Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. It has the following features



Fig. 9. Raspberry Pi

- Processor speed is 1.2GHz for the Pi 3
- It has a 64bit quad core processor
- On-board memory ranges from 256 MB to 1 GB RAM.
- SD cards are used to store the operating system and program memory.
- It has one to four USB ports.
- For video output, HDMI and composite video are supported, with a standard 3.5 mm tip-ring-sleeve jack for audio output.
- Lower-level output is provided by a number of GPIO pins, which support common protocols like I²C.
- It also has an 8P8C Ethernet port and on-board Wi-Fi 802.11n and Bluetooth.

The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, has ten times the performance of a Raspberry Pi 1.

X. METHODOLOGY



Fig. 10. Lower body of our robot

We started our project by first making the body of the robot which was made of wooden ply as base, metal rods to connect the joints and servo motors to bring movement in the body. The motors, joints and microcontrollers are connected to each other by means of jumper cables and wires as shown in figure 10.

After that we used Raspberry Pi as our first controller, we conducted a series of tests which include the motion of the joints, delay in command execution and effects of power requirements of the motors. All these tests gave us an idea about how Raspberry Pi affected degree of freedom, repeatability, accuracy and IP rating of the robot

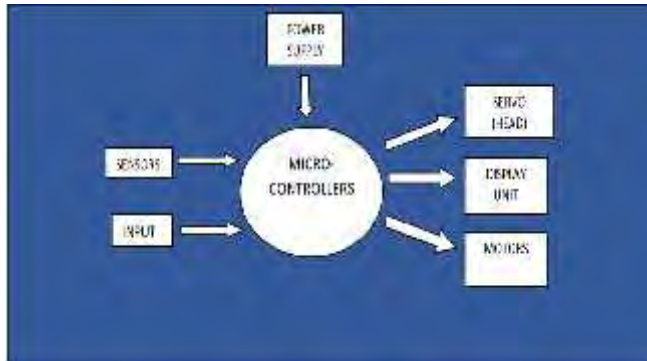


Fig. 11. Block Diagram of our Robot

Then we conducted the same tests by using Intel Galileo and MSP430 to find out how they affected the selected parameters of the robot. When we understood how different microcontrollers affected the selected parameters we concluded our study.

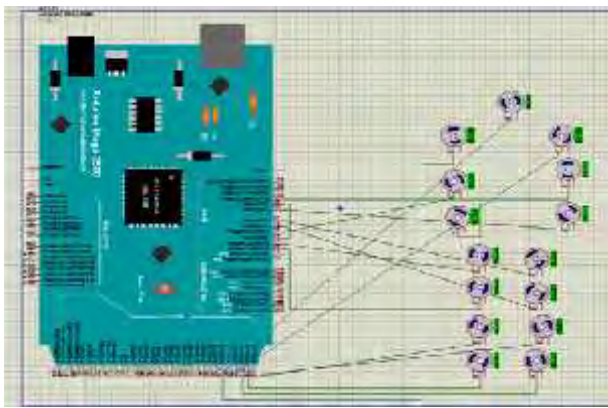


Fig. 12.simulation

We also ran simulation of our robot to get an idea about how our selected microcontrollers will affect our selected robotic parameters and compared with our obtained results to check the viability of our study.



Fig. 13. Our Simulated Robot

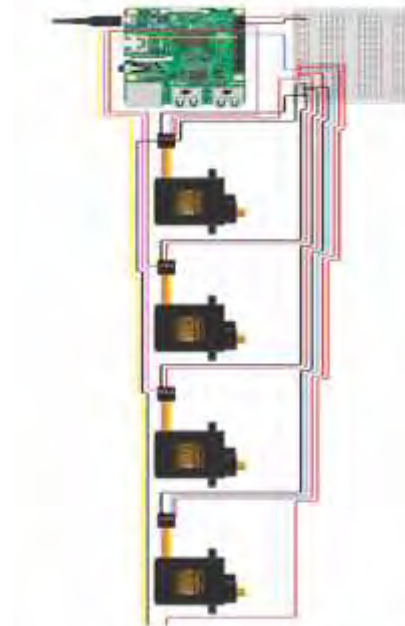


Fig. 14. Raspberry Pi Circuit Simulation

Raspberry Pi GPIO Code:

```

# set GPIO pin numbering method to BCM
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)

# define pins
SERVOMD_1_PIN_SIG = 4
SERVOMD_2_PIN_SIG = 17
SERVOMD_3_PIN_SIG = 18
SERVOMD_4_PIN_SIG = 27
SERVOMD_5_PIN_SIG = 22
  
```

In the simulation, shown in figure 13, we have connected Servo motors in series with Raspberry Pi to test the performance of Raspberry Pi with motors. We have done the same simulation with MSP430 and Intel Galileo to better understand these microcontrollers so we can put them to optimum use in our robot.

XI. RESULTS AND DISCUSSION

In order to design a robot that will perform a certain task we had to calculate the torque at each joint. As torque is one of the most important properties of a motor we had to be sure that the motor will be able to handle the payload with a certain microcontroller. The formula we used for torque calculation is

$$J1 = D1/2 * M1 + D1 * M4 + (D1 + D2/2) * M2 + (D1 + D3) * M3$$

$$J2 = D2/2 * M2 + D3 * M3$$

The above equations are for two joints J1 and J2 with M being the respective weights of joints and D being the distance between the joints.

XII. CONCLUSION

CONTROLLER \ PARAMETERS	DEGREE OF FREEDOM	REPEATABILITY	ACCURACY	IP RATING
RASPBERRY PI	HIGH	MEDIUM	LOW	MEDIUM
INTEL GALILEO	MEDIUM	HIGH	HIGH	HIGH
MSP430	LOW	LOW	MEDIUM	HIGH

The results of our study, can be seen in the table above. Raspberry Pi performed well in providing high degrees of freedom but did not perform well in rest of the parameters. MSP430 gave high IP rating, it was lagging in other areas. On the other hand, Intel Galileo gave exceptional performance in accuracy, repeatability and IP rating and moderately well performance in Degree of freedom. Based on these observations we can conclude that Intel Galileo microcontroller gave the most optimum performance in our robot.

REFERENCES

- [1] Ananya Benerjee, Robotics in Indian Industry – Future Trends, IJESC, Volume 7, Issue 2, March 2017.
- [2] MohdRashid Sheikh, Mohd Shoeb, Rizwan Ahmed, Microcontroller Based Speed Control of DC Motor, IJSRST, Volume 3, Issue 2, February 2017.
- [3] Niti Rajendra Patel, Interactive Interface for DC Motor using GUI with Raspberry Pi Controller, IJIRCCE, Volume 5, Issue 6, June 2017.
- [4] Sarita Umadi, Dinesh Patil, DC Motor Speed Control using Microcontroller, IJET, Volume 2, Issue 6, November 2016.
- [5] Pedro Dinis Gaspar, Antonio Espirito Santo, MSP430 Microcontroller essentials – A new approach for embedded system courses, Research Gate, January 2010.
- [6] CJ ChanJin Chung, Christopher Cartwright, and Matthew Cole , Assessing the Impact of an Autonomous Robotics Competition for STEM Education , 2014
- [7] Raffaele Grandi and Riccardo Falconi and Claudio Melchiorri , Robotic Competitions: Teaching Robotics and Real-Time Programming with LEGO Mindstorms , 19th IFAC World Congress , 2014
- [8] Akhilesh Arora, Sharbanee Bhattacharyya, An Approach towards Brain Actuated Control in the Field Of Robotics Using Eeg Signals , ICARI , 2014
- [9] http://www.societyofrobots.com/robot_arm_calculator.shtml
- [10] <http://robotics.naist.jp/wiki/?Robots%20and%20Equipment%20FKUKA>

Pick-N-Place Robotic Vehicle

Shalini Rai
Electronics and Telecommunication
TCET
Mumbai, India
raishalini55@gmail.com

Yash Shah
Electronics and Telecommunication
TCET
Mumbai, India
yashah311@gmail.com

Rutvi Thakar
Electronics and Telecommunication
TCET
Mumbai, India
rutvi.panchal@thakureducation.org

Abstract- A pick-n-place Robotic Vehicle using Microcontroller AT89S52, Motors, Wired Remote which will be used to pick an object and place it at the desired location. A voice controlled robot takes specified command in the form of voice. Whatever the command is given through voice module or Bluetooth module, it is decoded by the existing controller and hence the given command is executed. Here in this project, we have used Bluetooth module and Android application to give voice command in the form of hex code. There are certain digits which can be sent directly to the Bluetooth module and automatically the digit is converted into its hex code. In this project we can use these digits as a voice command for the specified operation pre-programmed in the microcontroller. Using digits as a voice command is easier than using alphabetical commands. In the earlier project based on this note the method which was used were wired which requires a lot of interfacing and programming and this makes the complicating. So in order to overcome this we are designed a Pick-n-Place Robot with the interface of microcontroller AT89S51, A robotic vehicle will be capable of taking an object from one location and placing it to the other desired location.

Keyword: voice module, android application, hex code, microcontroller, digit converter,

I. INTRODUCTION

Since Robot has played a very vital role in the Human life which includes both personal as well as industrial applications such as Human Robots are developed in order to perform the human task more efficiently and in a uniform and precise manner. There are several Robots developed for industrial use in order to perform Heavy task and to minimize the load on the mankind. Several Robots are developed for border security so as to diffuse bombs and detect suspicious objects in the civilian area. In this project we will be designing a robot that can efficiently pick the object and place it to the desired location. Later this robot can be molded into any form depending upon the choice. Industries have also been benefited from the drastic expansion in the fields of Robotics.

Automated machines have been doing the extensive dangerous duties and mundane jobs of Humans providing great productivity and efficient working. Since Robot are never tiered extra shifts are indulged in the factories. Farmers are also benefited with this expansive development in the field of robotics and thus make use of Automated Harvesters which are just another part of Robotics, not only this but there are several other applications such as Robots are used in more dirtier places in Waste Disposal Sites and also Assisted Surgical Robots are used in the field of Medicines.

The idea of non- human employment has also become realistic. IBM runs a "LIGHT OFF" factory in Texas completely staffed by fully automated robots making keyboards. Unlike Texas Military has also initiated various robotic programs such as Predators and Reaper unmanned aerial reconnaissance vehicle which allows the pilot to control the vehicle even from a larger distance. This vehicle can also be sent to high altitude for an enough longer period of time and can launch a mini shaft on the target without any pilot intervention.

This project when expanded on higher level such as, if this project is designed using VOICE COMMAND then the robot which is designed is fully controlled by the speech and will thus not require any kind of Human Intervention making it fully automated and self-depended

This Pick-n-place Robotic vehicle is designed in order to provide an ease in sorting the Heavy elements. Usually the transfer process is carried out by Human intervention in many places but if this process is carried out for a longer duration of time then it becomes highly injurious to the operator. By designing such a system, the operator will no longer be involved in caring the task on its own and thus this system will provide an ease in the work culture and also be an efficient one. Sometimes in Human involvement it is possible that the operator many tend to do some mistakes, such mistakes on a large scale is un-bearable either with respect to cost, or money, or time.

In order to over-come this above-mentioned issue, we come up with a proposal of designing a „Pick-n-place Robotic Vehicle“ which will be capable of segregating the material it has to lift and type of grip which is needed to hold on to the object, it will also be capable of placing the object from one location to the other desired one.

II. LITERATURE SURVEY

During the Literature survey we came across many contributions made in the field of Robotic Vehicle which is implemented to perform various pick and place functions depending upon the need later this can be molded into any particular form depending on the requirement and need. One of the developments uses a 6V and a 12V motors so to move the arm [1]. These Motors ratings can be changed depending upon the application of the robot. The wired control robotic arm is controlled by wires and the battery. Today the use of Robot has become imminence and is highly expanded. The Following chart shows the use of Robot in Professional and Personal Field Humanoid can provide the suitable assistance to the robot by giving timely instructions to it and the appropriate commands. There are three basic steps in the design of the robot panel such as forward and reverse, upward and downward direction and picking up and placing down [1]

The function of moving and rotating the object picked up can be continuous or at fixed interval of time, this can be decided based on the robot planned. From the above project made on Wire Controlled Robotic Arm we come to a conclusion that our robot is designed in such a way that it is perfect in all the aspects, it can able to move, pick and place objects up to 1 kg, in other categories it can able to hold heavy weighted objects [2].

In a better aspect we conclude that this robot can be used at riskier places in order to diffuse the bombs thus this could prevent the risk of Human Life and also avoid the nuclear wastage as well, while the other makes use of At-mega16, wherein the essential motion subsystem of Robot manipulator for positioning, orientating object so that robot can perform useful task. The main aim of this project is to design and implement a 4-DOF pick and place robotic arm [3]. This project can be self-operational in controlling, stating with simple tasks such as gripping, lifting, placing and releasing. In this project, the focus is on 4-DOF articulated arm. Articulated arm consists of revolute joints that allowed angular movement between adjacent joint [3]. Four servo motors were used in this project to perform four degree of freedom (4-DOF). There are numerous dimensions over which robotic arms can be evaluated, such as torque, payload, speed, range, repeatability and cost, to name a few. Robot manipulators are designed to execute required movements. Their controller design is equally important.

The robot arm is controlled by a serial servo controller circuit board. The controller used for servo motor actuation is AT mega 16 Development board where [4] as the other paper deals with the system which is designed to remove the human error and human interference to get more precise work. There are many fields in which human

interference is difficult but the process under deliberation has to be operated and controlled this leads to the area in which robots find their claims. Prose suggests that the pick and place robots are designed, applied in various fields such as; in bottle filling industry, packing industry, used in surveillance to detect and destroy the bombs etc [4]. The scheme deals with implementing a pick and place robot using Robo- Arduino for any pick and place function. The pick and place robot is controlled using RF signal [1]. The framework is supported for the displacement of robotic arm by four Omni wheels. The robotic arm implemented has two degrees of liberty. Many other features such as line follower, wall hugger, hindrance avoider, metal detector etc can be added to this robot for adaptability of practice.

III. SYSTEM MODEL

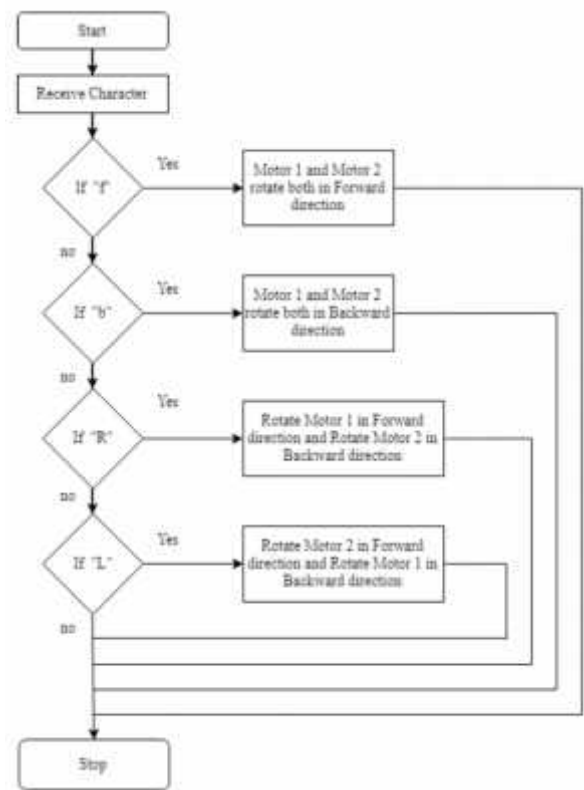


Fig 1: Operation Flow

In this project we are developing a Robotic Vehicle which will be operated on several voice commands, initially the input command is given through voice which will be transmitted to the Bluetooth module and then to the Micro-controller that is interfaced with the device, the character that is received will decide the motion of the Robotic vehicle, there are 5 different characters that are defined and that performs a specific task such as if the received character is „f“ then both the motor rotates in the forward direction and the status of the robot is that the vehicle moves in the forward direction, else if the character received is „b“ then both the motors rotate in the backward

direction and the status of the robot is such that it moves in the backward direction.

Else if the received character is neither f nor b and is „R“ then motor 1 rotates in the forward direction and the motor 2 rotates in the backward direction that leads to the status of the vehicle in the Right direction else if the character received is „L“ the motor 1 rotates in the backward direction and motor 2 in the forward direction so that the status of the vehicle is such that the vehicle moves in the Left direction.

IV. BLOCK DIAGRAM

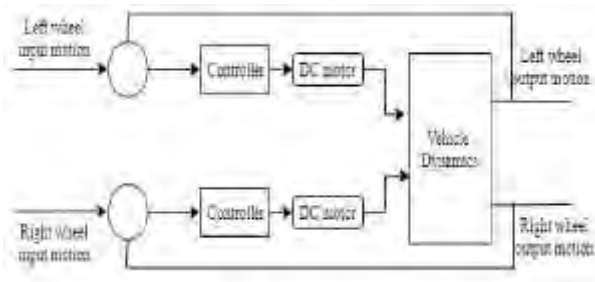


Fig 2: Circuit Operation block diagram

8051-microcontroller is a 8-bit microcontroller which has 128 bytes of on chip RAM, 4K bytes of on chip ROM, two timers, one serial port and four 8bit ports. The basic operation block diagram of the pick and place robotic vehicle circuit is shown in the Fig 2.

DC Geared Motors:

Any device which alters any form of energy to mechanical energy is called as motors. While designing any type of Robot the motors plays a very vital role in providing the movement to the body as well as the shaft. Motor shown in Fig 3 operates with the combined effect of current with the perpetual magnet.



Fig 3: DC Motor

The conductor in addition with the current will produce magnetic field which will then react with the magnetic field to produce by the permanent magnet to make the motor rotate.

There are 3 basic types of motor, DC motor, servo motor and stepper motor which are commonly being used in building a robot. The following figure indicates the basic diagram of Servo motor



Fig 4: DC Motor (ServoMotor)

Power Supply Adapter used for the pick and place robotic vehicle is shown in fig 5. The robot is basically operated with two different kind of supply they are: 5V Power Supply and 6V Power Supply. The 5V supply is vital for the microcontroller used and the IR Sensors as well as the Bump Switch.



Fig 5: Power Supply Adapter

The 6V Supply is used for driving the servo motors since the 5V battery is insufficient to drive the 5 servo motors used for the robot implementation. 5V supply is necessary in order to drive the microcontroller and IR Sensors used.

HC-05 is a serial Bluetooth module shown in Fig 6. It can be configured using AT commands. It can work in three unlike configurations (Master, Slave, Loop back). In our venture we will be using it as a slave. The features of HC-05 module includes,

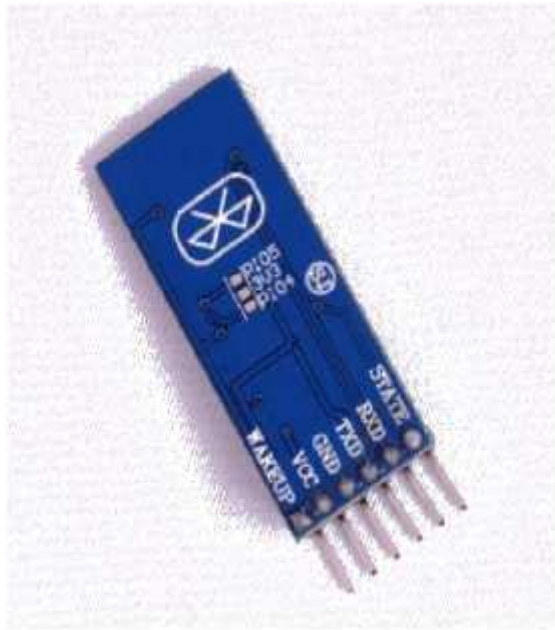


Fig 6: HC-05 Bluetooth Module

- Typical -80dBm sensitivity.
- Default baud rate: 9600bps, 8 data bits, 1 stop bit, no parity.
- Auto-pairing pin code: "1234" default pin code
- Vcc and Gnd pins are used for powering the HC-05.
- Tx and Rx pins are used for collaborating with the microcontroller.
- Enable pin for activating the HC-05 module, when it is low, the module is disabled
- State pin acts status indicator. When it is not paired / associated with any other Bluetooth device, LED flashes continuously.
- When it is connected / paired with any other Bluetooth device, then the LED flashes with the regular delay of 2 seconds.
- In this Smart Phone controlled Robot, the user of android app sends the data to 8051 microcontrollers through HC-05 module.

The flowchart shown in Fig 1 of the system model is best explained by the table shown below (Table 1)

Table 1: Motion Chart

Received Character	Motor 1	Motor 2	Status of Robot
F	Forward	Forward	Moves forward
B	Backward	Backward	Moves backward
R	Forward	Backward	Moves Right
L	Backward	Forward	Moves left
S	Off	Off	Stopped

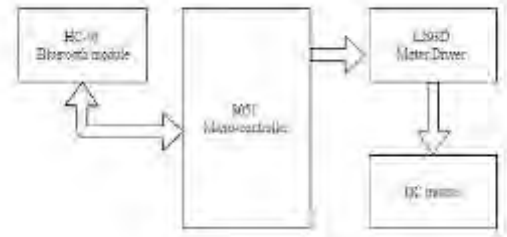


Fig 7: Bluetooth Interface

The arriving data is compared in 8051 microcontrollers and the decision is made accordingly. Table 1 shows the direction of motors and status of robot for diverse received characters. Fig 7 indicates the bidirectional communication between the microcontroller and Bluetooth module HC-05.

V. EXPECTED OUTCOMES

A pick-n-place Robotic Vehicle using Microcontroller AT89S52, Motors, Wired Remote which will be used to pick an object and place it at the desired location. Try to operate the vehicle on basically Two Modes:

1. Line Follower and
2. Fully Remote control

Imparting extra features onto it by adding Line follower concept, a coding using microcontroller will be used. A robotic vehicle will be capable of taking an object from one location and placing it to the other desired location.

Till a point where the line is straight, the robot will follow the line. As soon as it reaches a turn or the location of pick / drop, the mode can be changed to remote controlled mode which can be operated using voice commands.

VI. CONCLUSION AND FUTURE SCOPE

This project will open a lot of opportunities and development in the domain of Embedded Systems Domain and will also increase the pace of technological

In current world a smart approach for real time inspection and selection of object in continuous flow. Voice processing in today's world grabs massive attention as it leads to possibilities of broadens in application in many fields of technology [8].

The real problem in implement this concept is to improve existing sorting system in the modular processing system, which have 4 integrated stages of Identification, Processing, Selection and Sorting with new Voice Processing feature. Existing sorting method uses a set of inductive, capacitive and vocal sensors do differentiate objects. Voice processing

procedure senses the objects in a voice captured in real-time by a mic and then identifies commands and information out of it. This information is processed by voice processing for pick-and-place mechanism. Thereby eliminating the monotonous work done by human, achieving accuracy and speed in the work.

In order to design successful pick-n-place vehicle, Scopes are required to assist and guide the development of project.

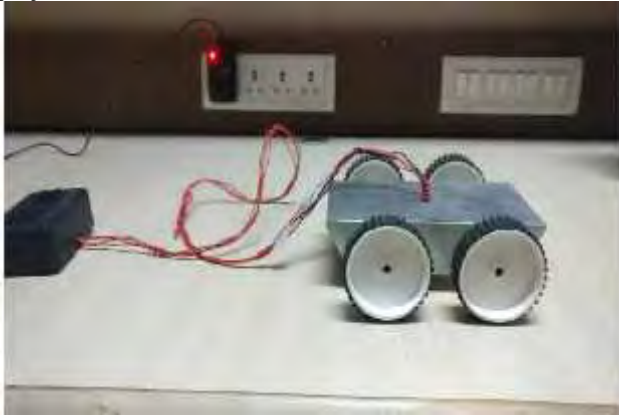


Fig 8: Pick-N-Place Vehicle base

The scope should be identified and planned to achieve the objective of the projects.

The scopes of the project are

- To design a Voice processing command which control the movement of the vehicle
- To design Mechanical Structure.
- To fabricate circuit board for the controller.

Robotic process is basically software which involves a robot that performs the human activities. The future scope of Robotic vehicles, arms and other application is very high. The Fig 8 shows the base of the Pick-N-Place Vehicle. There are various human jobs which can be easily performed using various tools and technology. The various monotonous tasks such as structuring, data accumulating or anything which requires a series of steps are easily carried out with the help of robotic processes. The Robotic applications would be helpful in improving the data gathering and these data can be analysed in a better way, if all the tasks which are carried out by humans today are performed by robots.

During the upcoming year, a tremendous growth is observed in the field of Robotic applications and therefore it reduces the common error and incorrectness while delivering the output thus increasing the efficiency. The Robotic submission in the market is progressing rapidly and thus such tremendous growth in the robot application can benefit the business and the market-place. This is due to the following advantages of Robotic Applications:

1. Efficiency: The Robotic application can perform with ease and without any human intervention thus thereby reducing the error in the task.
2. Accuracy: In order to carry out high data entries and data accumulation, this robotic application can perform the task without any hinderance and thus provides accurate work output
3. Cost Reduction: Since the Robotic applications are based on software thus their upgradation does not involve much cost.
4. Boosted audit and monitoring compliance

REFERENCES

1. Bhuvneshwari Jolda, Mohnish Arora, Rohan Ganu, Chetan Bhatia Department Of Electronics and Telecommunication 2017
2. Kannan, Dr. Selvakumar Embedded System Technology ECE Department 2015\
3. Anup Kumar, Ranjeet Chauhan Department of Computer Engineering Voice Controlled Robot 2014
4. Sagar Pinjarkar, Siddhi Khapde, Anuja Tavte Department of electronic engineering Voice Controlled Robot Through Android Application
5. P Sathya Priya, P Rathi, R Anusuya Devi. Smart Host Microcontroller based solar powered tool with robotic arm. International Journal of Mechanical Engineering and Robotics Research. 2013
6. Yong Zhang, Brandon K, Chen, Xinyu Liu, Yu Sun. Autonomous robotic pick-and-place of micro bjects. IEEE transactions on Robotics. 2010
7. Ankit Gupta, Mridul Gupta, Neelakshi Bajpai, Pooja Gupta, Prashant Singh, "Efficient Design and Implementation of 4-Degree of Freedom Robotic Arm", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, June 2013.
8. <https://www.scribd.com/document/330860393/Project-Report-on-Pick-and-Place-Robot-By-Chirag-Joshi>

This page is kept blank intentionally

PROGRAMMABLE SKETCHING AND WRITABLE MACHINE

Vishal Rawat
EXTC, TCET
Mumbai, India
vishuraw001@gmail.com

Vishal Sawant
EXTC, TCET
Mumbai, India
vishalsawant081@gmail.com

Parth Shah
EXTC, TCET
Mumbai, India
paddieshah@gmail.com

Rutvi Thakar
EXTC, TCET
Mumbai, India
rutvi.panchal@thakureducation.org

Abstract— *It is a simple and accurate pen plotter, capable of writing and drawing on any given flat surface. It can write with fountain pens, permanent markers, and a variety of other writing equipments to handle an endless number of applications. We can use it for almost any task that might normally be carried out with a handheld pen. It allows you to use your computer to produce writing that appears to be handmade, complete with the unmistakable appearance of using a real pen (as opposed to an inkjet or laser printer) to address an envelope or sign your name. And it does so with precision approaching that of a skilled artist. This can be used for small scale applications and is application based. It will be useful for physically challenged people. It is highly cost effective as it does not require any costly material or equipments. Here we are using servo motors which is totally responsible for the motion of the pen.*

Keywords—*pen-plotter, unmistakable, precision, skilled-artist.*

I. INTRODUCTION

In today's world the basic requirement of any industry is to produce large quantity and quality products with low production and installation cost having high surface finish and great dimensional accuracy. So this can be achieved by a machines which are controlled by Computer i.e. Computerized Operated Machines [1]. known as CNC machines. By using a CNC machine the products are produced at a faster rate with high accuracy and less human interference. The CNC machines usually are of various types. The most common used CNC machines are two-axis CNC machine and three-axis CNC machine. The CNC machine is a system. This system consists of three They are known as CNC machines. It used to create the drawing on the sheet. Mini CNC Plotter Machine is the automatic of machines that are operated by accurate. The main function of CNC Plotter It is used for plotting various drawings of products. The working principle of CNC Plotter is very similar to CNC machine. In this system instead of plotting the drawing of product by hand, it is plotted by a computer controlled pen. It produces a high quality work as

B) MOTIVATION

Arduino and microcontrollers like it have invigorated students, hobby, and makers of all types to add electronics and computer control to their hand--made contraptions. The Integration of electronics and electro--mechanical instruments with computer control

important parts viz. Mechanical design, Drive modules, and System any software. The mechanical design consists the body of the system. The drive modules consist of the Microprocessor. And finally the System Software is used to generate the drawing on the sheet. Mini CNC Plotter Machine is the automation of machines that are operated by precisely .

A) IMPORTANCE OF PROJECT

. By using a CNC machine the products are produced at a faster rate with high accuracy and less human interference. The CNC machines usually are of various types. The most common used CNC machines are two-axis CNC machine and three-axis CNC machine. The CNC machine is a system. This system consists of three important parts viz. Mechanical design, Drive modules, and System software. The mechanical design consists the body of the system. The drive modules consist of the Microprocessor. And finally the System Software is used to generate the drawing on the sheet. Mini CNC Plotter Machine is the automation of machines that are operated by precisely programmed commands. The main function of CNC Plotter is used for plotting various drawings of products. The working principle of CNC Plotter is very similar to CNC machine. In this system instead of plotting the drawing of product by hand, it is plotted by a computer controlled pen. It produces a high quality work as compared with the human work. Automation and precision are the main advantages of CNC Plotter table. In this project we will show how to build your own low cost mini CNC Plotter and to use it for sketching and writing with the help of software's like Inkscape and processing.

is known more generally as physical computing concise definition from Wikipedia is: Physical computing, in the broadest sense ,means Building interactive physical systems by the use of software and hardware that can sense and respond the analogue world. For artists, this provides tools that enable interaction with people and the environment. For engineers, this is an exciting and novel creative context For technology. For educators, this is a powerful way to introduce programming and physical computing concepts to students from high school to undergraduate and to students who might not normally be intrigued by a computer engineering course. This Workshop will include a brief introduction to Drawing Machines, building a creative and artistic context in which the technical content will be explored in the workshop. In this Workshop Participants will build (in teams) a simple drawing machine using foam

core, nuts/bolts, and masking tape. This Machine will be controlled using potentiometers and servos connected to an Arduino microcontroller. Topics which are covered by this activity include basics of microcontroller programming and electronic components, including how to use a breadboard, how to read a circuit diagram and how to interact with the physical world using programmatic control of a variety of input and output components. Once the simple prototype has been constructed, teams will have the opportunity to modify, enhance, and explore their machine's operation to optimize both the machine's appearance, and the drawings that are made by their machine. This Gallery event on Wednesday Will be a chance to show off both the machines and the drawings made by the machines. in our Experience is that the machines make relatively interesting drawings very quickly, but they make their most interesting drawings if they're left to operate on their own for an extended period of time. A few lines are interesting. A large number of lines can be very interesting and new.

C) PROBLEM DEFINITION

All the systems that are existing in the PCB printing have many of the following demerits:

- Lack of accuracy and preciseness.
- Requires large time.
- Use more manpower.
- Production cost is large.
- Faults occurred is more.

The available Arduino controlled CNC machines are having only 2 axis movement. The structure is weak and can machine foam only. The main objectives of this project is to design and implement a plotter machine (Drawing surface area 20cm x 20cm) which will be able to draw a PCB layout (or any image) on a solid surface. To make it cheap, CNC machine which can machine wood, plastic, foam and soft metals. Reduces cost of machine and increases the flexibility to work in more than 2-axis.

D) DESIGN AND MANUFACTURING OF MINI CNC PLOTTER MACHINE

In this paper describes a low cost serial communication based mini CNC Plotter Machine based on open source software and hardware. mini CNC Plotter Machine is an embedded system that works on the Principle on 'Computer Numeric Control (CNC) [2].The system basically works with three stepper motors (two for X-axis & one for Y-axis) and micro-servo controller (for Z-axis) wherein Arduino Circuit plots the input given from the computer through 'ENSCAPE Software' on the sheet which is placed on the drawing board using micro-controller. This plotter has four axis control (2 X-axis and 1 Y& Z axis resp.) and a micro-servo controller for movement of pen. [3]. This system reduces human effort and also reduces the chances of fault. The efficient and correct mounting of all the parts and proper use of software and correct alignment of circuit makes the system more efficient.



Fig.1: CNC PLOTTER MACHINE [2]

E) Implementation 3-Axis CNC Router for Small Scale Industry



Fig 2: 3-axis CNC router [4]

This paper discusses the design and realization of complex 3-axis CNC machines based on microcontroller which combined with spindle drill [4]. This machine can be used for cutting and engraving.

II. SYSTEM MODEL

A) FLOWCHART

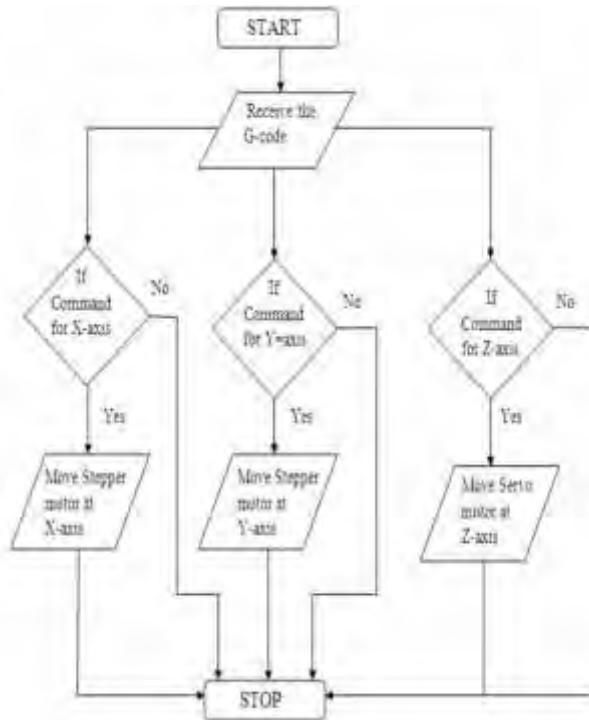


Fig.3: Flowchart

B) ALGORITHM

Step a: Start.

Step b : Generate G-code.

Step c : Send this G-code to the controller using G-code sender. The gcode which is generated is send to the controller using processing software and inkscape.

Step d.: Controller gives commands to the motors according to G-code. The controller will give the commands about moving a pen according to our use i.e left, right, up, down and can also sketch any picture or image whose gcode is available to us.

Step e.: According to the commands motors with mechanical part moves and plot the diagram whose G-code is provided to controller.

Step f: Stop

C) DATAFLOW

First the design of the text or image is taken and gcode is generated with the help of inkscape software and is processed and send to the controller i.e arduino this arduino is then interfaced with the CNC machine which is designed by us.

And then with the help of processing software the desired output is generated i.e a written text or any image which is desired.

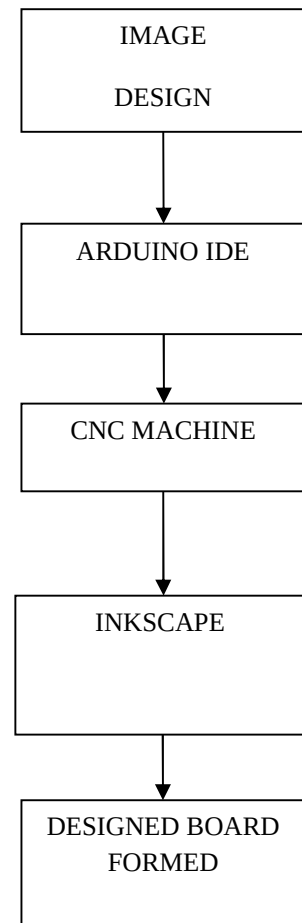


Fig 4 : Dataflow

III. TECHNOLOGY AND HARDWARE

A) ARDUINO

The Arduino board is a simple designed circuit which is very easy for beginners to understand . This board especially is breadboard friendly and it is very easy to handle the connections. We should start with powering with the Board.

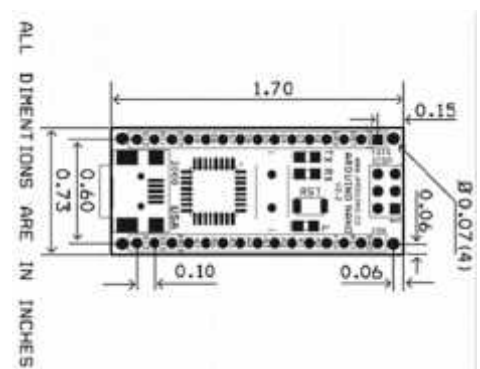


Fig 5.ARDUINO [1]

B) POWERING YOUR ARDUINO NANO:

There are mainly three ways by which you can power your Nano.

USB Jack: It drives power required for the board to function by connecting the mini USB jack to a phone charger or computer through a cable.

Vin Pin: The Vin pin will be supplied with a unregulated 6-12V power supply to board. The on-board voltage regulator regulates its stability voltage to +5V.

+5V Pin: If you have a regulated +5V available supply then you can provide this to the +5V pin of the Arduino.

Input/output:

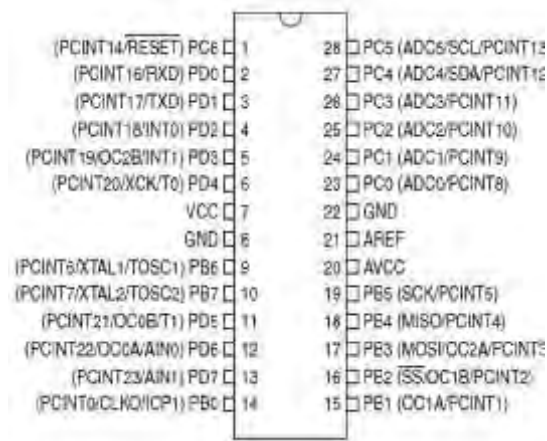


Fig 6: Arduino pinout [1]

There are in total 14 digital Pins and 8 Analog pins on your Nano board. The digital pins are used to interface sensors using them as input pins or drive loads by using them as output pins. A simple function like pin Mode() and digital Write() can be used for the control of its operations. The operating voltage is between 0V and 5V for digital pins. The analog pins can measure analog voltage between 0V to 5V using any one of the 8 Analog pins by using a simple function like analog Read().

C) L293D

L293D is H-bridge dual motor driver IC. Motor drivers will act as current amplifiers as they take a low-current control signal to provide a higher-current signal. This higher current signal can be used to drive the motors.



Fig 7.L293D [1]

D) SERVO MOTOR

The servo motor is actually made of four things: a normal DC motor, a gear reduction unit, a position-sensing device and a control circuit. The DC motor is connected with a mechanism of gear which will provide feedback to a position sensor which is mostly a potentiometer. From the gear box we get the output of the motor which is delivered via servo splinter to the servo arm. For standard servomotors, we make the gear of plastic where as for high power servos, the gear is made up of metal. A servo motor consists of three wires mainly a black-wire connected to ground, a white/yellow wire connected to control unit and a red wire connected to power supply.

The function of the servo motor is basically to receive a control signal which will represent a desired output position of the servo shaft and apply power to its DC motor until its shaft turns to that position.

It uses the principle of position sensing the device to figure out the rotational position of the shaft, so that it knows which way the motor must turn to move the shaft to the instructed position. The shaft does not rotate freely in similar to a DC motor, however rather can just turn it to 200 degrees.

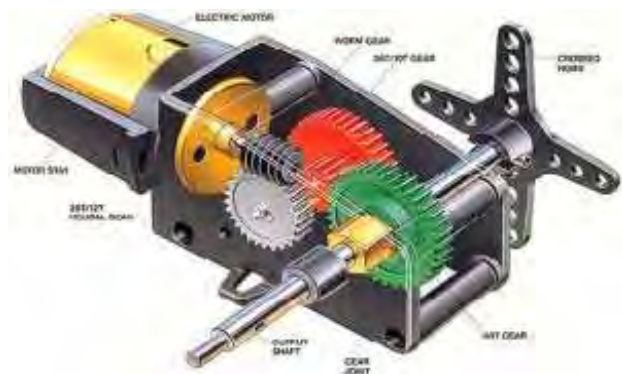


Fig 8: SERVO MOTOR [2]

E) INKSCAPE

Inkscape is basically a free and open-source vector graphics editor which can be used to create or edit vector graphics like illustrations, diagrams, line arts, charts, logos and complex paintings. Inkscape's primary vector graphics format is related on Scalable Vector Graphics (SVG), however many other formats which can be imported and exported are used. Inkscape can render primitive vector shapes and different texts [5]. These objects may be filled with solid different colours, patterns, radial or many linear colour gradients and their specified borders may be stroked, both with adjustable and stabilised transparency. Embedding and also optional tracing of raster graphics is also supported strongly, which enables the editor to create vector graphics from photos and other raster sources. Created shapes can be further manipulated with transformations involving moving, rotating, scaling and skewing.



Fig 9 : Inkscape [3]

F) RESULT

After following the data flow diagram as described in chapter 2 we have obtained the following results

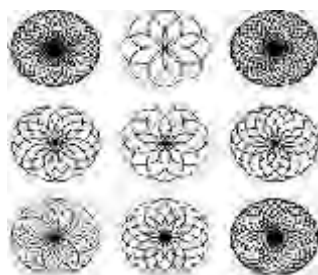


Fig 10: Observed output 1



Fig 11: Observed output 2

It is a simple and accurate pen plotter, capable of writing or drawing on almost any flat surface. It can write with fountain pen, permanent markers, and a variety of other writing implements to handle an endless number of applications.

It gives more accurate and does not make any mistake which we often observe when humans write or sketch

IV. CONCLUSION

This project is about building a mechanical prototype of a CNC plotter machine which is able to draw a PCB layout (or any image/text) on a given surface.

A) ADVANTAGES

1. It requires minimum power and high amount accuracy because of precise controlling of stepper motors.
2. The components required for this project are easily available in the market and it has been done within a small budget
3. The pen can be replaced with a pinhead or laser head or any other tool for different purpose of use. Software that has been used is open source and user-friendly.
4. It is simple in construction and can be carried anywhere without much effort.

B) APPLICATIONS

1. Electronic Circuit layout can be plotted on to a copper-clad board which can be etched normally.
2. By replacing the pen with a drill, the user can precisely drill holes on circuit boards.
3. Charts and graphs can also be plotted.

REFERENCES

- [1] Mohammad Kamruzzaman Khan Prince, Muhsi-Al-Mukaddem Ansary, Abu Shafwan Mondol "Implementation of a Low-cost CNC Plotter Using Spare Parts", Kumargaon, Sylhet-3114, Bangladesh, Volume 43, number 6, Jan-2006.
- [2] A S Patil, S R Kakade, M B Lad, D D Saste, D N Homkar "CNC MACHINE PCB PLOTTER", Department of Electronics and communication Engineering, Rajarshree Shahu Institute of Technology And Research JSPM NTC Narhe Technical Campus, Pune, India 411041, Volume 5, Issue 03, March -2018.

- [3] S.K.Kamble, Govind S. Mali “Design Of CNC Printing System For Spherical Objects”,Dept. of Mechanical Engineering, Datta Meghe College of Engineering Sector-3 Airoli, Navi Mumbai (MS) India,Volume- 2, Issue- 1, Jan.-2014.
- [4] R.Ginting, S. Hadiyoso and S.Aulia “Implementation 3-Axis CNC Router for Small Scale Industry” Telkom Applied Science School, Telkom University, Indonesia.
- [5] Mr. Pritesh Runwal, Mr. Anil Shelke, Mr. Pankaj Udavant, Mr. Sujit Rokade, Prof. D.A. Baitule “Design and Manufacturing of Mini CNC Plotter Machine”,Department of Mechanical Engineering Trinity Academy of Engineering, Pune ,Volume 5 Issue IV, April 2017.

WATER CLEANING ROBOT

Saurabh.s.sankpal
Saraswati college of Engineering
Kharghar
sssankpal54@gmail.com

Saurabh.s.mohade
Saraswati college of Engineering
Kharghar
saurabhmohade21@gmail.com

suvaish.s.ambhore
Saraswati college of Engineering
Kharghar
suvaishambhore@gmail.com

prathamesh.p.mhatre
Saraswati college of Engineering
Kharghar
prathameshmhatrepm98@gmail.com

Abstract—Water is a basic need for all living being, it is important to maintain the cleanliness and hygiene of water. Water gets polluted due to many reasons such as waste from industry, garbage waste, sewage waste etc. water from lakes and ponds are cleaned by traditional methods. We have to incorporate technology such that cleaning work is done efficiently and effectively. We consider this as a serious problem and start to work on the project. We collected information from the various resources, based on the details collected we listed objectives that a design has to carry. Various concepts were generated through Pugh evaluation chart. Design calculation was being done where theoretical values of required parameters were calculated to match them with actual values achieved by the solution. A detailed engineering drawing is created and later fabrication process will be done stepwise. Mechanisms used for our design is such a way that it collects the waste which floats on water bodies and the collected waste can be easily disposed from the product, our product cleans wastes found such as plastic wastes, garlands, bottles and other wastes found floating on water. We detect the waste in the water with a help of an action camera and our product is RC controlled using a battery, we have mainly used parts such as frame, waste collector bin and a propeller. A clear vision regarding the level of rejuvenation of water bodies is recommended. In order to make a productive use of limited available resources, it is important to determine an acceptable level of restoration of lakes.

I. INTRODUCTION

This Lakes are an important feature of the Earth's landscape. They are extremely valuable ecosystems and provide a range of goods and services to humankind. They are not only a significant source of precious water, but extend valuable habitats to plants and animals, moderate the hydrological extreme events (drought and floods), influence microclimate, enhance the aesthetic beauty of the landscape and offer many recreational opportunities. Lakes have a very special significance in India.

A major cost moving in-water vessels (surfaces) is the cost of fuel. Any reduction in fuel consumption will result in a direct and proportional reduction in operating costs. Since the majority of its propulsive energy is needed to overcome hydrodynamic resistance (friction), for that reason keeping the external surface smooth will minimize waste and improve the speed and/or distance to be gained from the same amount of fuel.

Prime objective of our project is to collect all the wastes which are found floating on water bodies and to minimize labor work, we can use our product for few other purposes such as we can attach a life jacket to it and send it for rescue and if there is any oil spilled we can collect the oil through our product. We have tried to meet all the objectives to this product successful such that our product gets launched in the market.

Technically, in urban areas, water bodies are owned by land owning agencies. However, their survival and protection depend on the role of a number of other institutions /agencies such as Ministry of Water Resources, Ministry of Environment and Forests, Agriculture Ministry, Fisheries Ministry and other local authorities, i.e., Municipal Corporations, Development Authorities, Tourism Department, Water Supply Boards, etc. At the Central Government level, Ministry of Environment and Forests (MoEF) plays an important role in restoration of lakes in India under its initiative called National Lake Conservation Plan (NLCP) developed in 2001 specifically for the protection and management of lakes.

II. PROBLEM STATEMENT

In the absence of garbage disposal facilities, the practice of dumping garbage into nearby water bodies has become quite common in recent years. And has posed long-term negative impacts both on biodiversity of the area and as well as on the local environment.

III. REQUIREMENT OF HARDWARE

A. AVR MICROCONTROLLER

The Atmel AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum

frequency of 16MHz. ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000; respectively. ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD. ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16.

Typical features of ATmega16:-

- 16 KB Flash memory
- 1 KB of SRAM
- Up to 16 MHz clock
- Four 8-bit I/O ports
- ADC, Timers, Serial Interface etc
- 40 pin DIP, operates at 5V

B. IR Sensor

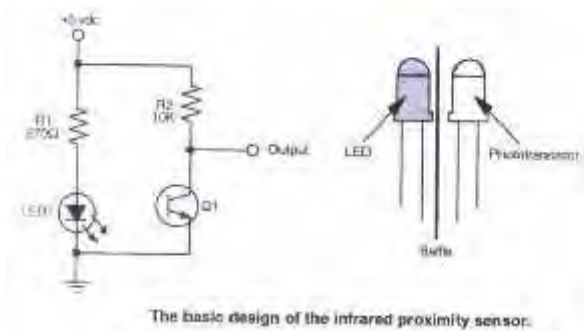


Fig 1 IR Sensor

The Principle of operation of the I.R. L.E.D. and Phototransistor :-

A Photodiode is a p-n junction or p-i-n structure. When an infrared photon of sufficient energy strikes the diode, it excites an electron thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region, producing a photocurrent. Photodiodes can be used under either zero bias (photovoltaic mode) or reverse bias (photoconductive mode). Reverse bias induces only little current (known as saturation or back current) along its direction. But a more important effect of reverse bias is widening of the depletion layer (therefore expanding the reaction volume) and strengthening the photocurrent when infrared falls on it. There is a limit on the distance between I.R. L.E.D. and infrared sensor for the pair to operate in the desired manner.

C. Relay



Fig 2. Relay

The Single Pole Double Throw SPDT relay is quite useful in certain applications because of its internal configuration. It has one common terminal and 2 contacts in 2 different configurations: one can be Normally Closed Normally Closed and the other one is opened or it can be Normally Open and the other one closed. So basically you can see the SPDT relay as a way of switching between 2 circuits: when there is no voltage applied to the coil one circuit "receives" current, the other one doesn't and when the coil gets energized the opposite is happening.

D. LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

E. HC-05

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. \Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

Hardware features:

- Typical -80dBm sensitivity.
- Up to +4dBm RF transmits power.
- Low Power 1.8V Operation, 1.8 to 3.6V I/O.
- PIO control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

F. Gas Sensor

A GAS sensor or a GAS Detector is a type of chemical sensor which detects/measures the concentration of gas

in its vicinity. Gas sensor interacts with a gas to measure in concentration. They are used in various industries ranging from medicine to aerospace. Various technologies are used to measure Gas concentration such as semiconductors, oxidation, catalytic, infrared, etc.

Applications:-

- Process control industries
- Environmental monitoring
- Boiler control
- Fire detection
- Alcohol breath tests
- Detection of harmful gases in mines
- Home safety
- Grading of agro-products like coffee and spices

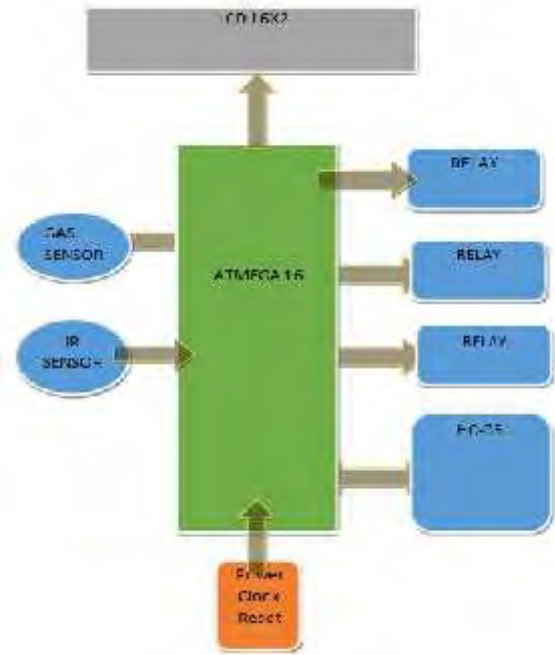
Features:-

- High sensitivity
- Fast response
- Wide detection range
- Stable performance and long life
- Simple drive circuit



Fig 3 Gas Sensor

IV. BLOCK DIAGRAM



REFERENCES

- [1] Ministry of Water Resources, Government of India URL: http://www.worldlakes.org/uploads/Management_of_lakes_in_India_10Mar04.pdf.
- [2] M. A. Abkowitz, "Measurement of hydrodynamic characteristics from ship manoeuvring trials by system identification,"
- [3] NMP Kakalis, and Y Ventikos Robotic swarm concept for efficient oil spill confrontation Journal of hazardous materials, 2008 .
- [4] E.K. Boulougouris, A.D. Papanikolaou, Y. Le Corre, F. Ghazlan, O. Turan, N.M.P. Kakalis, Y. Ventikos, D. Fritsch, V. national Symposium on Maritime Safety, Security and Environmental Protection, Athens, Greece, 2007 .
- [5] (PDF) Aquatic multi-robot system for lake cleaning. Available from: https://www.researchgate.net/publication/268471526_Aquatic_multi-robot_system_for_lake_cleaning [accessed Oct 03 2018].

This page is kept blank intentionally

Intrusion Detection System

Ms. Purva Pramod Ghag
Dept. of Information
Technology
Finolex Academy of
Management and Technology
Ratnagiri, India
purvaghag86@gmail.com

Ms. Sonali Sudhakar Ghogale
Dept. of Information
Technology
Finolex Academy of
Management and Technology
Ratnagiri, India
ghogalesonali@gmail.com

Ms. Purva Pramod Ghag
Dept. of Information
Technology
Finolex Academy of Management
and Technology
Ratnagiri, India
manasijadhav2006@gmail.com

Mr. A.R.Palwankar
Dept. of Information
Technology
Finolex Academy of
Management and Technology
Ratnagiri, India
amar.palwankar@famt.ac.in

Mr. S.A.Shete
Dept. of Information
Technology
Finolex Academy of
Management and Technology
Ratnagiri, India
suraj.shete@famt.ac.in

Abstract— As we know nowadays, the robbery & theft increases day by day, so for that reasons security is one of the most important part in modern daily life. The main goal of this paper is to design and implement Intruder Detection System based on the Arduino which can be organized in jewelry shops, bank locker room, personal office cabin, homes, etc. The system develops along with the automatic door lock system which can authenticate and validate the user. This system is supported by the GSM module which can able to receive alert messages to the user. The proposed system is standalone and provides high security in many areas. The system gives security access control by using various IoT based sensors. The proposed system is better, efficient to detect and prevents unauthorized activities by using IoT based applications from a remote place.

Keywords—Intruder, Security, Access control, Locks.

I. INTRODUCTION

In present days, the need for safety is an essential issue which makes many people look for different way to protect their property [1]. To overcome security threat different types of sensors and alarm systems are available in the market. In this paper, we have implemented a infrared motion sensor, light sensor and automatic door lock system with the help of Arduino for the safety of bank lockers, jewelry lockers, homes, etc. Infrared motion sensor detects the motion of a person during a specific period of time [4]. When any unauthorized motion will get sensed, the system will glow the lights by using a light sensor and at the same time the door will get automatic lock by using automatic door lock system so the intruder will get lock inside the room and alert message will send to the user, so the user will get aware about the attack and will take some action. It provides both intruder detection and provides security for door access control [2].

II. LITERATURE SURVEY

The existing security consists of Pyroelectric sensor along with CCTV cameras to detect the intruder which is costly because of use of computers and requires more hardware and highly complex. It does not aware the user immediately at the time of attack happens [3]. The traditional locking system is based on lock and key but, managing such mechanism is hard work for a person who has authority to lock. It has to physically check and maintain the multiple keys which are not efficient and it was created lots of issues [9]. So, for that reasons, the digital locking system is invented. There are various types of door lock systems are used like password based system, biometrics-based system, RFID card or ID card and also with the use of face recognition system is used to lock the doors which need to improve reliability and robustness [7]. But, these systems are used to prevent the unauthorized or intruder to enter into the sensitive area.

We have to implement those type of system which will work after the intruder will enter into such sensitive areas. We have to not only detect the intruder but also prevent them. So, the current systems are work only for detecting the intruder not to prevent [5]. In this paper, we are invented such type of system which is useful for a monitor as well as control the intruder with the help of automatic door lock system after the intruder's motion is sensed by a infrared motion sensor which is more reliable

[6].By using various wireless communication techniques it is possible to aware the user by sending the alert emails.

III. PROPOSED SYSTEM

In Intrusion Detection System, we have used two types of sensors i.e. Infrared motion sensor and Light

sensor. We have connected both the sensors to Arduino with the help of jumper wires. Arduino is the interface between hardware and software which is connected by using USB 2.0. When an intruder enters the room at that time motion is detected by the Infrared motion sensor and at the same time, lights will glow with the help of the Light sensor. At that same time, the door will be lock automatically with the door lock system. Then automatically email is sent to the user by using IoT module i.e Ubidots. Ubidots is the platform which is used for email sending which sends sensor data to the cloud and with the help of Ubidots, email is sent to that particular user. So the user will aware regarding the attack and will take further actions against robbery from a remote location.

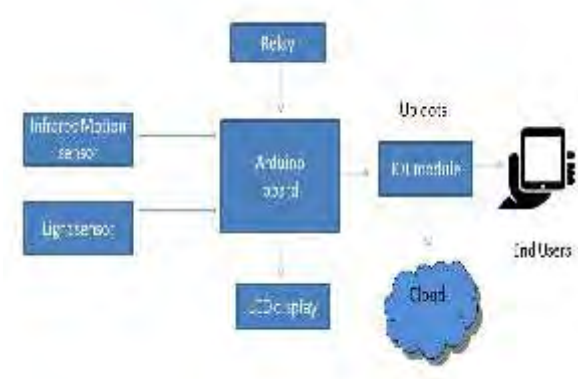


Fig.1 Block diagram of Intrusion Detection System

IV. RESULTS



Fig.2 Arduino connected to Infrared motion sensor and Light sensor

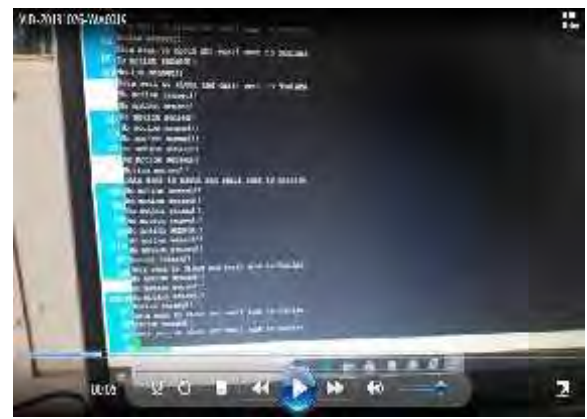


Fig.3 Motion detection

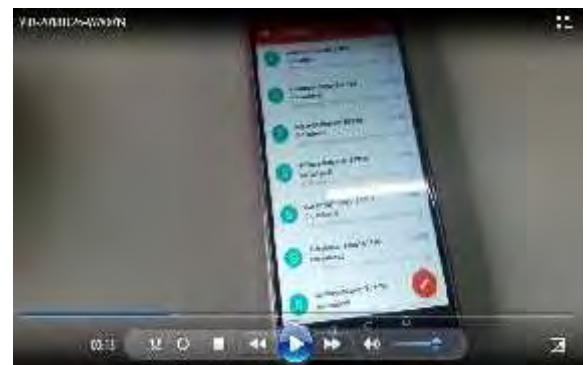


Fig.4 Email receive to the user

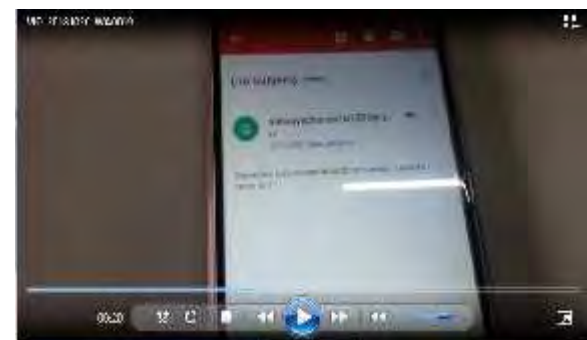


Fig.6 Light turn off



Fig.7 Light Glow

V. CONCLUSION AND FUTURE SCOPE

This system is replacing different types of traditional locks or locking systems by applying automatic door locking. By implementing this system robbery gets decreases and people will survive freely and live without any fear about their property. The Internet of Things provides better security to the citizens [8]. This proposed system has more features will be added for the future scope for enhancing better security.

In this paper, we only lock the intruder inside the room but, in upcoming days we will implement the system which is an auto-triggered report about the robbery and theft into the nearest police station along with the address [10]. This improves our proposed system more secure and better and it easily handles the robbery.

REFERENCES

1. R.Ramani, V.Valarmathy, S. Selvaraju, P. Niranjana. "Bank Locker Security System based on RFID and GSM Technology" proceedings of International Journal of Computer Applications.
2. E. Isa and N. Sklavos. "Smart Home Automation: GSM Security System Design & Implementation" Proceedings of JOURNAL OF Engineering Science and Technology Review.
3. P. Nalini, I. Abinaya, R. Dharini, P. HelanSathya. "Bank Locker And Jewellery Shop Security System by Using Stimulated Radar System" Proceedings of International Journal of Scientific Research in Computer Science, Engineering and Information Technology.
4. R. Manjunatha1, Dr. R. Nagaraja. "Home Security System and Door Access Control Based on Face Recognition" Proceedings of International Research Journal of Engineering and Technology (JET).
5. Abhishek Chorage1, Devashree Joshi2, Aishwarya Bhatode3, Mayuresh Devanpalli4, M.K. Kodmelwar5. "Providing Security and Internal Intrusion Detection to a system Using Forensic Techniques and Data Mining (IIDPS)" Proceedings of International Journal of Innovative Research in Electrical, Electronics, Instrumentation, and Control Engineering.
6. Priya B. Patel, Viraj M. Choksi, Swapna Jadhav, M.B. Potdar, Ph.D. "Smart Motion Detection System using Raspberry Pi" Proceedings of International Journal of Applied Information Systems.
7. Pradnya R. Nehete, J. P. Chaudhari, S. R. Pachpande, K. P. Rane. "Literature Survey on Door Lock Security Systems" Proceedings of International Journal of Computer Applications.
8. Ammar Almomani, Mohammad Alauthman, Firas Albalas, O.Dorgham, Atef Obeidat. "An Online Intrusion Detection System to Cloud Computing Based on Neucube Algorithms" Proceedings of International Journal of Cloud Applications and Computing.
9. Parth Parab, Manas Kulkarni, Dr. Vinayak Shinde. "Smart Locker Management System Using IoT" Proceedings of 2018 5th International Conference on "Computing for Sustainable Global Development".
10. Jayant Dabhade, Amish Javare, Tushar Ghayal, Ankur Shelar, Ankita Gupta. "Smart Door Lock System: Improving Home Security using Bluetooth Technology" Proceed of International Journal of Computer Application

Indoor GPS Technology

Dr S C Patil
Associate professor Etrx Department
TCET Kandivali
Mumbai, India
scpatil66@gmail.com

Mr Sunil khatri
Assistant professor Etrx Department
TCET Kandivali
Mumbai, India
sunilkhatri1919@gmail.com

Mr Sumit Kumar
Assistant professor Etrx Department
TCET Kandivali
Mumbai, India
ys.sumitkumar@gmail.com

Abstract—It is notable that GPS, when utilized outside, meets all the area prerequisites for E911 just as business area-based administrations. The issue, till now, has been making GPS work inside. This paper tends to the specialized issues going up against indoor GPS, and shows, in clear and basic terms, how GPS innovation can, and has been brought inside. We start with a hypothetical review of the innovation, and afterward show how the hypothesis has been diminished to rehearse in a solitary baseband chip that performs enormously parallel connections to recognize the GPS motion at power levels 30dB (one thousand times) beneath those found outside. The paper likewise addresses the job of the remote administrator in giving supporting data to the GPS beneficiary, the industry models that have risen, and the issues looked by anybody assessing this new innovation. At long last, the paper exhibits certifiable outcomes demonstrating the execution of Global Locater's Indoor GPS equipment usage

Keywords—GPS Innovation, baseband chip, Global Locator indoor, innovation, business area-based administrations.

I. INTRODUCTION

This paper presents a new approach to high sensitivity, wireless-aided, GPS. The new design implements the correlation and integration functions entirely in hardware, with a real-time convolution processor; an on-chip integrator; and a full-range loop that obsoletes the traditional separation of acquisition and tracking. We also introduce a worldwide network of tracking stations that provide the aiding data used by the GPS hardware, and a server that performs the position computation function.

The benefits of the new approach are:

- High sensitivity, even in environments with significant signal fading (i.e. indoors).
- No precision frequency reference required.
- No need for GPS time synchronization from the wireless network.
- Ultra-low CPU requirements – with no DSP and no dedicated CPU.
- Autonomous or wireless-aided operation.

II. THEORY

Traditionally GPS receivers have been designed with separate acquisition and tracking modes [1-3]. To compute a position, the device must first acquire the

satellite signals, and to do this it must search over all possible frequency and code-delay bins. Why is this? Let's look at frequency first, and then code delay.

The satellite transmits at a known frequency of 1575.42 MHz, to which the satellite motion adds 4.2 kHz of Doppler shift. The speed of the GPS receiver adds 2.3 Hz/mph, and the uncertainty in the GPS receiver's local frequency reference adds an error of 1.575 kHz for each 1ppm of oscillator error. Thus, there is a frequency uncertainty of greater than 4.2 kHz on the observed GPS signal.

The GPS receiver detects the signal by correlating. That is, multiplying the received signal with a locally generated replica of the code used in the satellite, and then integrating (or low-pass filtering) the product to obtain a peak correlation signal. The peak of this signal vanishes when the locally generated code-delay is wrong, or when the frequency is wrong. Thus, to acquire the signal, a GPS receiver must search the entire space of possible frequency offsets and code delays, illustrated in Fig 2. The search is conducted over ranges of frequency and code-delay, which we call bins.

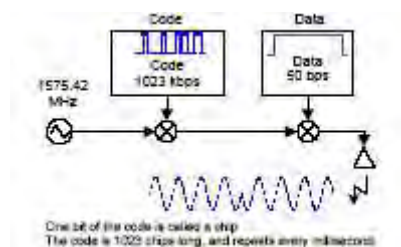


Fig.1 GPS signal at the satellite

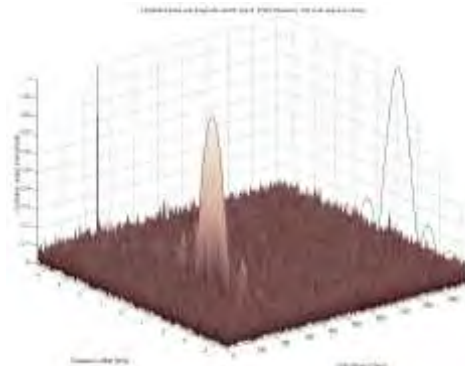


Fig.2 Freq/Delay space and correlation peak

Classical GPS receivers have two to four correlators dedicated to each satellite. To detect the signal these correlators must be used with a locally generated code delay within one chip of the (unknown) correct delay.

This implies a sequential search over 1023 possible chips, at each different frequency bin. Typically, there are 40 frequency bins required to span the frequency uncertainty. So, the total search space is 40·1023 freq/delay bins. Once the signal has been acquired, the receiver switches to tracking mode. But if it loses lock then acquisition must be repeated.

Acquisition is a slow process. Typically, GPS receivers have been designed to dwell for at least one millisecond in each freq/delay bin, taking 40 seconds in all to search the entire freq/delay space. This led to the fundamental idea of aiding, or Assisted-GPS (A-GPS), proposed in 1981 [4]. The idea is to provide the receiver with information, such as the satellite ephemeris, from which the receiver can estimate the satellite Doppler ahead of time, thereby dramatically reducing the required freq/delay space that must be searched.

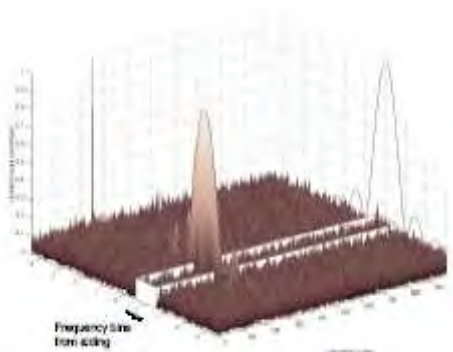


Fig.3 Freq/Delay search space with aiding

Fig. 3 illustrates the reduced search space that results from aiding. The range of possible frequencies can be reduced by a factor of ten thus reducing the acquisition time by ten – a significant improvement! Alternatively, with the right receiver architecture, instead of speeding acquisition, one could make use of the aiding to increase the dwell time in each bin, thereby increasing the sensitivity.

Unfortunately, this does not increase sensitivity enough to allow indoor operation. Here's why [5]: if the search space is reduced by a factor of 10, then the dwell time in each bin could be increased from 1 to 10 milliseconds, without changing the original total search time. Each extra millisecond of data can be integrated (summed) with the previous results, yielding SNR (signal to noise ratio) gains that approach N for each extra N milliseconds. Thus, the aiding could produce a sensitivity gain that approaches 10 ($\log_{10} 20 = 10\text{dB}$). Unfortunately, GPS signal levels indoors are 20 to 30dB down from the signal levels outdoors, and so aiding alone is not enough to make a receiver work indoors.

High-sensitivity receivers work by performing far more correlations and integrations than a standard receiver in the same amount of time. With enough correlators, all possible delays (i.e. an entire convolution) can be calculated at the same time, and hundreds of milliseconds of convolutions can be integrated to give the required sensitivity for indoor operation.

There are two existing methods of implementing an entire convolution, a DSP approach and a hardware processing approach. The DSP approach is a store-and-process technique that performs the convolution in the frequency (transform) domain. Because it is a non-Real-time process, it cannot be used as part of a feedback loop, and so the DSP method relies on a-priori knowledge of the local oscillator frequency. A hardware approach that matches the sensitivity of the DSP technique requires in excess of 8000 correlators [6] until recently this was not feasible because the required chip would be too large (and expensive). Now, with 0.18-micron technology, Global Locate is producing a chip that has in excess of 16000 correlators. The packaged chip is 8mm x 8mm. Details of this chip are discussed in Section 4.

Indoor GPS Technology Worldwide network implementation

III. WORLDWIDE NETWORK IMPLEMENTATION

The GPS satellites transmit data that can be decoded by any receiver that has a clear line of sight to the satellite. There are, currently, 28 satellites in the GPS constellation. Thus, one only has to "see" all 28 satellites simultaneously

The most efficient and cost-effective way of doing this is with a worldwide network of GPS reference stations that feed data to a server. Such a network, once constructed, can support any number of A-GPS devices, anywhere.

Global Locate has designed and implemented this network. The network provides the aiding information required for A-GPS and, if necessary, the server can process the GPS measurements made at the phone. The network and server are novel in three ways:

1. The network is fully redundant, with stations placed round the world such that each GPS satellite can be seen at all times by at least two different stations.
2. The server includes a worldwide terrain model that gives the altitude of the surface of the earth, relative to the GPS datum. This allows the server to compute a position with fewer satellite measurements. Altitude aiding for A-GPS has been done using the altitude of nearby cell-towers but this leads to position errors when the phone's altitude differs from the cell towers by an unknown amount. Thus, the worldwide terrain model improves accuracy, particularly in hilly terrain. The model comprises approximately one billion discrete grid points, with altitude known to 18-meter accuracy.
3. The server can compute position from GPS pseudo range measurements, from any device (by any manufacturer), *without* accurate GPS time tags. This means it can be deployed on networks such as GSM, W-CDMA, and US-TDMA, which are not synchronized to GPS time. The Global Locate server has been implemented according to location services standards being developed by different standards bodies, such as 3GPP for GSM/UMTS, TR45 for US TDMA and 3GPP2 for CDMA/CDMA2000.

Fig. 4 shows how the Global Locate server fits into the proposed architecture for GSM [7]; it shows an SMLC and the corresponding logical network elements.



Fig.4. Worldwide network and 3 GPP implementation

The Global Locate server performs the A-GPS PCF (Position Computation Function) of the SMLC as well as the assistance data management. Location services standards specify two modes of position computation, MS Assisted, where the network computes the handset's position, and MS Based, where the handset computes position. The Global Locate server PCF supports both of these alternatives which computes positions. In MS based mode, GPS measurements collected at the MS are processed at the MS to yield a position fix. Satellite orbit information at the MS can be obtained from the assistance data or, in outdoors), directly from the GPS satellites. According to the standards, assistance data can be delivered using either broadcast mechanisms or point-to-point. The Global Locate server supports both formats. Broadcast assistance data is delivered using Cell Broadcast Messages via Cell Broadcast Center. The broadcast mechanism is efficient since the satellite information contained is valid for a large geographic area and therefore it is exactly the same for many users. As a rule of thumb, the elevation of a GPS satellite (vertical angle above the horizon) changes by 1 degree every 100 kilometers, so users in the same general region see the same satellites above the horizon.

Where the network infrastructure to support the standards is not yet in place, the server has been implemented using pre-standard interfaces.

Example: in a deployment in Europe the Global Locate network provides GPS assistance data to messages to deliver the data.

Timing

Precise timing is a significant implementation issue for indoor GPS. The satellite measurements need a time-tag so that the position computation function can compute the location of the satellites at the time of transmission. The satellite ranges change at a rate of up to 800m/s, so

a 1 second time-tag error would lead to an 800-meter range error, and, in turn, a position error of hundreds of meters. For this reason, time-tags of better than 10 millisecond accuracy have typically been a requirement for a position computation function¹.

Traditional GPS receivers get measurement time-tags directly from the satellites, by demodulating "time of week" bits contained in the headers of the transmitted satellite data.

Receivers indoors cannot demodulate the satellite data. Even high-sensitivity receivers, which can measure the code delay indoors, cannot demodulate the data. Thus, indoor GPS receivers must get this timing information elsewhere, and they can only get it from the cellular network if the network is synchronized to GPS time. US-CDMA networks are synchronized to GPS time. Other cellular networks are not. LMUs (Location Measurement Units) have been proposed to add GPS synchronization to networks to support A-GPS, but this implies a significant infrastructure build out. However, with the Global Locate PCF it is possible to provide a full GPS assistance service (even for indoor GPS) without deploying a single LMU.

This is because the Global Locate PCF employs a position computation algorithm that processes GPS pseudo range measurements to produce position *without* needing an accurate GPS time tag. This dramatically reduces the burden on an operator who must implement A-GPS support, since the Global Locate implementation requires no deployment of new infrastructure

IV. INDOOR GPS HARDWARE PROCESSING APPROACH

The new approach to high-sensitivity (indoor) GPS is based on real-time convolution of GPS signals over the entire range of possible code delays.

A standard GPS receiver, with an early-late pair of correlators per satellite, can observe just one possible code-delay chip at a time. This is illustrated by the shaded bar in Fig 5. As discussed earlier (see Section 2) this receiver must search to acquire the signal before it can track it.

Fig 6 illustrates the new design, which makes use of a real-time convolution processor instead of an early-late correlator. The convolution processor contains over 2000 correlators per satellite, and can compute all possible correlation delays (i.e. a complete convolution) in real time.

This design obsoletes the need for separate acquisition and tracking stages, since, no matter what the actual code-delay is, the output from the convolution processor will always contain the correlation peak. In outdoor situations this means that signal acquisition occurs almost instantaneously.

Fading signals

In indoor environments there is frequently significant signal fading. Even if a conventional GPS receiver manages to track the satellite at the low signal strength (usually by increasing the loop time constants), fading will cause frequent loss of lock and return to the

acquisition stage, where integration times are again limited by correlator resources. By contrast, the new design, which includes all possible code delays in the loop, can integrate continually, even when the signal is fading. With a large amount of integration (e.g. 1000ms) the SNR increases significantly over a receiver with 1ms of integration, enabling detection of approximately 23dB lower signal strengths. This gives us the sensitivity for indoor operation with signal strengths of -150dBm .

Signal integration in hardware

In standard GPS receivers accessing the correlators every millisecond generates significant CPU load. By including dedicated hardware for long term integration (up to several seconds) the new approach minimizes CPU interaction. There is no need for a dedicated CPU, as required in a conventional GPS design. The new chip can be integrated in a phone, and share the phone's CPU. The demands on the CPU are very low. Furthermore, there are no hard-real-time constraints (interrupts are optional), and the GPS function operates without interrupting voice calls.

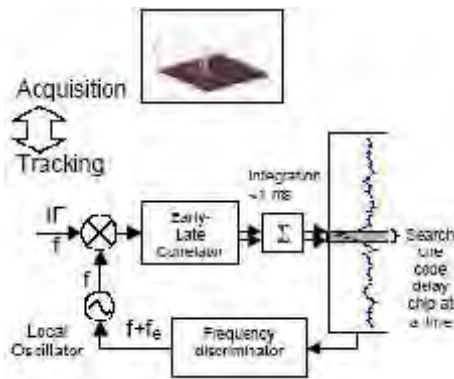


Fig 5 Standard GPS receiver

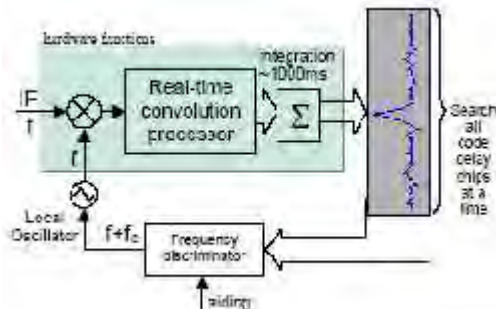


Fig 6 Indoor GPS, hardware processing approach

DSP-based high sensitivity GPS

Another approach to high-sensitivity GPS is a store-and-process DSP approach that performs the convolution in the frequency (transform) domain.

The DSP approach makes use of the fact that a time domain convolution is a simple multiply in the frequency (transform) domain, after a Fourier Transform. The technique works by first storing a block of IF data in RAM (typically one second's worth), then performing FFTs to yield the complete convolution in the time domain, which can be integrated to give high sensitivity.

We will now contrast the new hardware processing approach with this DSP approach.

No precise frequency requirement

The DSP approach is not a real time approach, and does not support frequency adjustment from the GPS signals. The DSP processing instead relies on having a very precisely known frequency reference, so that the local oscillator can be calibrated without feedback. This implementation is appropriate in certain wireless networks with very stable frequency references (e.g. US-CDMA).

The new hardware processing approach, because it is a real-time implementation, supports GPS-based frequency adjustment. The feedback loop from the convolution processor drives the local oscillator to produce the correct frequency (f) needed to demodulate the IF signal. Thus, even with error (f_e) in the local oscillator, the action of the loop causes the receiver to remain at the correct frequency. Thus, this implementation is appropriate regardless of the wireless network in which the design is implemented.

Autonomous or aided operation

The DSP approach, as described in the previous paragraph, requires wireless aiding for the frequency reference. The new hardware approach can make use of aiding, such as satellite orbit data, to compute the satellite

Doppler frequency, and thereby assist the frequency adjustment, by limiting the unknown frequency to that caused by the receiver's velocity, and the local oscillator error. However, in a situation where aiding is not available, the hardware approach can still operate, by using the frequency feedback and by demodulating the satellite data. In this mode the new design operates almost like a conventional GPS receiver, except that acquisition times are about one thousand times faster, thanks to the presence of the real time convolution processor.

V. FIELD TEST RESULTS AND SUMMARY

The Global Locate hardware design for indoor GPS has been tested in many challenging environments where conventional GPS receivers do not work



Fig 7 Reinforced concrete parking garage



Fig 8 GPS Position

Fig 8 shows a test inside a parking garage, two floors below the roof. Outside the structure is an apartment complex, blocking most open spaces in the walls. The Global Locate receiver computed positions to 20-meter accuracy, tracking and using 7 satellites. As a benchmark, standard GPS receivers tracked no satellites in the same test.

Indoor GPS Technology Field Test Results

In tests performed in the Global Locate offices we leave the receiver running for many hours, generating scatter plots that show the performance of the indoor GPS design. In this test the receiver computed positions with a mean accuracy of 21 meters. Standard GPS receivers in the same test tracked between zero and two satellites, and could not compute position. The Global Locate receiver tracked and used up to 11 satellites.

Next the antenna was placed inside a closed metal drawer, beneath two other metal drawers. Standard GPS receivers tracked no satellites in the same test; in fact, the standard receivers could not compute a position when placed on top of the desk in the picture.

In this test the Global Locate GPS receiver computed positions with a mean accuracy of 24 meters. The receiver tracked and used up to 10 satellites while inside the closed metal.



Fig 9a. inside 2-story office building

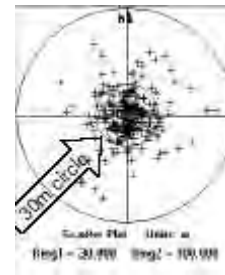


Fig 9b. GPS position.



Fig 10a. Inside a closed metal drawer 30m circle

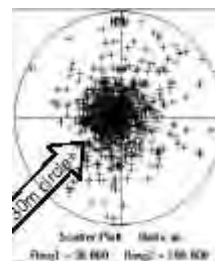


Fig 10b. GPS Position



Fig 11. Global Locate Indoor GPS chip

SUMMARY

The We have described a new approach to indoor GPS, using Assisted-GPS with aiding from a worldwide network of reference stations, and with a hardware processing approach that includes a real-time convolution processor of over 16000 dedicated correlators. The theory, comparison with other architectures, and field tests show the benefits of this design, namely:

- a. High sensitivity, even in environments with significant signal fading (i.e. indoors) See Sections 4 and 5.
- b. No precision frequency reference required. See Section 4.
- c. No need for GPS time synchronization from the wireless network. See Section 3.
- d. Ultra-low CPU requirements – with no DSP and no dedicated CPU. See Section 4.

- e. Autonomous or wireless-aided operation. See Section 4.

REFERENCES

- [1] “GPS Signals, Measurements and *Performance*”, P. Misra & P. Enge, to be published Summer 2001. Contact Navtech Seminars and GPS Supply.
- [2] “Understanding GPS, Principles and *Applications*”, E. Kaplan, Editor, 1996. Artech House Publishers.
- [3] “*Global Positioning System: Theory and Applications, Vol I*”, Parkinson, Spilker, Axelrad & Enge, Editors, 1996. American Institute of Aeronautics and Astronautics.
- [4] “Navigation System and Method”, United States Patent 4445118, Ralph Taylor and James Sennott, NASA, Filed May 22, 1981.
- [5] “Indoor GPS, Wireless Aiding and Low SNR *Detection*”, Course Notes: Navtech Seminars, Course 218, 2001.
- [6] “*An Introduction to Snap track Server-Aided GPS*”, Moeglein & Krasner Proceedings of the Institute of Navigation conference, ION-GPS1998.
- [7] GSM Technical specification 03.71

Algorithm Of Identifying And Reporting Of Potholes And Humps Using IOT

Smita Saitwadekar

PG Student

Thakur College of Engineering & Technology

smitassaitwadekar@gmail.com

Dr. Payel Saha

Professor

Thakur College of Engineering & Technology

payel.saha@thakureducation.org

Abstract- *One of the foremost vital problems in developing countries is conservation of roads. Well maintained roads contribute a big portion to the country's economy. Identification of pavement distress like potholes not only helps drivers to avoid accidents or vehicle damages conjointly helps authorities to require care of roads. Several on-going projects within the field of transport networks are operative within the direction of providing driver with relevant information regarding roads and traffic movements. Ultrasonic sensors are used for notice potholes and additionally to measure their depth. This sensed-data includes hollow depth and also geographic location. This information is keep in the server database (cloud). The projected system records the geographical location coordinates of potholes using GPS receiver. This is a valuable source of information to the government authorities and to vehicle drivers. A web application is employed to alert drivers in order that preventative measures are often taken to evade accidents.*

Index Terms – Pothole, Web application, ASP.NET, SQL database, IOT.

I. INTRODUCTION

Most Indian roads a pothole is a relatively asphalt failure caused by a mixture of water and traffic pressure. It's a structural failure during a paved surface, sometimes asphalt pavement, because of water within the underlying soil structure and traffic passing over the affected space. Several perceive that the standard of local roads could also be deteriorating due to the potholes. So there's a desire to hold out periodical review and maintenance of potholes to avoid inconvenience to road users. Initially water deteriorates the underlying soil, then because of traffic it ruptures the poorly supported asphalt surface within the affected space. Continuous traffic action ejects asphalt and also the underlying soil material to form a hole within the pavement. For the formation of potholes two factors need to be present at the identical manner, water and traffic. Potholes may result from four main causes:

1. Deficient pavement thickness to support traffic throughout freezing/thaw periods.
2. Deficient or unhealthy evacuation.
3. Failures at utility drains and castings.

4. Asphalt defects and cracks left unmaintained and uncapped thus it cause wetness and therefore loosening the structural reliability of the pavement.

When vehicle hits a pothole and the rough edges of the hollowed out concrete this can cause the damage of vehicle; major damage to tires, suspension and exhaust. Tires & Wheels: The rough edges of potholes are harmful to the tires and wheels of vehicle. Hard angles can cause sidewall bulges, tread separation and flat tires. These same angles can also cause cracks and dents in vehicle's wheels. A damaged wheel can obstruct the seals of the tires leading to flats and expensive repairs.

Suspension: Vehicle's suspension is meant to absorb jarring impacts to create a smooth ride. However, consistently driving over potholes can lead to misalignment, ball joint damage and damage to the shocks and struts.

Exhaust: Deep potholes that cause vehicle to bottom out may result in exhaust damage. If deep enough, the edges of the pothole may scrape muffler or catalytic converter. This can lead to loss of power or fumes leaking back into car if exhaust system has a hole.



Fig.1. Condition of roads with potholes.

One of the increasing problems the roads are facing is worsened road conditions. Because of many reasons like rains, oil spills, road accidents or inevitable wear and tear make the road difficult to drive upon. Unexpected hurdles on road may cause more accidents. Also because of the bad road conditions, fuel consumption of the vehicle increases; causing wastage of precious fuel. Because of these reasons it is very important to get the information of such bad road conditions, Collect this information

which in turn can warn the driver and make complaint of it. But there are various challenges involved in this. First of all there are various methods to get the information about the road conditions. And then information must be conveyed in the manner which can be understood and used by driver. This project tries to design and build such a system. In this system the access point collects the information about the potholes in the vicinity of a wireless access point and registered this information as complaint.

II. RELATED WORK

The proposed system by Smita Saitwadekar is created for spotting potholes and humps on roads suggests a cost effective solution and also warning drivers about pothole's existence. The Arduino Uno is used as microcontroller and the information about potholes is stored in the database. The execution of pothole location framework on Texas Instruments C6678 Digital Signal Processor (DSP) is portrayed by Chee Kin Chan. The framework works on several maps as info followed by surface fitting and Connected component Labeling (CCL) for pothole location. Memory management has also been connected for prime goals input pictures likewise as compiler enhancement for proficient code pipelining. The calculation authorized for the TMS320C6678 SoC Digital Signal Processor (DSP) is implemented by Aliaksei Mikhaliuk. Potholes might be distinguished by looking at the disparity estimations of the section to it of the imbalance of the cleared surface whenever recognized. A setup made to detect potholes based on a vision method by Sachin Bharadwaj Sundra with an explicit camera is mounted over the vehicle and the pictures will be procured. At that point, a project arrangement is planned utilizing MATLAB. Utilizing this methodology, potholes can be identified just if there should be an occurrence of uniform lighting conditions. These solutions do not provide any aid to the driver to avoid accidents. Byeong-ho Kang build up a pothole location framework and strategy utilizing 2D LiDAR and Camera. The blend of heterogeneous sensor framework is utilized to enhance the pothole identification exactness. The pothole location calculation incorporates clutter decrease pre-preparing, bunching, line section extraction, and slope of pothole information work. Vigneshwar K is executed picture pre-preparing dependent on contrast of Gaussian-Filtering and grouping based picture division techniques for better outcomes. From the outcomes the K-implies grouping based division was favored for its quickest figuring time and edge location based division is favored for its particular ID. The IoT based Pothole Detection System, utilizes 2 ultrasonic Sensors for identifying those potholes by Pathan Amir Khan Ayyub Khan all the more precisely then previously and GPS is utilized for plotting the area of potholes on World Maps, it will give a caution to the driver about potholes utilizing signal and gazing (or handle) vibrator. Ultrasonic sensors are

utilized by Rajeshwari Madli here to recognize potholes and protuberances and furthermore to gauge their profundity and stature separately. The framework catches the geological area directions of potholes and mounds utilizing GPS collector. The detected information incorporates pothole profundity, tallness of protuberance and furthermore geographic area, this data is put away in the database (cloud). This fills in as an entirely profitable wellspring of data to the Government experts and to vehicle drivers. An android application is utilized to caution drivers.

III. ARCHITECTURE AND IMPLEMENTATION

The architecture of the proposed system is shown in figure 2. It consists of 3 parts; microcontroller module, server module and the application module. Microcontroller module is used to gather information about potholes and their geographical locations and this information is sent to the server. Server module receives data from the microcontroller module, processes and stores in the database. Application module uses data stored in the server database and provides timely alerts to the driver.

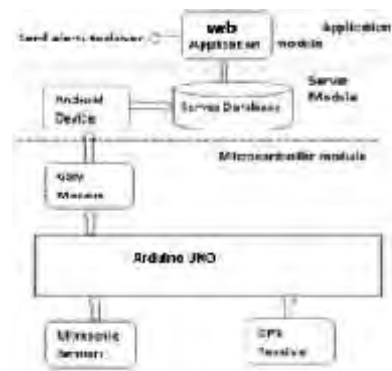


Fig.2. Architecture of the system

A. Microcontroller module:

This module consists of four elements, namely, Arduino UNO, ultrasonic sensors, GPS receiver and GSM modem. Ultrasonic sensor is used to measure the gap between the automotive body and also the paved surface and this information is received by the arduino. The gap between automotive body and also the ground, on a swish paved surface, is that the threshold distance. Threshold value depends on the ground clearance of vehicles and may be designed consequently. If the gap measured by ultrasonic device is larger than the edge, it's a pothole, if it's smaller, it's a hump otherwise it's a swish road. The GPS receiver captures the situation coordinates of the detected pothole or the hump and sends messages to the registered mobile SIM victimization GSM electronic equipment. This registered mobile SIM is available on the android device that acts as server. The messages sent embrace data regarding depth of the

pothole or height of the hump and its location coordinates.

B. Server module:

This module consists of two parts; the android device and the information. It acts as an intermediate layer between the microcontroller module and the application. The server module is enforced as an android application that runs on a device and is liable for reading messages sent by the registered mobile SIM present within the microcontroller module. It processes the contents of this message and stores it within the information (cloud).

C. Web application module:

This module is enforced as an android application that's installed on the vehicle driver's mobile phone to provide timely alerts concerning the presence of potholes. The appliance incessantly runs in the phone background. It initial captures this geographic location of the vehicle and so accesses the locations of potholes keep within the server information.

IV. EXPERIMENTAL STRUCTURE

Ultrasonic sensor is used to measure the gap between the vehicle and the paved surface and this information is received by the arduino. The GPS receiver captures the situation coordinates of the detected pothole and sends messages to the server via SIM using GSM electronic equipment. The hardware device will collect latitude and longitude data and uploads this data into the cloud using SQL database. The user then logs in the web application as shown in the fig 4 and fig 5. The user can then analyzed the recorded data in the same application in the structural form as shown in the table I. This structural table showcase information like latitude, longitude, type of pothole, pothole size, date and time of complaint registration. flow chart of system is shown in fig.3

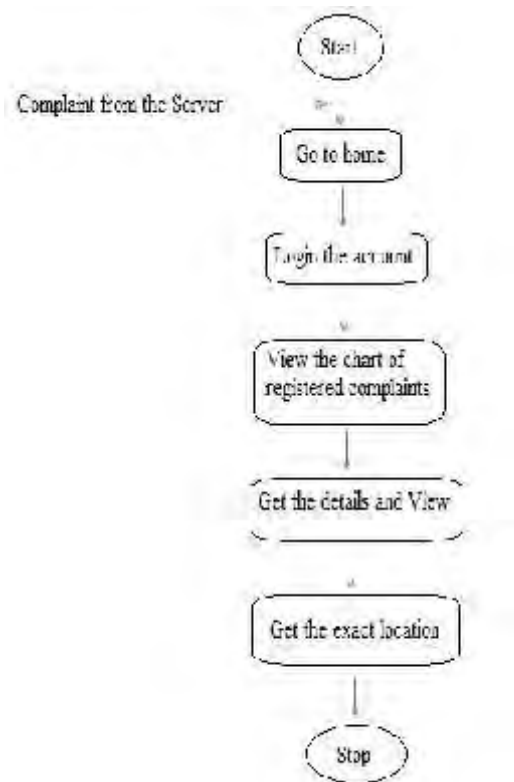


Fig.3 Flow Chart

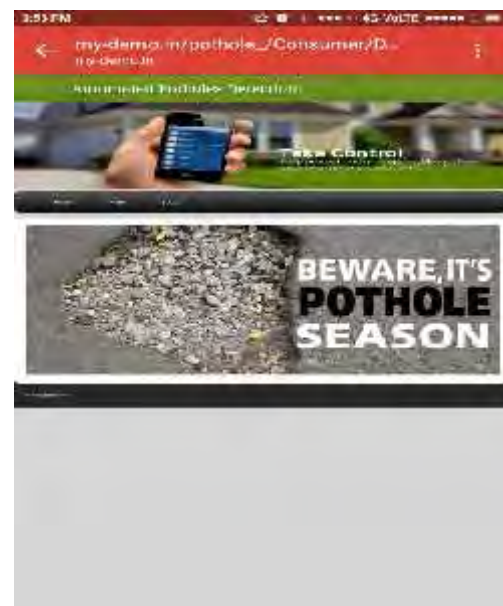


Fig. 4.Homepage



Fig 5 login and password

TABLE I.
INFORMATION ABOUT POTHOLES AND
HUMPS COLLECTED IN SIMULATED TEST
ENVIRONMENT

All Complaints						
ID	Latitude	Longitude	Type	Pothole	Date	
1	19.5	72.5	P	41	10/10/2018 09:07 AM	View
2	19.5	72.5	P	41	10/10/2018 09:07 AM	View
3	19.521	72.512	P	41	10/10/2018 09:07 AM	View
4	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
5	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
6	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
7	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
8	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
9	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
10	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
11	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
12	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
13	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
14	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
15	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
16	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
17	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
18	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
19	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View
20	19.5208	72.5206	P	41	10/10/2018 09:07 AM	View

Above table shows all the details about pothole including its location. In the above table, obstacle type 'P' indicates a pothole. This complaints are going to registered with their dates and location and also can view the location.

From this registered data user can view any complaint to get the location of the pothole which is shown in fig 6 and 7.



Fig. 6.Value of Latitude and Longitude



Fig.7 Geographical location of potholes

The programming is done in the ASP.NET server. This is an open-source server-side web application framework designed for web development to produce dynamic web pages. It allows to use a full featured programming language such as C# to build web applications easily. Body style of entire document is done in the HTML with CSS and JavaScript. With the help of this background color, font size, font color has been decided. SQL is used as a database to store the information in the structural form.

V. EXPERIMENTAL RESULTS

The working model of the proposed system was tested in a simulated environment with potholes. Tests were carried out in two phases. In the first phase, information about potholes and humps was noted and stored in the server database. In second phase, alerts were generated based on pothole and hump information stored in database server. While testing in the simulated environment, the microcontroller module was fixed on a toy-car and the threshold value was configured to 10 cm. During the tests it was found that themicrocontroller module worked as expected to identify potholes and humps. Table I shows a set of potholes identified by the system in the simulated environment. Information about potholes and humps was successfully sent to

the server. The server processed the information received and stored in the database server.

VI. CONCLUSION AND FUTURE RELATED WORK

The model proposed in this paper serves two important purposes; automatic detection of potholes and humps and alerting vehicle drivers to evade potential accidents. The proposed approach is an economic and practical solution for detection of dreadful potholes and uneven humps, as it uses low cost ultrasonic sensors. The web application used in this system is an additional advantage as it provides timely alerts about potholes and humps. This application also registers pothole complaints with the date and location and also it registers one complaint only at one time. The solution also works in rainy season when potholes are filled with muddy water as alerts are generated using the data stored in the database server.

The proposed system considers the presence of potholes and humps, however, it does not consider the fact that potholes get repaired or maintained by concerned authorities periodically. This system can be further improved to consider the above fact and update server database accordingly.

ACKNOWLEDGMENT

The authors would like to thank EXTC Engineering Department of Thakur College of Engineering for their technical support and cooperation in providing information.

REFERENCES

- [1] Smita Saiwadekar, Dr. Payel Saha “Identifying and Reporting of Potholes and Humps using IOT” IRJET, Volume 6, Jan 2019
- [2]Chee Kin Chan, Yuan Gao Implementation and evaluation of a pothole detection system on ti C6678 digital signal processor 2014.
- [3]Aliaksei Mikhailiuk, Naim Dahnoun, “ Real-Time Pothole Detection on TMS320C6678 DSP” IEEE 2016
- [4]Sachin Bharadwaj, Sundra Murthy, Golla Varaprasad “Detection of potholes in autonomous vehicle”, IET Intelligent Transport Systems, Vol.8, No.6, pp.543-549, 2013
- [5]Byeong-ho Kang and Su-il Choi, “Pothole Detection System using 2D LiDAR and Camera” IEEE 2017.
- [6]Vigneshwar.K, “Detection and Counting of Pothole using Image Processing Techniques”, IEEE

International Conference on Computational Intelligence and Computing Research, 2016

[7]Pathan Amir khan Ayyub khan, “IoT Based Pothole Detection & Alert System”, International Journal for Innovative Research in Multidisciplinary Field, Volume - 4, Issue - 4, Apr – 2018

[8]Rajeshwari Madli, Santosh Hebbar, Praveenraj Pattar, G.V.Prasad, “Automatic Detection and Notification of Potholes and Humps on Roads to Aid Drivers”, IEEE Sensors Journal, 2011

[9]https://www.itead.cc/wiki/SIM808_GSM/GPRS/GPS_Module

This page is kept blank intentionally

Indoor Positioning System

Sharma Mohinish¹, Upadhyaya Shraddha², Rajmane

Aditi³, Tawadia Tejas⁴

UG student, EXTC

K.J.S.I.E.I.T,

University of Mumbai,

India1mohinish.sharma@somaiya.edu, shraddha.upadhyaya@somaiya.edu, aditi.rajmane@somaiya.edu, [tejas](mailto:tejas.tawadia@somaiya.edu)

tawadia@somaiya.edu

Kiran Rathod

AP, EXTC

K.J.S.I.E.I.T

University of Mumbai, India

kiran.rathod@somaiya.edu

Abstract—This paper describes a method for indoor localization using Android-based mobile or any communication device. Approach is based on signal propagation and received signal strength measurement which indirectly can be used to detect the location of the user. In this method we take RSSI and grid location of the tracking space and generate a fingerprinting database. Generated database is then run through machine learning algorithm to predict user location. The users Wi-Fi signal strength and MAC address is tracked using beacon and RSSI value will be calculated and it'll be used to point location of user.

Keywords—WIFI, Indoor Positioning System

I. INTRODUCTION

The easy access and availability of wireless technologies and mobile computing and internet have led to new opportunities in developing mobile applications which purpose is to make people's life easier. Nowadays, an individual will possess over one mobile device intend for various usage like communication, entertainment, office works. This paper proposes a mobile application ready to be able to estimate the position of a user inside a building by mistreatment local area network technology. The existence of mobile devices as a location pointing device using Global Positioning System (GPS) is a very common thing nowadays. The use of GPS as a tool to see the placement in fact incorporates a shortage once used inside. Therefore, the employment of indoor location-based services in an exceedingly space that leverages the use of Access point (AP) is incredibly vital.^[5]

Indoor positioning techniques mistreatment radio wave primarily based approaches for localization will use completely different wireless technologies like Bluetooth, Wi-Fi, signals of cellular towers and ZigBee. The ways mistreatment Wi-Fi are a lot of most popular as a result of Wi-Fi networks are current in most public buildings and its use don't needs an extra infrastructure and permits confirm a location of each user of mobile device.

There are loads of algorithms supported Wi-Fi trilateration approach. Trilateration is that the determination of absolute or relative locations by mensuration of distances, mistreatment pure mathematics. By the mistreatment of this technique there are 3 fastened points is required to see an inside position. The main plan is that the calculate distances between access points (AP) and mobile device to produce a vicinity of localization. This distance is often provided

by such signal mensuration techniques sort of a received signal strength (RSS), time of arrival of radio signals from transmitters (ToA) or time difference of arrival of several radio signals (TDoA). Similar approaches are supported triangulation technique and mistreatment mensuration of incoming signal angle. We are designing an easy approach to maintain indoor positioning system and implement this system at very low cost. And android application to easily generate fingerprinting database. We are using Machine Learning to make location tracking easy and accurate.

II. RELATED WORK

Our initial research to the problem statement is a problem. The problem is inaccurate location provided by GPS. GPS location is influenced by various factors, as some are mentioned below. Satellite position, takes significant time to track moving objects, to locate us we need a new form of location technology. Our Workable Solution are:

A. Fingerprinting

This solution is based on RSSI Pattern. The RSSI pattern will be recoded with available APs. Then when new device is entered the RSSI pattern will be matched with existing pattern. This method is called as Fingerprinting.

B. Angle of Arrival (AoA)

This solution uses Angle of Arrival (AoA). AoA determines the direction by measuring the Time Difference of Arrival at individual elements of the array. By deriving the Angle and determining radius by RSSI. The location can be tracked.^[1]

C. Time of Arrival (ToA)

In this method location can be directly calculated from the time of arrival as signals travel with known velocity. From multiple APs, deriving To helps the position accuracy to increase. This solution uses Time of Arrival (ToA). The distance

III. THE PROPOSED SYSTEM

The Proposed System will be based on Fingerprinting.

A. Wi-Fi fingerprinting

The fingerprinting method uses the existing Wi-Fi access points available in the surrounding and use those

access point as reference and uses parameters of known Wi-Fi networks like its signal strength, the network MAC-address and real coordinates of Wi-Fi access points in the location. The aggregator is used to collect the beacon frames of the user. Aggregator is an ESP8266 Wi-Fi integrated SoC which has custom firmware flashed in it to capture the beacon frame and extract probe request messages from the management beacon frame and will calculate the RSSI signal strength of the mobile and relay it to the central server for processing. The fingerprinting database is generated using custom designed Android application, which generates a CSV database file with all the Wi-Fi signal record at different position of the racking area

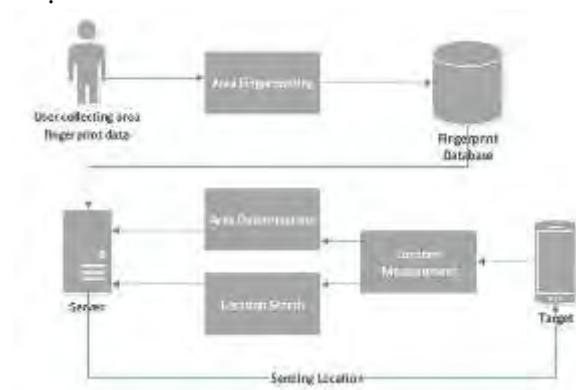


Figure 1. Flow chart showing parts of IPS^[7]

The app will generate the database for us by scanning all the available access points in the surrounding and will only record have assigned access points received signal strength of the targeted access points at different location at different instant. Multiple recording will make the training database file size more but the accuracy of the predicted result will be higher. The recorded access point's data at different location is mapped to the floor plan.



Figure 2. Fingerprint to Floor plan map^[6]

Once the mapping is done then the dataset generated by the app is transferred to the ML algorithm to train the classifier on the generated dataset.

B. K-Nearest Neighbor

The principle of this algorithmic rule is to assign membership as to perform the Euclidian distance vector from the essential K-NN algorithmic rule and memberships within the probable label. The basic matching algorithmic rule wide accustomed find the most effective classifier, really perform and non-parametric classification technique is that the K-NN algorithmic rule. In the process of online positioning step, the K-NN algorithm was used to search for K-neighbours closest between classes of training database and measure RSSI point based on Euclidean distance. Before we get into details of the K-NN we need to define the minimum distance using Euclidean distance based on Bayesian classifier^[2]

The KNN algorithm selects and combine the nearest K neighbours around a device to determine its position. Using a fastened variety (K) of fingerprints could decrease positioning accuracy; if K isn't modified throughout the positioning method, sometimes, access points far from the device might be included in the KNN algorithm. Therefore, eliminating some access points before applying the algorithm. Therefore, eliminating some access points before applying the positioning algorithmic rule seems necessary.^[1]

KNN seems to be a good candidate for classification of this sort. It is due to the fact that KNN tries to make the classification by calculating the distance between features, while the intensity of various RSSI signals depends on the physical distance between Wi-Fi source and mobile phones. In this case, closeness in feature area could be a smart indication of closeness in physical area.

C. Wi-Fi RSSI measurement collection

In presented paper signal strength levels was measured by distance of three access points allocated in the three rooms within the floor. This data is collected to points estimation for fingerprint method described above. These measurements are made in 15 points at the 1-meter interval for each access point using developed Android application. This application found three different access points by MAC addresses and measured the RSS levels 10 times for each of 15 distances for every access point. The RSS level changes at time therefore it is necessary to use its average value. The AP RSS levels are displayed in the Table I.

some more functions like auto increment, so that each time we do not enter the location coordinates manually. Result is shown in Figure 3 & 4.

Figure 5 shows the output of the Aggregator which is the collector device which is collecting the RSSI and MAC address of the device in the field.

Distance, m	AP1 RSS, dBm	AP2 RSS, dBm	AP3 RSS, dBm
1	33.3	38.8	55.3
2	45.7	43.1	50.3
3	50.9	48.9	65.7
4	51.7	55.2	61.2
5	51.8	75.1	62.5
6	53.4	75.5	66.4
7	57.8	76.4	70.5
8	62.4	80.8	72.3
9	65.7	80.8	74.7
10	62.9	76.0	78.0
11	72.9	88.6	76.07
12	72.7	88.2	86.02
13	63.9	91.0	79.03
14	74.0	91.9	85.08
15	76.7	92.1	82.05

TABLE I. THE RSSIMEASURE RESULTS FOR THREE ACCESS POINTS

Proceeded measurement points may be selected for location estimation as reference points. The reference points are the points with RSS level difference more than observational error calculated for each of 15 measurement points.

IV. ACKNOWLEDGMENT

We would also like to thank to our Principal Dr. Suresh Ukarande and head of Department Dr. Jayashree Khanapuri for her thought provoking comments, valuable suggestion constant motivation encouragement and support.

We would like to thank my project guide Prof. Kiran Rathod for his provoking comments, valuable suggestion constant motivation encouragement and support. We would also like to thank our entire faculty for contributing to our overall training.

V. RESULTS

The resulting android app created by android studio is completed. It is able to perform all the functions required for the purpose of efficient calibration/tracking of an entire room showing good results.

The app is reading the RSSI values received by a mobile phone from the APs even when not connected to them.

We asked to enter the location coordinates inside the room and to add it. The system saves the coordinates and reads RSSI values from all nearby APs and shows them for respective APs on a single-click.

Further by clicking on create database, it creates one and keep on adding more data to it. The app also has

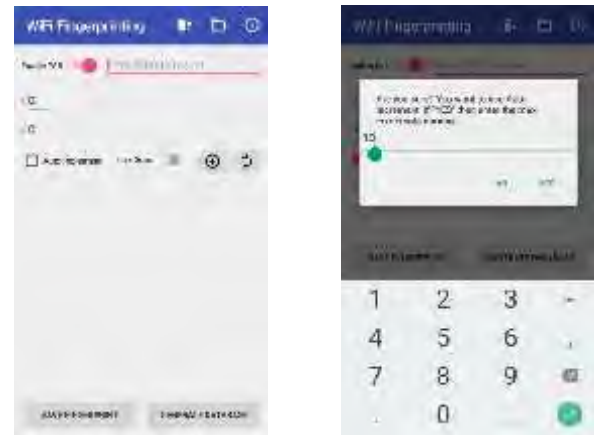


Figure 3a. Screenshots form Android Application



Figure 3b. Screenshots form Android Application



Figure 4. Software of System



Figure 5. Serial output form Aggregator

VI. CONCLUSION

The fingerprinting app is working as required. There are some factors which may cause a decrease in accuracy of the results. We need to consider all such factors, we need to improve the system more in order to increase the accuracy of tracking in order to achieve desired result.

The instability of RSS in indoor environments is the major challenge for RSS-based WLAN positioning systems.^[3] The first reason is the structure of the indoor environment and the presence of different obstacles, such as walls, doors and metal furniture etc. Also the RSS value varies over time, even taken at the same location.

Many devices such as microwave ovens, smartphones, laptops another wireless signal transmitters. In the calibration phase, which is used for Collecting the RSS data and storing the corresponding location information in a database, these devices will likely lead to radio interference and make the wireless signal strength fluctuate.^[5]

Furthermore, normal human body can also affect the WLAN signal strength. The RSS values on the straight line between the smartphone and an access point (AP) will be influenced by the body of the person. We have overcome this by taking multiple RSSI reading to decrease the error.

VII. REFERENCES

- [1] M. Roshanaei and M. Maleki, "Dynamic-KNN: A Novel Locating Method in WLAN Based on Angle of Arrival," IEEE Symposium on Industrial Electronics and Applications, Kuala Lumpur Malaysia, October 4-6, 2009
- [2] S. Theodoridis, K. Koutroumbas, An Introduction to Pattern Recognition: A MATLAB Approach. Academic Press an imprint of Elsevier, 2010
- [3] Battiti, R.; Le, N.T.; Villani, A. Location-Aware Computing: A Neural Network Model for Determining Location in Wireless LANs; University of Trento: Trento, Italy, 2002.
- [4] Patwari, N.; Hero, A.O.; Perkins, M.; Correal, N.S.; O'Dea, R.J. Relative location estimation in wireless sensor networks. IEEE Trans. Signal Process. 2003, 51, 2137–2148

- [5] Ettlinger, A.; Retscher, G. Positioning using ambient magnetic fields in combination with Wi-Fi and RFID. In Proceedings of the International Conference on Indoor Positioning and Indoor Navigation, Alcalá de Henares, Spain, 4–7 October 2016.
- [6] <https://content.iospress.com/articles/journal-of-ambient-intelligence-and-smart.../ais371>
- [7] A Mobile Based Indoor Positioning System using Wireless Indoor Positioning System

Zero touch network: A Comprehensive Network Design Approach

Mrs. Poorva Waingankar
Thakur College of Engineering
& Technology, Mumbai, India.
pwaingankar@gmail.com

Mr. Vaibhav Gijare
Thakur College of Engineering
& Technology, Mumbai, India.
Gijarevaibhav2@gmail.com

Mr. Raman Mishra
Thakur College of Engineering
& Technology, Mumbai, India.
mishraraman94@gmail.com

Abstract - Zero touch provisioning and Service Management is imagined as a cutting edge management system that uses the standards of Network Functions Virtualization (NFV) and Software Defined Networking (SDN). It will be intended for the new, cloud-based system frameworks and works, and dependent on cloud-local standards to address zero-contact (completely automated) management and services.

The difficulties presented by the organization of new system establishments, for example, NFV and new designs, for example, 5G trigger the need to accelerate change and fundamentally changes the manner in which systems and administrations are overseen and coordinated.

These new system models accompany an outrageous scope of necessities, including gigantic limit (saw as unbounded practically speaking), imperceptible latency, ultra-high reliability, customized administrations with sensational upgrades in client experience, worldwide web-scale reach, and backing for massive machine-to-machine correspondence. Systems are being changed into programmable, software-driven, service-based and comprehensively overseen foundations, using empowering agents and catalysts, for example, NFV, SDN and Edge Computing.

In this paper new plans of action, including those empowered by innovation leaps forward, such as, Network Slicing, are being presented and discussed in detail. This is achieved by Deploying clouds, having efficient routing alternatives and orchestration systems.

Keywords –ZTP, SDN, NFV, Network

I. INTRODUCTION

Increasing demand of automation has stressed the overall network architecture. Therefore, adding additional services to the network which is already pre-occupied by carrying various tasks such as Network Optimization and Management of the Network is not feasible. To make this process feasible and efficient for seamless networking, network engineers have come up with a solution that will automate at least daily responsibilities related to administration like processing, analysing, collecting performance data and most importantly to automatically adjust network configuration parameters. The concept of integrating network planning, configuration, and optimization were dealt at an individual level. However, integrating them

into a single Homogenous mixture of Automation is something that is practiced currently but not on a large scale. The most important objective of this concept is to cut-off the skilled labour required for network operation tasks, as well as optimization of network capacity, coverage, and service quality. Which will lead to reduction in the capital expenditure. Zero Touch Provisioning (ZTP) is based on widely explored SDN (Software Defined Networks) and NFV (Network Functions Virtualization). The holistic approach to the definition of ZTP suggests that the newly connected network devices should be fully configured automatically, in a plug-and-play sort of fashion.

II. THEORY

ZTP is an automation solution that's designed to reduce errors and save time. Rather than using command-line interfaces (CLI) to configure systems one at a time, administrators can use automation tools to roll out the operating system software, patches and packages on new servers automatically.

- A) All system tasks are robotized, requiring no administrator ventures past the instantiation of expectation.
- B) Changes connected to singular system components are completely revelatory, seller nonpartisan, and inferred by the system framework from the abnormal state organize wide goal
- C) Any system changes are consequently stopped and moved back if the system shows unintended conduct
- D) The framework does not permit tasks which abuse arrange approaches.

1. Traditional network provisioning

System gadgets have customarily been overseen by means of the CLI. For a model, switches are customarily combined with pre-stacked exclusive system working frameworks. System professionals use CLI or the producers claim devices to arrangement the gadget, a procedure that can be

separated into the accompanying fundamental advances.

1) The new switch as of now has a pre-introduced OS to help bootstrap the gadget. At the point when originally expelled from the case, the gadget is kept disconnected while the director checks the working framework form and makes any updates - patches, bug fixes, or any new element refreshes as essential.

2) An underlying arrangement is made to build up fundamental organize availability. This incorporates parameters, for example, director and client confirmation data, the board IP address and default portal, essential system administrations (DHCP, NTP, and so on). The procedures of empowering the picked L2 and L3 arrange conventions are additionally instances of the bootstrap procedure. When the underlying OS and arrangement has been confirmed, the gadget can be introduced into nature (racked and cabled), where further redone setup can be made (either locally by means of the comfort or utilizing a remote access convention). These last arrangements are explicit to the application and area inside the system.

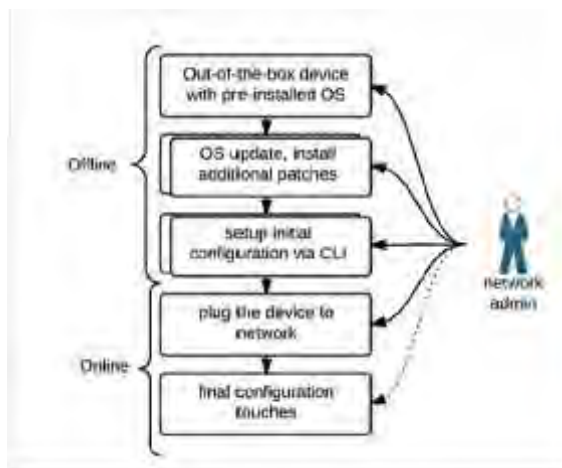


Fig.1 Procedure stream of the customary new system gadget provisioning

2. The ZTP Approach

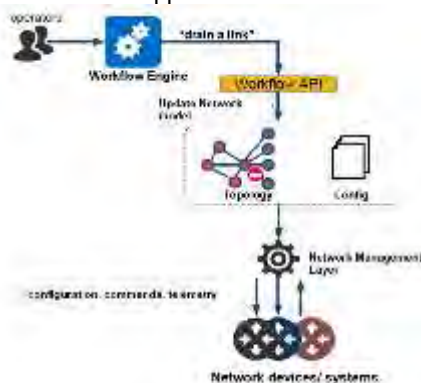


Fig2. New Approach

1) Workflow Engine

- The work process motor executes an objective looking for work process diagram
- Workflows are communicated in a meta-language
- All fascinating measurements of execution logged
- Workflows have a similar test inclusion as any product framework

2) Network intent

- The work process motor interfaces with the aim based system the board foundation over value-based APIs
- Workflow intents are expressed at the network-level, as changes to

- o Topology
- o Config
- o Functional calls

3) Network Models

- OpenConfig (www.openconfig.net) for seller nonpartisan setup show
 - o YANG for information demonstrating, gRPC as transport
 - o Both arrangement and operation state models
 - o BGP, MPLS, ISIS, L2, Optical-transport, ACL, approach
- "Brought together Network Model" for topology
 - o Protocol Buffer based Google inner blueprint
 - o Describes all layer-0/1/2/3 reflections

4) Network Management Services

- Compose full config (merchant nonpartisan furthermore, merchant explicit) from topology/config aim refresh
- Provides secure transport of full config to arrange components (OpenConfig+gRPC)
- Enforce Operational Policies
 - o Rate constraining
 - o Blast span control
 - o Minimum survivable topology

5) Streaming Telemetry

- Arrange state changes seen by dissecting complete time-arrangement information stream
- Common outline for operational state information in OpenConfig
- stream information persistently - with steady updates
- Efficient, secure transport convention, gRPC

6) Workflow Safety

- Ability to consequently check the security of tasks
- Ability to over and again approve the arrange state against the expressed aim
- Ability to perceive "awful" organize conduct
- Ability to move back to the first state

III. ZERO TOUCH NETWORK AS A SERVICE

The rising utilization of cloud administrations and system virtualization greatly affects the future improvement of the NREN (National research and education network) systems and administrations they give. With the extending use of data transfer capacity ravenous, low inactivity cloud based applications, the customers' key requests relentlessly turn

Towards on-request, guaranteed, cloud-driven system administrations.

So as to answer this developing need, NRENs need to take a stab at changes towards virtual system the board that will empower light-footed conveyance of new, dynamic, on-request administrations with fast new administration and innovation operationalization that will have execution and security ensures.

Since the cloud specialist co-ops can possibly be gotten to from inside an alternate NREN than the one where the customer dwells, the topic of organized conveyance of mechanized availability as an administration over numerous system areas and various interior multi-innovation systems emerges.

The zero touch worldview in this utilization case situation converts into empowering the customer with availability on demand administration: self-picked kind of network and higher level administrations, joined by administration flexibility and conceivable change of administration qualities amid the network lifetime. In this manner, a definitive test for the zero touch approach in GEANT is the execution of an administration/organize arrangement that permits administration congruity with no administration sway amid administration creation/change/evacuation computerizing the system designers' setup changes. In this situation, see Fig. 4, the NRENs' end-clients request a consistent affair for all availability towards conceivably different cloud specialist co-ops (CSPs), including those inside the NREN reach and those that

can be come to over GEANT. The administration ought to be setup in merely minutes, what's more, a constant conveyance status and execution checking ought to be accessible to the customer. The SLAs gave to the customer should be observed proactively all together for the customer to probably check that there are predictable execution ensures over every single included area.

The NREN (or GEANT) going about as a network supplier needs to uncover on-request self-administration requesting for all accessible CSPs with a completely organized activities arrangement and reconciliation between inward accomplices and the CSPs end focuses. So as to give programmed administration requesting, plan, testing and initiation of system benefits, this situation requires an execution of API mix together with a consistent combination between the higher layer administration passageways and the (conceivably SDN based) controllers and the system work virtualization (NFV) based organization. The programmable NFV framework is a should so as to give quick instantiation of new administrations. Additionally, the arrangement needs to give protection to the quality of administration and fulfilment of the prerequisites in the concurred SLAs for the start to finish arrange availability. On the other hand, this requires secure APIs for cross-area trade of execution data, together with administration confirmation applications, just as, administration respectability checks. One conceivable bearing towards the improvement of the answer for this utilization case can be drawn from the Zero-time

Orchestration, Operations and Management (ZOOM) venture pushed by TMF and different organizations that points to give zero touch organize as an administration arrangement. This venture is incredibly upheld by the MEF people group .

IV. CONCLUSION

Conveying new administrations to clients quicker is the way to increasing upper hand. With the completely robotized server virtualization in the cloud world, it's turned out to be basic to computerize the system forms by utilizing examined here Zero Touch organize provisioning idea and extend it to computerized provisioning of the entire cloud based applications foundation.

Be that as it may, usage of zero touch approach and situations ordinary for R&E people group will require extra innovative work of a typical stage and a number of segments to make this working in heterogeneous multi-supplier and multi-merchant condition that can be effectively adjusted to the particular condition of each NREN and coordinate with the current gear.

REFERENCES

- [1] Juniper Networks, “Understanding Zero Touch Provisioning,” in *Juniper TechLibrary*, Oct. 2014
- [2] “Zero Touch Network-as-a-Service: Agile, Assured and Orchestrated with NFV”, TMForum, July. 2015<https://www.tmforum.org/events/zero-touch-network-as-a-servicenaas-agile-assured-and-orchestrated-with-nfv/>
- [3] Zero-time Orchestration, Operations and Management (ZOOM), TeleManagement Forum, 2015 [online]
<https://www.tmforum.org/wpcontent/uploads/2014/10/ZoomDownload.pdf>
- [4] Andromeda: Google’s cloud networking stack.

Author Index IC – TELCON 2019

A

Aachala Singhan	151 - 154
Aasman Patel	79 - 84
Abhishek Singh	113 - 116
Aboli Sawant	165 - 170
Adarsha K	97 - 100
Aditi Jain	101 - 106
Aditi Rajmane	203 - 206
Akanksha Rai	113 - 116
Akshay Prabhu	1 - 6
Amar Palwankar	187 - 190
Anamika Pandey	79 - 84
Anand Shukla	17 - 18
Anil Nandgaonkar	23 - 28
Anirudh Pednekar	101 - 106
Ankita Jha	101 - 106

B

B K Mishra	7 - 12
Bhumika Sharma	79 - 84

C

Chandrashekhar Beral	47 - 50
Chandrashekhar Beral	51 - 56
Chetana Kabre	155 - 160
Chinmay Kargutkar	51 - 56

D

Deepak Kumar Sinha	29 - 34
Deepak Singh	135 - 140
Deviprasad Pandey	85 - 90
Divya Pawar	123 - 126
Dr. Uday Pandit	35 - 40

H

Hari Khatavkar	161 - 164
Hemant Kasturiwale	73 - 78

I

Imran Tamboli	141 - 144
---------------	-----------

J

Jalpaben Pandya	57 - 60
Jaya Gaitonde	127 - 134
Jayasudha Koti	7 - 12
Jinit Thakkar	151 - 154

K

Karunesh Loke	141 - 144
Khushboo Maurya	145 - 150
Kiran Rathod	19 - 22
Kiran Rathod	203 - 206
Kusum Mishra	85 - 90

L

Leena Chakraborty	57 - 60
-------------------	---------

M

Mahesh Munde	23 - 28
Manasi Jadhav	187 - 190
Manoj Chavan	85 - 90
Mayank Mishra	13 - 16
Meet Gopani	51 - 56
Mohinish Sharma	203 - 206
Ms. Megha Gupta	13 - 16

N

Narpinder Singh Pannu	123 - 126
Navneet Sharma	165 - 170
Niket Amoda	29 - 34
Nilesh Barshe Patil	183 - 186

O

Om Patel	97 - 100
----------	----------

P

Parth Shah	177 - 182
Pavan Borra	51 - 56
Pawan Sakpal	107 - 110
Payel Saha	197 - 202
Pooja Gohil	145 - 150
Pooja Shimpi	135 - 140
Poorva Waingankar	207 - 210
Prathamesh Pradeep Mhatre	183 - 186
Pratik Bole	107 - 110
Punit Deshmukh	123 - 126
Purva Ghag	187 - 190

R

Rahul Kini	161 - 164
Rahulkumar Jha	1 - 6
Rajesh Lohani	127 - 134
Ram Makwana	145 - 150
Roohi Mehta	57 - 60
Rutvi Thakar	145 - 150
Rutvi Thakar	151 - 154
Rutvi Thakar	171 - 176

S

Sandesh Sawant	19 - 22
----------------	---------

Sanjay Patil	191 - 196
Sanjeev Ghosh	41 - 46
Sanket Kasturiwala	73 - 78
Satyam Bhikadiya	13 - 16
Saurabh Amburle	123 - 126
Saurabh Suresh Mohade	183 - 186
Saurabh Suresh Sankpal	183 - 186
Sayali Shinde	97 - 100
Shalini Rai	171 - 176
Shankar Deosarkar	23 - 28
Shikha Mishra	13 - 16
Shilpa Chaman	91 - 96
Shital Mali	35 - 40
Shital Patil	61 - 66
Shraddha Upadhyaya	203 - 206
Shubham Shukla	165 - 170
Shubham Singh	17 - 18
Smit Mistry	151 - 154
Smita Saitwadekar	197 - 202
Smitha Pai B	117 - 122
Somiyani Guchait	107 - 110
Sonali Ghogale	187 - 190
Srija Unnikrishnan	41 - 46
Sujata Alegavi	67 - 72
Sumit Kumar	191 - 196
Sunil Khatri	191 - 196
Sunil Yadav	111 - 112
Sunilkumar Gupta	17 - 18
Suraj Shete	187 - 190
Surendra Bhosale	97 - 100
Surendra Bhosale	141 - 144
Surendra Bhosale	61 - 66
Suvaish Subhash Ambhore	183 - 186
Suyash Pandey	161 - 164

T

Talha Shaikh	111 - 112
Tanmay Kalal	113 - 116

Tejas Tawadia	203 - 206
---------------	-----------

V

Vaibhav Gijare	207 - 210
----------------	-----------

Vighnesh Mane	19 - 22
---------------	---------

Vijay Rasal	19 - 22
-------------	---------

Vishal Rawat	177 - 182
--------------	-----------

Vishal Sawant	177 - 182
---------------	-----------

Vishal Singh	111 - 112
--------------	-----------

Y

Yash Patel	1 - 6
------------	-------

Yash Shah	171 - 176
-----------	-----------



IC-ISCN - 2019

**International Conference on
Intelligent Systems and
Communication Networks**



IC-TELCON - 2019

**International Conference
on Trends in Electronics
& Communication**



IC-AMCE - 2019

**International Conference
on Advances In Mechanical
& Civil Engineering**



CHSTE - 2019

**Conference on Humanities,
Science and
Technical Education**



EC - 2019

**Engineering Colloquium
Post Graduate Students &
Doctoral Scholars**



EWPPC - 2019

**Engineering Workshop
& Paper Presentation
Contest**



IOTW - 2019

**Industry Oriented
Technology Workshop**



PBW - 2019

**Professional Body
Workshop**