PUNJABI UNIVERSITY PATIALA

3rd International Conference On Innovative Trends In Electronics Engineering

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Vice Chancellor's Message

The foundation stones of Punjabi University Patiala are laid on the essence of academic pursuit and excellence. Excellence in any work can be achieved with utmost dedication, hard work, and determination. We, at Punjabi University, have made this statement our motto and our way of life in every single activity in the campus.

Research and development form the backbone of our curriculum at Punjabi University Patiala. The staff and students are engaged in various path-breaking innovative research activities all throughout the year. Every department of our University organizes conferences and seminars frequently on contemporary and relevant topics in order to facilitate research in those areas which will lead to necessary metamorphosis in the academia as well.

The Department of Electronics and Communication Engineering at Punjabi University Patiala, right from its inception, has been active in research and innovation and has setup an ambient academic environment for its students and research scholars. With the commitment of highly qualified and efficient staff, the department endeavors vigorously to make a mark in the field of research and development. The 3rd International Conference on Innovative Trends in Electronics Engineering (ICITEE-2021) organized by the Department of Electronics and Communications is another venture to provide a platform for academicians – teachers, students, research scholars, and industry personnel – globally to discuss on contemporary trends and innovations in Electronics, Computer and Communications.

My sincere admiration goes to Convener of the conference Dr. Ranjit Kaur, Organizing Sectaries Dr. Sonia Goyal, Dr. Reecha Sharma and members of all committees of ICITEE-2021 whose hard work, diligence and sincerity mode the Conference and academically rewarding experience.

I wish the conference all the very best and urge all participants to brainstorm on the various thrust areas of the conference.

PROFESSOR ARVIND

Dean Academic's Message

The science and engineering research conducted in academic institutions, industry, R & D Laboratories and elsewhere plays a critical role in raising our standard of living, creating jobs, improving health and providing for national security and development. I am extremely happy to note that Department of Electronics and Communication Engineering, Punjabi University, Patiala is organizing 3rd International Conference on Innovative Trends in Electronics Engineering (ICITEE-2021).

I am sure that the conference of this type will inculcate the much needed research culture among the students and teachers, and trigger interactions among researchers to exchange the ideas of recent advances in the areas of Electronics, Computers and Communications.

I wish the conference a grand success.

Dr. B.S. SANDHU

Convener's Message

The main goal of organizing 3rd International Conference on Innovative Trends in Electronics Engineering (ICITEE-2021) was to bring academic scientists, engineers, industry researchers together to exchange and share their experiences and research results, and discuss the practical challenges encountered and the solutions adopted in all aspects of Electronics & Communication Engineering Technologies. Through this event, we intend to bridge the gap between theories developed in academia and applications used in the industries by implementing the state-of-the-art. A good opportunity has been given for those who have a thirst in knowing the present technological developments and also share their ideas. Additionally, this conference has also facilitated the participants to expose and share various novel ideas.

The objective of ICITEE-2021 was to present the latest research and results of research scholars, and post-doc scientists related to Electronics & Communication Engineering, Electrical Engineering, Computer Science & Engineering, and Information Science & Engineering. The conference has featured traditional paper presentations as well as keynote speeches by prominent speakers from U.A.E., Peru, USA and India, who have focused on related state-of-the-art technologies in the areas of the conference.

I want to express my sincere thanks to Organizing Secretaries Dr. Sonia and Dr. Reecha Sharma, to the whole conference committee for extending their valuable time in organizing the program and all the authors, reviewers, and other contributors for their sparkling efforts and their belief in the excellence of ICITEE-2021.

Dr. RANJIT KAUR

Organising Secretaries Message

This book presents the post-conference proceedings of the 3rd International Conference on Innovative Trends in Electronics Engineering (ICITEE-2021) which took place and organized by the Department of ECE, Punjabi University, Patiala, Punjab, INDIA on 14th December 2021.

Six months ago, when we started the task of organising this conference we were very electrified and enthusiastic. But down the road we faced many steeplechases and glitches like Covid-19 Pandemic. Due to lockdown in the country at that time, we hosted this conference by online mode. However, with the support of our vice chancellor, dean Academic and our colleagues we were able to sail through this journey.

In ICITEE-2021 around 50 papers have been received from various institutes. All papers have been subjected to plagiarism check and reviewed by reputed reviewers. About 125 delegates from all over the country and abroad had participated in ICITEE-2021. There were two keynote speeches and two expert talks during the inaugural function. There were four parallel tracks for presenting the papers. These tracks were: Role of computer in Internet of Things, Recent trends in Antenna & optical Communication, Advances in wireless communication, challenges and opportunities in artificial intelligence & Deep learning Systems. All the researchers presented their paper in their respective tracks according to their field of specialization. At the beginning of each session, participants were presented with background information and discussion questions. Then, following a structured process of brainstorming and information exchange, participants in the sessions reached consensus on various recommendations and discussed related barriers and solutions.

We would like to express our deepest appreciation to the authors whose technical contributions are presented in these proceedings. It is because of their excellent contributions and hard work that we have been able to prepare these proceedings.

Dr. SONIA GOYAL **Dr. REECHA SHARMA**

CONTENTS

Investigations on Genetically Engineered Bioweapons & Computer Based Techniques for Counter Measure and Mathematical Modeling for Prediction of Novel Sars-Cov-2

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Abstract— **The deaths due to spreading disease have taken more lives than actual deaths in war itself. In 1918, during World War 1 great influenza disease killed 20 million people worldwide although it was a naturally occurred disease. But genetic engineering is used to create agents for bioweapons. Bioweapons are weapons in which intentional use of toxins and micro-organisms are used to produce any disease and deaths in humans. Easily available biological agents, easy transportation from one place to another, detection less by regular security check and low production cost makes this weapon dangerous and attractive to choose. In this paper, various bioweapons system is discussed and computer-based techniques used in medical field and agriculture field to detect, counter and produce rapid and accurate detection of any disease spread by bioweapons are discussed and mathematical model (SEIR) for the prediction of infectious diseases have been described and modelled which can be used to predict the cases**

Keywords— **Geonme Pathogen, Artificial Intelligence, Machine Learning, Computer Vision, SIR, SEIR, Bioweapons**

I. INTRODUCTION

The process of human intervention of transfer of biological organisms to functional genes (DNA) is known as genetic engineering [1]. In today's world, other than natural disasters we face threats of bioweapons and bioterrorism with genetically engineered agents. The "black biology" is used to create bioweapon is one of gravest threat we face. The manipulations of genes to make new type of genes which have pathogenic characteristics (infectivity, increased survivability, virulence, drug resistance and infectivity etc.) are use as bioweapons [2]. In 1991 gulf war, production of bioweapons started and near about 20 countries engaged in proliferation of such weapons [3]. In 1970s, the genetic engineering began to develop and became global multibillion dollar industry by 1980s. The knowledge of molecular biology increased exponentially in last decade of 20th century. With these genetically engineered pathogens many offensive bioweapons can be created. In 1918 influenza also known as Spanish flu infected 500 million people (about quarter of world's population at that time) with estimated deaths of 50 million across world. It spread by cough and sneeze. The massive troop movements and close quarters during World War 1 hastened the pandemic [4-5]. In 1979, outbreak of anthrax infection happened. A military facility out-breaked anthrax spores which 105 victims and 64 people had died. In 2001, anthrax spores were mailed in letters through U.S Postal service. 18 people got sick with some sort of disease and 5 people died of inhalation anthrax. In 2014 outbreak, 7 people died and indian government quarantined 30 houses. In 2016, anthrax outbreak, 100 people were infected and 2300 reindeer died in Russia [6].

In the late 1960s, morphological constraints were found to be having similarity between certain animal viruses such as mouse hepatitis virus, swine flu, gastroenteritis virus and infectious bronchitis virus with some human strains as studied by Tyrrell along with a group of virologists working together. Crown like appearance of this new group of virus was officially named as coronavirus [7].

H1N1 is the subtype of influenza A virus which was caused in 2009 and has an association with the outbreak of Spanish flu in 1918. During flu pandemic of 2009, in the United States patients were isolated from the virus and it was found out that H1N1 virus was made from the genetic elements of four different viruses [8]. The outbreak of this pandemic started in Mexico in 2009 and then in the United States. H1N1 was declared as pandemic on 11th June 2009 by World Health Organization (WHO) and was declared as national emergency by the US President on 25th October 2009. At least 213 countries were affected by H1N1 pandemic by 21st March 2011 and 16,931 deaths were reported. The preparedness alert of H1N1 pandemic was issued by WHO in 2011 [9].

SARS virus was an animal virus identified in 2003. It was thought to be spread from bats and other animals which perhaps transferred to humans in China in 2002. 26 countries were affected by the SARS epidemic and 8000 cases were reported in 2003.

The SARS virus transmission is from person to person. The symptoms of this disease include malaria, headache, shivering, diarrhea, shortness of breath and cough. The countries which were affected by SARS epidemic in 2002-2003 were China, Canada, Singapore, Hong Kong and Viet Nam. The vaccines for SARS-CoV is still under development [10-11].

MERS stands for Middle East Respiratory Syndrome. Saudi Arabia first identified this viral respiratory disease in 2012. The typical symptoms of MERS include pneumonia, shortness of breath, cough and fever. 35 % of patients have died due to MERS virus. 2494 cases were reported by WHO since 2012 and 858 deaths have been occurred. It is a zoonotic virus meaning the transmission is between human and animals. According to studies, the transmission to the humans is through infected camels [12]. The MERS virus is not transmitted from human to human. 27 countries have been affected from MERS virus since 2012 including China, France, Bahrain, Egypt, Malaysia, Germany etc. in Saudi Arabia 80% of human cases were reported. Most of the outbreaks of MERS virus have occurred in Middle East area. The vaccines for MERS virus are not currently available and are still under development [13].

The evolution of bioweapons can be categorized in four phases. The first phase in world war 1which experienced first phase in which gaseous chemical like phosgene and chlorine was used. The World War 2 experienced second phase in which use of a cholinesterase inhibitor, nerve agents e.g tabun and plague bombs and anthrax were used. The third phase constituted in 1970 in Vietnam war, a mixture of herbicides stimulated hormonal function was used for defoliation and destruction of crops. Also a new group of "Novichok" and mid spectrum agents like bioregulators, auxins and physiologically active compounds were used. In fourth phase, genetic engineering and biotechnical evolution are used to generate gene-designed organisms and can be used for wide variety of bioweapons [14]. Gene-engineered organisms can be used to produce microorganism with enhanced environmental stability and aerosol, microscopic factor producing a venom, toxin or bioregulator, microorganism which resist to antibiotics, therapeutics and routine vaccines, microorganisms with altered immunological profile and microorganisms which can escape detection by antibody sensor system.

The biological weapon is a device with a delivery system which expedites dispersion and appropriate dissemination of the designed biological agent in such a way that it targets the object (human, crop etc.) with its effect. It can be used as to inject the virus/bacteria, spray from airplane on area of denial, or handheld spray weapon [15].

Also bioweapons can release pathogenic and harmful micro-organisms which can kill crops and destroys reserves of enemies [16]. Anticrop warfare with use of bioweapons results in malnutrition, debilitating famines, food insecurity and decimation of agriculture based economies. In Vietnam war defoliants have been widely used as anticrop warfare agents. Wheat smut caused by fungus t. foetida or tilettia caries was used as bioweapon. In 1984, deliberate contamination of salad bars with salmonella typhimrium was done in USA to incapaciting voters. In 1995, Aum shinrikyo released nerve agent (sarin) in japan in Tokyo subway [17].

II. GENETICALLY ENGINEERED PATHOGENS

A. Gene therapy as bioweapon

Gene therapy is permanent replacement in genetic composition of any person by replacing faulty gene or repairing it. The two classes of gene therapy involve somatic cell line (therapeutic) and germ cell line (reproductive). Changes in DNA of somatic cell could not be passed on next generations but only affects individual however changes in DNA of germ cell would be followed by next generations. The first genetically altered primate was produced by virus of jellyfish gene into rhesus monkey egg. [18]

B. Designer genes

A human molecular blueprint was provided by human genome project which decoded alphabets of life which has complete genome sequence and known for 205 naturally occurring plasmids, 599 viruses, one fungus, 31 bacteria, one plant and two animals. These blueprints enable a manufacturer of bioweapon to make microorganism more harmful and critically affecting. From the designer genes the microbiologist can develop synthetic virus, synthetic genes or also a new microorganism. Some of bacteria develop resistance to antiviral agents or antibiotics, identifying antibiotic resistance genes an organism can be developed which can render its resistance to antibody. Gene with beta-lactamase codes defeats action of penicillin. [19]

C. Binary Bioweapon

To use the form of pathogen, two component system containing innocuous parts are mixed. Multiple plasmids that code for virulence or any special characteristics are contained by many pathogenic bacteria. The virulence of plague, anthrax and other diseases are enhance by these plasmids and these plasmids can be transferred often across species barrier to different kinds of becteria [20, 21]. A virulent plasmid and host becteria can be produced in required quantity for bioweapons.

D. Stealth virus

A cryptic viral infection which enters human genome and remains dormant for extended time is stealth virus. The triggering of this virus is done by external stimulants later on. Through this external stimulus the virus gets activated and cause disease. Herpes virus is carried by many humans who can be activated to cause genital lesions or oral lesions. Some people who had chicken pox earlier in life carries vericella virus. Segments of DNA (Oncogenes) when triggered can initiate misbehaviour and wild cellular growth. Some genes can cause cancer [22].

A stealth virus can infect the genome of population through bioweapon and can be triggered anytime for targeted population or government can be blackmailed by threat of triggering [23].

E. Hot swapping disease

A zoonotic disease is transmissible to human by a virus in animal species. These viruses have a natural animal reservoir in which they reside and cause no damage or very little damage to that animal. However when transferred to human they cause significant disease. Examples of natural animal reservoir are water fowl for eastern equine encephalitis, birds for west line virus bat for ebola virus and corona virus and rodents for hantavirus. HIV virus which is natural reservoir for chimpanzee becomes disease in human as AIDS [24]. The bioweapon can contain these viruses taken from animals as hot swapping disease.

F. Designer disease

The Molecular biology has reached to a point where symptoms of hypothetical disease can be proposed, designed and created these pathogens are known as designer disease. These designer diseases in bioweapon can cause disease by inducing specific cells to multiply or divide rapidly, turning of immune system and programmed cell death [25]

III. COMPUTER BASED TECHNIQUES FOR COUNTER MEASURE

Is With the development of bio-robots, bio detection has been spurred. With the use of computerized artificial system robotic insects mimics certain biological processes which can help in detection of viruses. Single operation tasks like screening of blood samples, DNA processing, identification of genes, scan of presence of virus/bacteria and monitoring of genetic cell activity can be done through computerized techniques. Bio sensors using electrochemical devices or fiber optics are used for detecting microorganisms in food, military application and clinical work. For detection of candida albicans an immunosensor is used. Optical sensor is used to detect bacillus anthracis. In USA several systems has been developed to detect bioweapons. To detect biological agents that cause metabolic damage, polyvalent immunosensor has been developed. Combination of neural informational network, electronic nose and Laser eyes to detect particle densities with alarm has been developed.

A. *Computer and Artificial Intelligence based counter measure techniques*

The implementation of the computer based technology and artificial intelligence in health sector means that the patients who require care are diagnosed and treated using sensors embedded in the smartphones and computers. Since it seems like the diagnosis and treatment are quite simple steps there are so many unseen background factors to be taken care of to properly treat the patient. These unseen factors include: data collection through various modes such as calls and interviews; results are processed and analysed; accurate and proper diagnosis is done using multiple sources of the data. The treatment method to be chosen is prepared and administered. Continuous monitoring of the patient and the aftercare which includes follow-up appointments [26]. Figure 1 shows the stages in which the computer technology can be implemented in the health sector and provide a solution to combat carious diseases spread by bioweapons.

Figure 1. Solution stages for computer based technology

There are four solution stages for computer based technology which are dependent on each other. There is an interconnection between all the four stages of the architecture such that the data from the first stage is processed to the next stage. In the first step, the interconnected devices such as sensors from computer connected device collects the data. These devices include sensors, monitors, actuators, camera, detectors, etc. embedded or connected with computers. In the second step, includes the pre-processing and standardization of the data which is moved to the cloud network in third step. At the fourth and final stage, the analysis and management of data is done [27].

Using holographic telescope the intensity of light scattered off object can be captured. The researcher took 400 individual spores of 5 different species bacteria out of which one is bacillus anthracis(anthrax) and trained the neural network algorithm to detect the spores, the AI detected the spores [28].

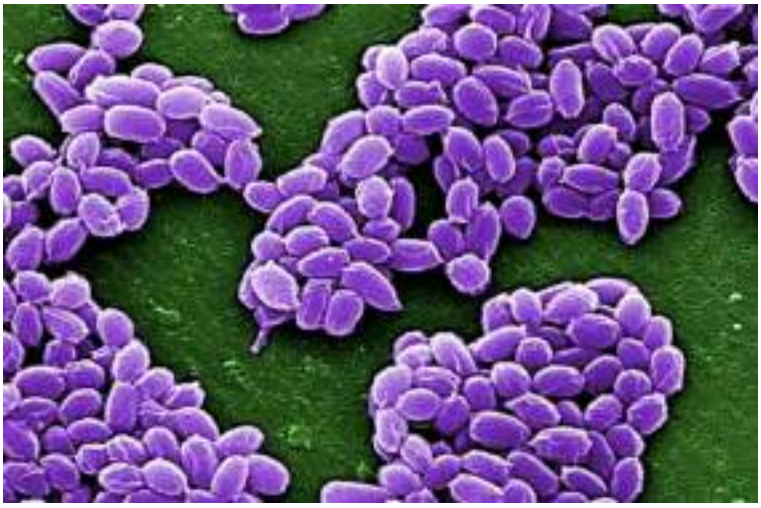

Figure 2. Anthrax spores at 12000x microscope

B. *Computer assisted surgery as counter measure*

During the spread of any virus,/bacteria during bio-war. The systems has been updated to provide computer assisted surgery. When the computer technology is used for planning and guiding the surgical intervention then it is called computer assisted surgery (CAS). The surgical process is improved through CAS by integrating the computer technology. CAS aims to increase the accuracy, reduce invasiveness and costs related to the procedures of surgery [29]. Figure 3 shows the pipeline of the computer assisted surgery.

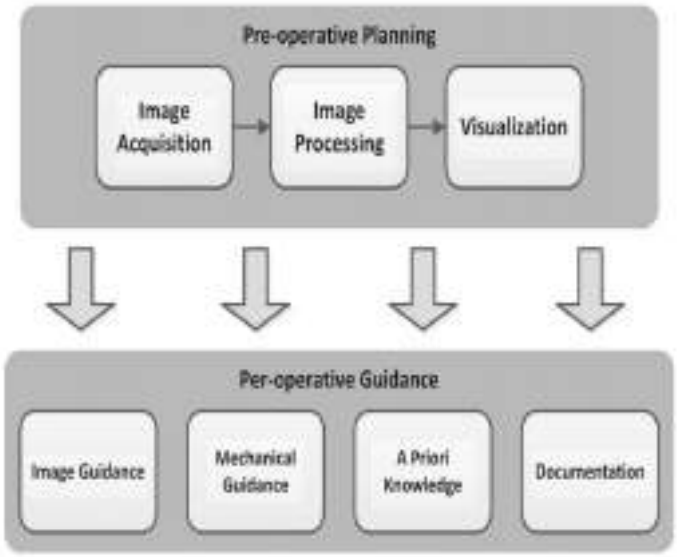

Figure 3. Pipeline of computer assisted surgery

Acquiring the data of the patient is the first step in the pipeline. This data acquisition is based on imaging such as X-rays, CT scans, MRI and any type of measurement taken from the optical tracking system. The processing of the data takes place so that the information of higher level can be extracted which is usually done through segmentation. The data is then prepared for the stage of visualization. Surgical planning is done in the visualization stage. The anatomy of the patient is studied by the surgeon. The surgical procedure is virtually performed by studying the pathology of the patient specific data acquired in the first step [30]. The surgical outcomes which are predicted are examined in some cases. All these three steps of image acquisition, image processing and visualization comes under pre-operative planning. Next is the transfer of whole surgical plan to the operating room so that it can be applied to the process of surgery. The plan is implemented in the surgical process through image guidance, mechanical guidance or with the surgeon's mental model that he had prepared in the planning stage. Image guidance and mechanical guidance are explicit in nature while the documentation is implicit guidance. In computer assisted surgery, visualization has a very significant role. It comes under the planning phase where the acquired data, predicted outcomes of the surgery and the derived measurements of the patient are displayed [31]. The efficient interaction of the surgeon with various components is also enabled through visualization. Many general tasks are facilitated in computer assisted surgery for planning and guiding the surgery. These tasks include spatially understanding the anatomy and pathology, access planning, resection planning, reconstruction planning and implant planning. The patient data visualization is explored by the surgeon which comes

under spatially understanding the patient data anatomy in the specific region. This task is very important and basic in complex anatomy [32].

The hand motions of the surgeons are facilitated with the help of computer assisted surgery. Also known as robotic surgery, it limits the operation space of the surgeons. The various advantages of the devices used in computer assisted surgery are magnified vision, improved access and stabilization in implementing the instruments. The operative dexterity is reduced significantly in the instruments of standard endoscopy whose degree of freedom is four. The reversed hand motions are required by the operator where the motion of the trocar is dependent on fulcrum. Moreover, the manipulation of operating tips in the shaft shear instrument leads to fatigue in the hand muscle as high forces are induced. Also, in endoscopic surgery there is incompatibility between the skills of human motor visual motor. All these limitations are overcome by enhancing the computer assisted or robot assisted surgery. The robotic arms are mounted with microwrist instruments which reproduces the motion in scaled proportions with the help of computer interface. The activity of the wrist is emulated to all the axis of the wrist through the instrument. In confined spaces of operation, the enhancement of dexterity is being transformed from motion scaling and tremor filtering. Figure 4 shows a console from where the surgeon operates in 3-D field of operation. It is a robot assisted tele-manipulation system with a camera and two instrument arms [33].

Figure 4. Computer assisted tele-manipulation system

C. *Big data as healthcare*

The prevention, diagnosis and treatment of human health is the main aim of any healthcare system. Health professionals, facilities and funding companies fall under the healthcare. The health professionals include doctors and nurses, healthcare facilities include clinics and hospitals whereas funding companies are those which run the healthcare facilities. The various health sectors include medicine, psychology, nursing, dentistry and so on [34]. The healthcare professionals include doctors, scientists, surgeons, dermatologists, neurologists and so on. The patients' medical history is required by the doctors at such levels which include the personal history and medical data required for the treatment of the patients. EHR (Electronic Health Records) are in practice nowadays which store all the necessary information of the patient required for treatment. Figure 5 shows big data in health care applications

Figure 5. Big data in healthcare

The transmission, reception, storage and manipulation of data are all possible with the computer aided technology. All this data is required by the healthcare sectors and departments to work efficiently [35].

There are many data care components related to healthcare which gather the patient; information which results in quality improvement and makes the service efficient by reducing the costs and errors in healthcare and medical sectors. Some healthcare related data components include Medical Practice Management (MPM) and Personal Health Record (PHR). The cost control and health improvement are the factors to be taken care of in the healthcare field which is possible through big data. Various healthcare

centers receive the data for further investigation making it confidential. A large amount of information related to diseases their treatment is possible through the computer aided technology. Vast amount of data is stored in the data warehouses from different sources through Big Data Analytics [36]. The analytic pipelines are used to process this stored data so that affordable and smarter options are obtained. Figure 6 shows analysis of big data. The healthcare sector has been digitalized with the help of big data which further enables to deal with healthcare problems and provide improvement in preventive care and discovery of new medicines in the healthcare field.

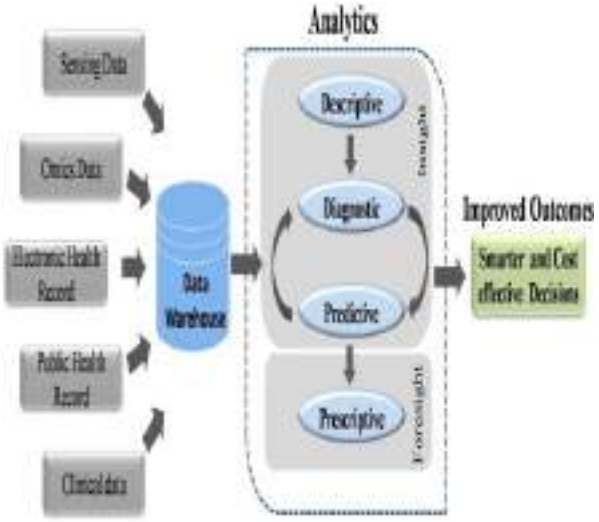

Figure 6. analysis using big data

D. *Computer assisted decision making*

Dataset With every passing day, computers have become very significant in the daily lives of broad section of people. As microcomputers were invented in late seventies and due to the enhancement in their performance in the eighties, computers have reached at a very significant role in our lives. The whole lifestyle is being revolutionalized with computers. Computer based techniques have a great social impact due to their medical field applications. Large hospitals are being run depending on computer based measures and techniques. The facilities provided by the computers have been integral in the equipments of diagnosis. In medicine field, the computers are majorly used in information system for hospitals, medical imaging, analysis of data in medicine, monitoring of the patients, computer-assisted surgery , decision making and therapy, treatment of critical patients, telemedicines, electronic health records, medical databases and research and application of computers in offices and hospital administration [37]. Computers can accept, store and access the data automatically to produce the output results. Data in very large amounts can be stored and processed in computers to provide the user with required information as well as rapid and accurate calculations are being performed. The informatics in medical is growing very rapidly. The organization and management of the information for patient care seems to be very significant. The medical informatics seek education and research in biomedical through the use of information networks and computers. If the information system of the hospital is computerized, then the data can be continuously transmitted, stored and monitored at all transactions. The valuable information regarding the patient care gets an easy access through this. All the information can be accessed by the physicians directly through the application of computer based techniques [38]. The information system in the hospital covers registration, billing, diet, pharmacy, accounts and biomedical maintenance. There are various softwares available which are customized according the needs and requirements of the hospital information system. The data is collected in large numbers in medical research. Then there is compilation, analysis and interpretation of the dara. For this, the application of various statistical methods becomes necessary which calculate the standard deviation, error, t test, Z test and chi square test. All these statstical methods consume a huge amount of time. But with the aid og computer based techniques all these calculations can be done in a very short time.the various stastical packages of good quality include biomedical computer package, statistical package for social sciences (SPSS), Genstat and Epi-Info. The first package which was developed was BMD and statistical programs of advanced level were provided. SPSS provides various statistical options for analysis of multivariant and simple statistics. The most powerful package is the Genstst which is used for variance analysis. WHO developed a package called Epi-Info for the study of epidemics. This package can processes the word, analyse the data has graphical abilities. WHO and Centre for Disease Control (CDC) made this non-copyrighted package available for statistical programming [39].

Laboratory computing is one of the applications of computer based techniques in medical field. The analysis of laboratory includes photometry, blood chemistry, microbiology and so on. Proper validation of the results with the patient identification is done. This contributes to the efficiency in the care system of patients. The monitoring machines based on the computers can automatically collect the heart rate, blood pressure and respiratory activity of the patient in digital form. The chart of the patient is updated automatically and the hospital staff is notified of vital changes [40]. The decision making based on the computers is CMD which is an interactive system as the doctors can be assisted with the task of clinically decision making. The natural abilities of the doctors to make judgments is complemented with the vast memory of the computer through this system. Figure 7 shows the model of decision making assisted by computers.

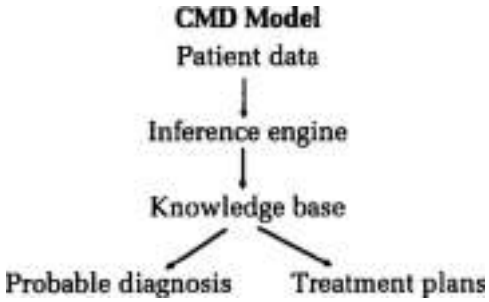

Figure 7. Decision making model assisted by computers

Large interventions of therapy are required to predict the survival of critically ill patients. For this, there is frequent collection of variables and the derived data is provided to the doctors. The recorded data to be significant should be clear as the information can be in very large quantity. The Intensive Care Unit (ICU) computerizes all the necessary and required information so that there is perfect management of the patient's data. There has been the development of closed loop system for vasodilator infusions [41]. The computer techniques based therapy includes various methods to plan, monitor and adjust the dosage of toxic drugs such as in antibiotics. The regimens of dosage can be planned by the physicians through the target peak selection. Various surgical procedures can be planned, taught and performed with the aid of computer based technologies. Robotically assisted surgery (RAS) is one of the major and recent development in the medical field. The use of computer software and robotic devices allows the surgeons minimal-invasive techniques. The images of high resolution can be generated with computer assisted techniques. The human body images are created with the technology of medical imaging. The hardware and software are dedicated for this purpose so that high resolution images are obtained in CT scans, gamma cameras, ultrasound and Magnetic Resonance Imaging (MRI). The information system of the hospitals can be integrated with these workstations. There are various technologies in the field of medicine which has helped transforming it completely. These technologies include 3-D printing, Artificial Intelligence, BCI and BBI's, Robotics, Electronic Diagnosis, technologies related with the interaction between patient and physician. 3-D printing can be used in future to test the toxicity of a specific drug on the human body. The use of artificial intelligence in the field of medicine includes the evaluation and analysis of patient's personal and biometric data including all the levels of diet and activities. A whole new understanding level can be achieved through Artificial Intelligence. The complex connections of human and computers are incorporated with advancement of interface between brain and computer. With the advancement in technology, the healthcare has become efficient, better, more accurate and easier for patients, physicians and hospital staff [42].

E. *Computer vision based techniques as counter measure*

Using the computer based technology to diagnose disease the data is stored through the sensors present in the computer chip. For example, the CT scan of lungs is stored in the camera sensor. The other symptoms are also identified through the sensors embedded in the computer. All this data is then aggregated and configured. The configuration is done by running the algorithm in the applications of smartphones and computers. All the symptoms of disease are recorded and configured separately through the computer based technology. This data is then stored and analysed. To identify the presence of virus in the lungs through CT scan images, many reports of radiology are trained in order to get a better diagnosis. Since the computational techniques have become very advanced, CPUs and GPUs are required which are provided by the cloud in the form of virtual machines. The progressive CT scan images of the lungs is shown in figure 8. The key technique for detecting the COVID-19 disease is the CT scan. The increase in the volume and density of CT scan images is the evidence for confirmed COVID-19 case. The proposed framework allows the radiologists to efficiently decide the suspected cases which would otherwise take longer time if done manually by the radiologists. [43]

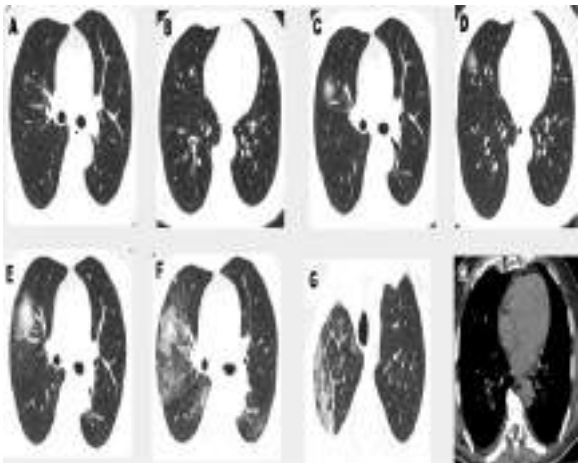

Figure. 8. CT scan images of a suspected COVID-19 case

Using deep learning the COVID-19 can be predicted using x-ray images. The epithelial cells of respiratory systems are affected by presence of COVID-19. So, X-Rays can be used to analyze the presence. The dataset of X-Rays of normal people and X-Rays of COVID-19 people can be used to train the model and with the use of CNN and deep learning, the model will be able to detect the presence of COVID-19 virus in X-Ray [44]. Figure 9 shows the x-ray dataset of normal and COVID-19 positive people and Figure 10 shows detection of COVID-19 using algorithm.

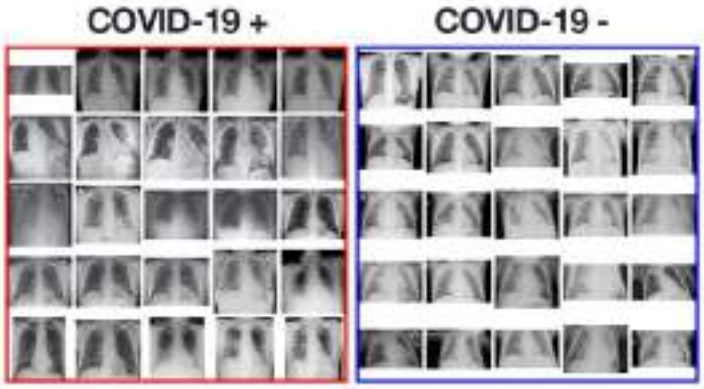

Figure 9. Dataset of normal and COVID 19 people

Figure 10. Detection of presence of COVID-19

Medical imaging and the analysis of medical image data are growing very rapidly in the medical field. Due to advancement in the imaging technologies large amount of data is available due to which medical applications have risen and the need for better methods of data analysis and algorithms has increased in demand. The operation of minimal intervention is one such example. Due to the advancement of methods in real time imaging major surgeries are being possible which also require the surgical tools having precise and automatic tracking. The methodologies in Deep Learning helps in the analysis of medical image data by significant framework in the medical field [45].

Brain Tumor Segmentation is one of the applications of computer vision based Deep Learning. In the United States more than 20,000 people are diagnosed with tumor of spinal cord and brain of primary stage every year. The image processing of the brain tumor can be used to detect the tumor fall extensions where the anatomical structure is being segmented. The anatomical structures having unexpected shapes such as tumors in soft tissues can be challenging for automatic segmentation and the supervision of humans is required for complete segmentation [46]. Figure 11 shows the segmentation of the tumor in the brain. Active contours can be employed for tumor delineating with the aid of probabilistic maps. The successful segmentation of the brain tumor comes from the convergence of active contours at level set.

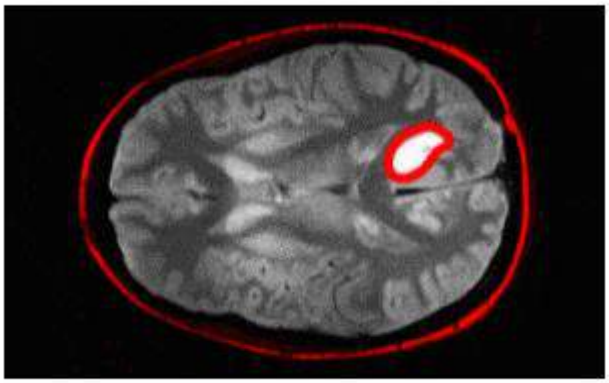

Figure 11. Segmentation of the Brain Tumor

Another application of the computer-based vision in deep learning is the measuring the density of damaged cartilage. The shock impulses are damped and absorbed between the between the thigh and shin bones with the help of knee cartilage. The tissue of

the cartilage layer is very flexible due to which the pressure on the knee joint is eased which is caused by walking or body weight. The damage to cartilage layer needs a clinical intervention such as encouraging new cartilage by drilling small holes or by totally replacing the knee cartilage. The ultrasonic imaging can be used to observe the state of erosion [47]. Figure 12 shows the ultrasound image of damaged cartilage tissue. The level of intervention is evaluated by trained orthopedics and the physicians access the knee cartilage thickness. The computational tools measure and analyze the output images.

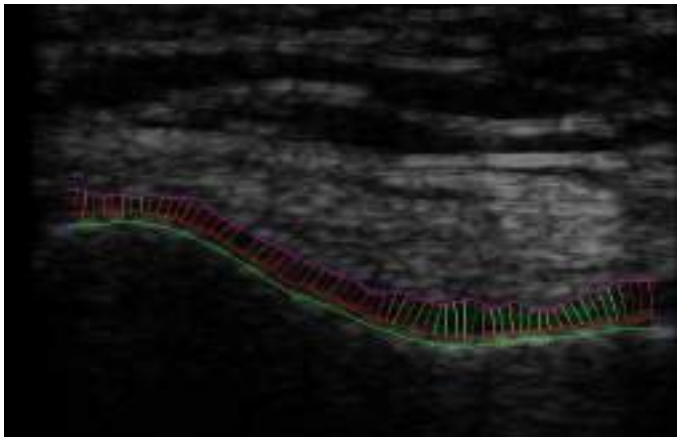

Figure 12. Ultrasound image of damaged cartilage tissue

Segmentation of skeletons and bones is another application of computer vision based deep learning. The image of the bone can be easily obtained by Computed Tomography (CT) scan. Figure 13 shows the CT scan of the bones and skeleton. This is because the bone tissue can be easily identified through simple thresholding. The fractured bones can be observed by 3-D modelling which has become necessary and significant in medical applications. The bone density can be assessed as a measurement in the CT scan which is the actual rate of intensity. Manual segmenting had been used for bone geometry segmentation but is very long process and full of errors. Deep learning models combined with the computer vision technology are able to provide the algorithm that segments the bones accurately in CT scans with robustness and high speed [48].

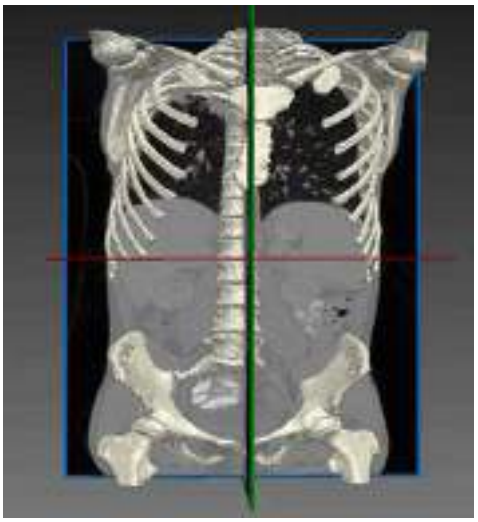

Figure 13. CT scan of bones and skeleton

The tumor cells can be automatically segmented through machine learning methods. Examining the tumor cells manually and visually is highly time consuming and in case of rapid intervention this method is not readily available. This makes the manual segmentation very unpractical task by the experts. Therefore, the algorithms based on computer vision and machine learning are proposed in which the tumor cells could be automatically segmented. The quantification tasks can be autonomously performed by these algorithms which scans and analyze the histological tissue at a very fast pace. Precious money and time can be saved by incorporating learning methods based on computer visions in the system of tumor cell segmentation [49].

F. *IoT based system as counter measure for bioweapon against crop-war*

In the threats described in previous section, smart farming, IoT based sensors (humidity, soil moisture, light, temperature, pesticide detect etc) are used to combat against attack of bioweapons. Further these are also used to increase the crop production and weather forecast based automatic irrigation system are used which optimizes water usage and eliminates wastage of water

[50]. Figure 14 shows various application of IoT in agriculture industry. During bio attacks on crops, the pre-symptoms can be detected on earlier stage and proper precautions and fertilizers can be provided to plants. Several applications has been developed though computer vision and deep learning which can detect the type of disease of plants and to cure the suggestions are also provided. Figure 15 shows the data set for deep learning. The algorithm using deep learning and image processing is able to recognise infected leaf and stem, measure the affected area, it can find the shape of infected region, determines the colour of infected region and can also influence the shape and size of crop [51]. The farmer can click the photograph of crop and can upload via desktop application or mobile app. Using Artificail intelligence and deep learning, through uploaded image the disease can be detected..

Figure 14. Applications of IoT based smart agriculture devices

Figure 15. Image set for deep learning

IV. MATHEMATICAL MODEL FOR SARS-COV-2 PREDICTION

The SIR model is generally commonly used to study the count of individuals in a population suffering from an infectious disease in a population. It categorizes the population into under three points.

Susceptible (S) – Individuals not yet infected but are potentially vulnerable to get infected.
Infectious (I) – Individuals at present infected (active cases) and could potentially infect the people who come in contact with them.

Recovered (R) – Recovered individuals from the disease and are therefore immune to any further infections.

The three categories or compartments have a certain number of persons on each day. However, that number varies from day to day, as individuals shift from one category to another. Those Persons of compartment S, who get infected, will move to the compartment I. Similarly, infected people in compartment I, who recover or die from the disease, will shift to the recovered R compartment.

It is assumed that the cumulative populations in the three compartments (S+I+R) always remain the same. It is the total population of the region under consideration. This model ignores the fact of occurrence of continuous births and deaths in the region. But for short epidemics that last a few months, this is a reasonable assumption to make! For modelling other diseases like childhood infectious diseases, such as measles, that recur regularly, natural birth and death rates of the population will also have to be taken into account.

For diseases like CoVID-19, another compartment called 'Exposed' (**E**) is required to be considered. This consists of asymptomatic persons i.e. who might possess the virus but do not show any kind of symptoms. They are between the susceptible

and infected compartments. In spite of being asymptomatic, these individuals can still pass on the disease to susceptible individuals. So we get a new model 'SEIR model'. More compartments, like 'Quarantined' or 'Isolated', can be added to the model for more deep study of disease control measures. The Susceptible-Exposed-Infectious-Removed (SEIR) Model is one of the most used and simple model for prediction of human to human transmission during an epidemic [52-54]. During any epidemic, the model divides the population into 4 different partitions with different variables. In the SEIR model, by adding exposed/latent person population (E-exposed) and letting infected persons move from S(susceptible) to E(exposed) and from Exposed to Infected, the delay between the acquisition of infection and state of infection can be incorporated. Figure 16 shows SEIR model.

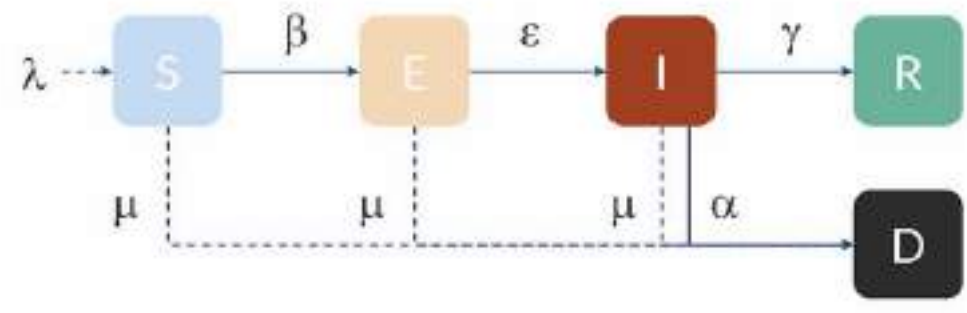

Figure 16. S-E-I-R Model for prediction

From the model, persons can flow from S to E partition with the β rate, from E towards I with ε rate, from I towards R with γ rate. However the person can move from I to D(dead) with α rate. R do not return to S as they are assumed to be immune.

When some person had some sort of contact with any infected person he/she comes in susceptible compartment (S). The probability is product of number of susceptible people in population and fraction of infected people. Considering β as transmission rate, the exposure rate can be given as

$$r_{nE} = \frac{\beta}{N} SI \quad (1)$$

β can be given as

$$\beta = \frac{R_0}{n_{id}} \quad (2)$$

Where R_0 is basic reproduction number and n_{id} is average number of days when an individual is infectious. For simulation for shorter epidemic, a constant population in birth and natural deaths balance is assumed. With the increase in new exposed cases, the number of susceptible persons decreases and is given as

$$\frac{dS}{dt} = -\frac{\beta}{N} SI \quad (3)$$

Where N denotes population size

For number of exposed (E),

$$\frac{dS}{dt} = \frac{\beta}{N} SI - \varepsilon E \quad (4)$$

Where ε is rate of progression towards infectious (per day) and if length of incubation increases this will decrease. The rate at which person is isolated, died or recovered the εE decreases otherwise it increases. The rate is inversely proportional to average number of days that a person is infectious and is shown as

$$\gamma = \frac{1}{n_{id}} \quad (5)$$

The rate at which infectious persons die due to disease is given as αl and I is given as

$$\frac{dI}{dt} = \varepsilon E - \gamma I - \alpha I \quad (6)$$

R variable shows those who have built immunity and are no longer susceptible, the equation of R can be given as

$$\frac{dR}{dt} = \gamma I \quad (7)$$

However for the D which dies due to disease, the equation of D can be written as

$$\frac{dD}{dt} = \alpha I \quad (8)$$

For Prediction of COVID-19 cases a model is designed in COMSOL software using above mathematics. The model is used to predict cases for India. The Population is taken as 1,391,790,362, new cases is taken as 1012 on 16th May 2020 and active cases is taken as 3,618,423 [55] while the basic reproduction number for India is taken as 1.379 [56], Erlang mean rate (ε_r) is taken as 2.414 and reduction in transmission rate (β) is taken as 0.3 in weekend lockdown state. Figure 17 shows input parameters.

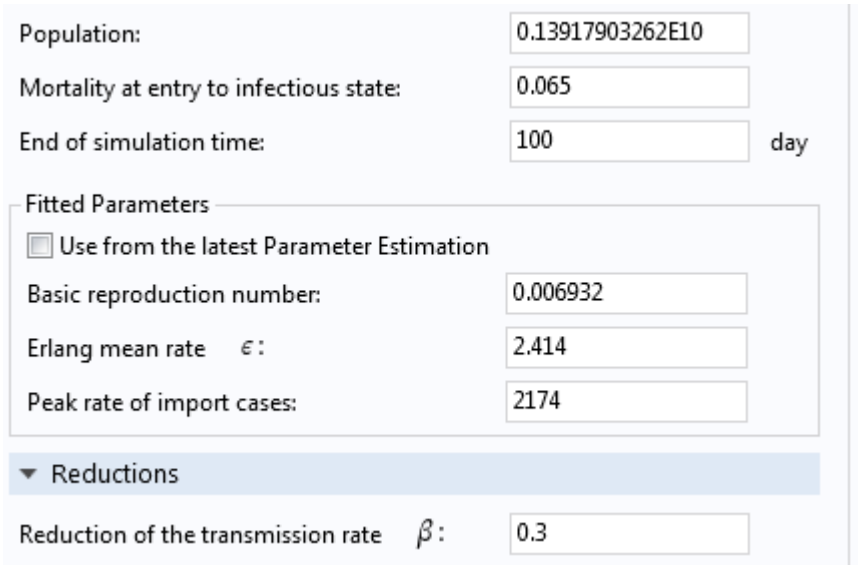

Figure 17. Input parameter for model.

After computation for 100 days, by the model the output is shown in figure 18. The graph shows number of exposed, infectious, recovered and death cases. From the prediction it can be observed that the death rate will continue to rise on exponential scale and will get flatten after 50+ days.

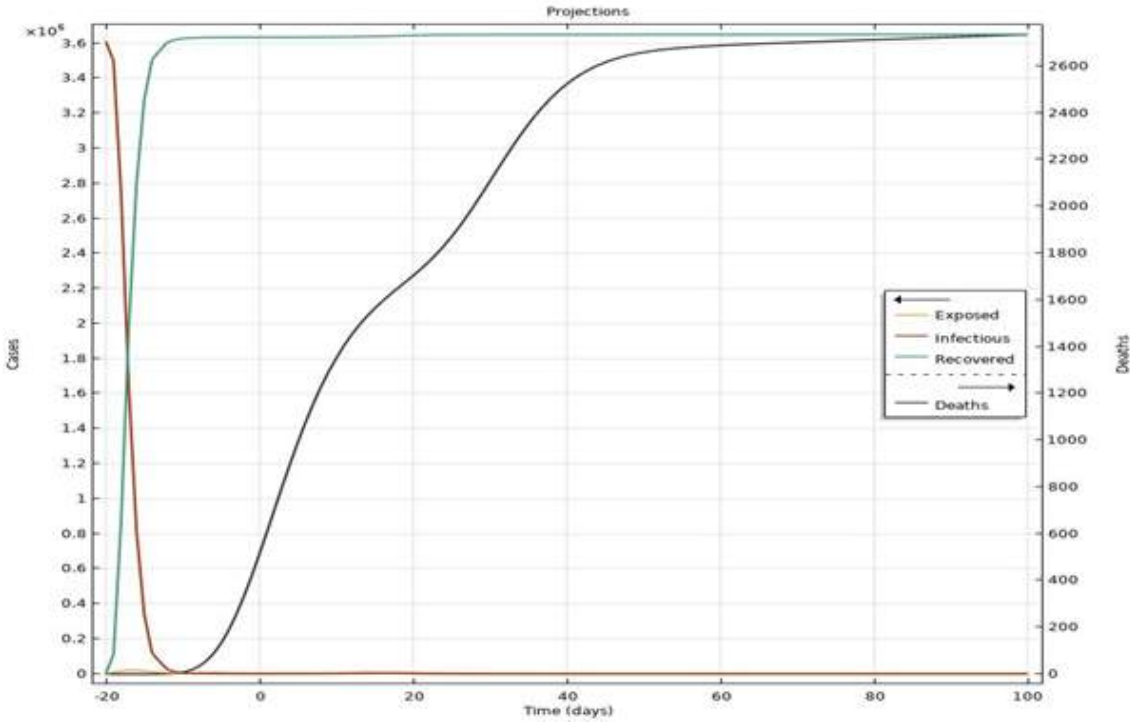

Figure 18. Projection by model

V. CONCLUSIONS

Other than natural disasters we face threats of bioweapons and bioterrorism with genetically engineered agents. The bioweapon with a delivery system which can inject, spray or throw projectile of genetically engineered genes to infect human and crops are increasing day by day. In this paper, various genetically engineered pathogens, the effect of biological agents are discussed. To counter the effects which is spread by these bio agents several computer based techniques are used. To provide faster, accurate results with computer vision and deep learning the algorithms are helping the medical area. Artificial intelligence, big data, computer vision, computer assisted systems and IoT based systems are providing solutions in any pandemic spreads. Computer based surgery is helping doctors at great extent. Even the doctors are able to do surgery at remote locations. IoT based smart farming devices are not only used to increase the crop production also it can monitor the crops damage done due to any biological agent during crop war and can also suggest the cure to farmer. With the increase in bio war technology the counter measures using computer assisted techniques are also growing. Also the mathematical model for prediction of communicable diseases and the detailed discussion about predication of SARS-CoV-2 coronavirus cases can be predicted with mathematical model.

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Location-Based Restaurant Preferences in Metropolitan Cities of INDIA

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Abstract— **Wealth is not a legitimate goal of a company. The legitimate goal of a company is to deliver a product or service that people want and that is lucrative. There are numerous aspects that contribute to a company's growth, but location serves as an origin point for our concept, assisting us in surviving in this competitive food market. It is, in fact, the single most critical thing you can do for your restaurant. While good cuisine and services are essential, a terrible location may completely derail restaurant business. The location of restaurant has a significant impact on how it operates. India's growing population is concentrated in the country's major metropolitan areas. As business representatives, we picked eateries and employed a hybrid approach to explore the types of cuisines that people enjoyed. The study was carried out in three major cities: Bangalore, Delhi and Mumbai. The Zomato dataset was utilised for this, which was cleansed before being processed in Hadoop Ecosystem. The data were presented, and when they were scrutinised, it was determined that ready-to-eat meals were preferred. It is impossible to underestimate the value of Dine Out and Desserts. The pattern is consistent across all of the locations researched.**

***Keywords*—Big Data Analysis, Hadoop, Hive algorithm, Restaurant Preferences, Business Intelligence, Community Based Influence Maximization**

I. INTRODUCTION

The decision-making process for a restaurant client begins when the consumer perceives a need that can be met by using the restaurant's services. Restaurant consumption may be prompted by a variety of causes, including the need for fast meals, the celebration of special events, the entertaining of business clients, and so on. Customers will look up a range of data about eateries, compare distinctive sorts of restaurants, and decide about which restaurant to eat at.

A. Need to Identify Location

Not solely because of the ubiquitous popularity of smartphones and location-based programs, but also because of the proliferation of location-based big data. Location is important since it connects many different business divisions and allows you to solve issues that couldn't be handle before. It allows to ask new questions and acquire new insights and knowledge by examining conventional data in novel ways, such as sales, profit drivers, and consumer traits or wants. Many of the new forms of information that are essential to twenty-first-century enterprises are interwoven with location—social media, check-ins, mobile searches, online sharing, and more. It's time the fog lifted and to glimpse business opportunities with clarity.

In this research, we chose a restaurant as a company representative and performed an exploratory examination to see how the placement and location of a restaurant impacts its effectiveness. Using a longitudinal strategy, we investigated the effect of restaurant type and location on business excellence. We glanced at the Zomato restaurant records for Delhi, India's capital, Mumbai, the city of dreams, and Bangalore, India's Silicon Valley, to test this theory. Bangalore is the third most populous city in India and the fifth most crowded city in the world, with an inhabitant of over 8.5 million [1] and a metropolitan census of about 11 million. Delhi is Nation's second city, following Mumbai, that has a census of 13 million people with an acreage of just 603.4 km^2. [2] These regions are not just the nerve centres of India's information technology sector, but also academics and training hubs. Catering services from all around the earth may be available here, with a wide range of flavours, bars and nightclubs, delivery, and other facilities. The study's goal is to uncover hidden trends in the restaurant industry, such as consumer preferences and the influence of location on business performance.

The rest of the paper is laid out as follows. First, the eateries literature is read, as well as a variety of factors that influence restaurant success or failure, such as location, cuisines, local business, and so on. The methodology and deployed model are then given, which is briefly discussed together with the procedures and queries utilised for analysing the data and presenting the empirical results visually. Finally, we have discussed the results of analysis and mentioned the possibilities for further research.

B. *Scope of Research*

Ambience, family income and size, price, gender, reviews and most recently, the COVID pandemic are all elements that impact a restaurant's performance. More factors, such as marital status, educational credentials and religion can be considered. The scope of this study is confined to two variables, but it may be expanded by incorporating more factors. Furthermore, the research is restricted to India's urban areas. The same might be said about downtowns, and a connection could be drawn. COVID pandemic's influence has now become a game changer in any firm, and its effect is highly suggested for investigation.

C. *Hypothesis*

H1: People in the different metropolitan cities have different preferences of Restaurant-Type

H2: People in different metropolitan cities have similar preferences of Restaurant-Type

D. *Research Questions*

RQ1: What is the preference of the people for Restaurant type in a particular city?
RQ2: What is the preference of the people for Restaurant type at a particular location in a particular city?

II. MOTIVATION

Business intelligence is a paradigm for transforming data into valuable information, information into knowledge, and knowledge into insight for a company. Technology for database query and reporting, as well as a tool for multidimensional analysis, are the most prominent Business Intelligence tools. The connection between Business Data Analytics and Business Intelligence was examined in *"Big Data Analytics Services for Enhancing Business Intelligence"* [3]. Relativity, Expectability, and Temporality are the three aspects of Business Intelligence. In terms of system, products, and services, Business Data Analytics can develop three aspects. Then, to enhance Business Intelligence, decision-making process needs to be strengthened. Big Data Analytics can improve Business Intelligence, according to the authors.

M. Lu, C. Lai, T. Ye, J. Liang and X. Yuan [4] has provided two methods for identifying customers' preferences for food in a given area: predictive analytics and learning analytics. They chose restaurant-related tweets and used HIVE to stream process them in order to discover the association between people and restaurant data. Similarly, the authors of *"Location Wise Opinion Mining of Real Time Twitter Data Using Hadoop to reduce Cyber Crimes,"* [5] relied on the opinions of others while making decisions. They did this by leveraging location to extract in-depth information from Twitter unstructured data using flume and storing it in Hadoop HDFS. The data was then processed using a combination of PIG and the HIVE platform. For streamed data, PIG and HIVE were evaluated in terms of analytical power.

Dr. Laddha [6] emphasised the importance of food in our lives, opening of restaurants in large amount and data generation due the widespread usage of mobile technologies. She focused on the metropolitan cities as a market for online food aggregators. She worked on the pattern "*How kitchen requirements vary by location."* She investigated whether there is a link between demographic strategies and customer perception of the online market and actions. She discovered that demographic characteristics and related behaviour parameters such as readiness to order, awareness of terms and conditions, knowledge of available restaurants, and transaction channel trustworthiness have no association. However, there is a strong link between frequency and occupation. According to Dr. Laddha and Javed Mahmud [6,7], there is no significant relationship between respondents' university level students' parental income and their purchasing behaviour. Furthermore, there is no correlation between gender and the number of incidents university students dine out in a specified timeframe. This study is extremely conflicting, and it suggests that additional in-depth research into variances in customer behaviour at various locations is needed.

III. METHODOLOGY

People who are successful don't do different things; they do things differently. In the restaurant industry, the same rationale applies. The qualities of an excellent restaurant are similar to those of a normal restaurant; the distinction is in how these traits are recognized, understood, and implemented.

We picked restaurants as business representatives based on the research needs. For this, we used the Kaggle repository to fetch restaurant data. The Dataset is quite massive and contains some irrelevant information. This dataset was helpful to answer research question, "What is the preferred restaurant type in a certain location?" By eliminating and cleaning the dataset with Pandas and Microsoft Excel, the important information is preserved. Two columns, City and Restaurant types, were chosen for study because they may show hidden patterns that would help us answer our research question. The dataset is organised into thirty categories and seven cuisines, which is sufficient for our research.

Because of Hadoop HDFS's extensive capabilities, we used it to store our data in CSV format. We did this by creating a directory within HDFS using command

Hadoop fs -mkdir /Zomato;

Afterwards, following command was used to move the pre-processed data to HDFS:

Hadoop fs –put 'home/cloudera/Downloads/Bangalore.csv' /Zomato

C. *Business Intelligence Model Deployed*

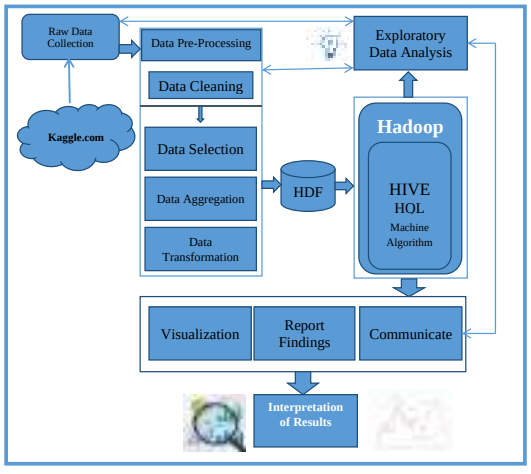


Figure 1: Business Intelligence Model to detect Location Based Preference

Hadoop is an open-source ecosystem for hosting and executing applications and data on commodity hardware clusters. It offers enormous data memory, immense processing capabilities, and the capacity to perform nearly unlimited concurrent activities or jobs.

C. HIVE

We picked HIVE above the other Hadoop ecosystem components because of its simplicity and relevance to our project. Apache HIVE is an open-source data warehouse programme that allows you to read, write, and manage big dataset files stored in HDFS or another storage system like HBase. Apache HIVE supports enhanced HDFS and MapReduce operations. It allows SQL developers to write HIVE Query Language statements in the same way that normal SQL statements are written. Its purpose is to make MapReduce programming simpler.

The HIVE meta-store is included with HIVE installation and allows you to quickly apply a table structure to substantial volumes of unstructured data. After the table has been formed, defining the columns, rows, data types, and so on. All of this data is kept in the meta store and eventually becomes part of the HIVE's framework. The data in the meta-store may then be accessed by other tools like Apache Spark and Apache PIG.

D. HIVE Algorithm Used:

1. Enter the HIVE shell using command: HIVE
2. Check if database database_name exists, if yes go to step 3 else go to step 4
3. Use database_name; Goto Step 5
4. Create database database_name and go to step 3
5. Create table using command:
Create external table if not exists table_name (col1 datatype string, col2 datatype string)
Row format delimited
Fields terminated by 'specific Delimiter'
Stored as type_of_file;
Location ' path to location' use tlb properties (if required)
6. Load data into table;
7. Run HIVE queries a) if Research question 1 go to step 8 else if research question 2 go to step 9
8. Select col1, count(col2)
From table_name
Group by col2; go to step 10
9. Select col1, col2, count(*)
From table_name
Group by col1, col2; go to step 10
10. Retrieve outcome of MapReduce task;

E. Table Creation & Loading of Data

Using the HIVE JDBC/ODBC drivers, queries may be executed from the command line interface (HIVE Shell), from a Java database connection (JDBC), or from an open database connectivity ODBC application. We built a Zomato database in HIVE, using query:

```
Create database Zomato;
```

Then this database is used using "Use Zomato;" query. We used query to build a table in Zomato to store our data:

```
CREATE EXTERNAL TABLE IF NOT EXIST Bangalore(area string, rest_type string)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
LINES TERMINATED BY '\n'
STORED AS TEXTFILE
Location'/home/cloudera/Documents/Bangalore.csv' TBLPROPERTIES('skip.header.line.count'='1');
```

Then, the data is loaded inside above created table using:

```
LOAD DATA INPATH 'Zomato/Bangalore.csv' OVERWRITE INTO TABLE Bangalore;
```

Following that, the data is seen from two perspectives: first, a wide view, and second, a detailed view. For that the information was examined to get answers to these questions about our business data. Our First research question can be achieved with "What is the restaurant count of a particular type in Bangalore?" This query returns the total number of restaurants in Bangalore that fall into a specific category. This is the HIVE query: -

```
SELECT rest_type,count(rest_type)
FROM rest_rq1
GROUP BY rest_type;
```

Our second research question can be achieved with "What is the restaurant count of a particular type for each locality in Bangalore?" With this question, we may obtain a good sense of the number of restaurants of various sorts in various parts of Bangalore. This is the HIVE query: -

```
SELECT city, rest_type, count(*)
FROM rest_rq1
GROUP BY city, rest_ type;
```

Our curiosity does not end there; we want to know if the similar pattern can be seen in other metropolitan areas, as this would help us strengthen our research. As a result, we decided to focus on Delhi and Mumbai and gathered data from Kaggle.com of a similar service i.e., Zomato. It wasn't simple to pre-process the Delhi and Mumbai datasets. To make the data more useful for processing, extraneous fields were removed, leaving only the area and restaurant type variables. Following that, the area field is renamed to city for uniformity in Delhi, and areas are divided into districts. Pins and Police Zones were utilised in the Mumbai

region. Data from nearby large cities was also present in sufficient quantities and was preserved. Desserts was created by combining similar cuisines such as dessert, desserts, mithai, and confectionery into one category. Similar approach is followed to categorize other types also. After it, the pre-processed data was moved to Hadoop HDFS. The following commands were used to move the pre-processed data to HDFS:

Hadoop fs –put 'home/cloudera/Downloads/Delhi.csv' /Zomato
Hadoop fs –put 'home/cloudera/Downloads/Mumbai.csv' /Zomato

Using our deployed model, tables were created inside HIVE Zomato database using queries:

Table creation for Delhi inside HIVE

```
CREATE EXTERNAL TABLE IF NOT EXIST Delhi(distt string, rest_type string)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','.
LINES TERMINATED BY '\n'
STORED AS TEXTFILE
Location '/home/cloudera/Documents/Delhi.csv' TBLPROPERTIES('skip.header.line.count'='1');
```

Table creation for Mumbai inside HIVE

```
CREATE EXTERNAL TABLE IF NOT EXIST Mumbai(zones string, rest_type string)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
LINES TERMINATED BY '\n'
STORED AS TEXTFILE
Location '/home/cloudera/Documents/Mumbai.csv' TBLPROPERTIES('skip.header.line.count'='1');
```

After creating tables, data from datasets was loaded into concerned table using query:

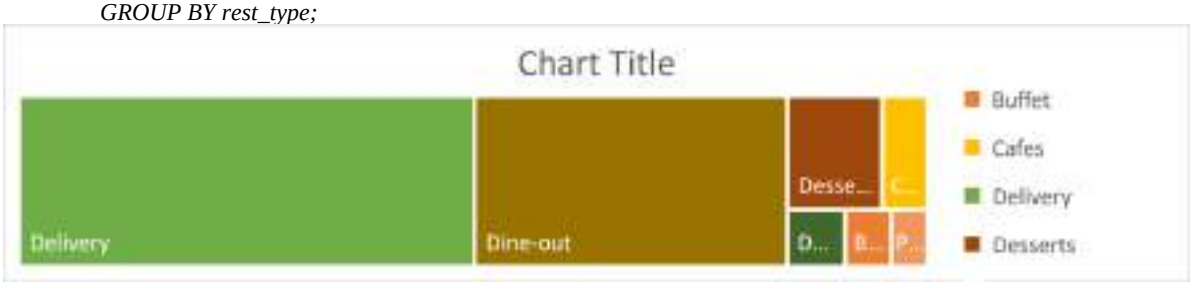
```
LOAD DATA INPATH 'zomato/Delhi.csv' OVERWRITE INTO TABLE Delhi;
LOAD DATA INPATH 'zomato/Mumbai.csv' OVERWRITE INTO TABLE Mumbai;
```

IV. RESULTS AND DISCUSSIONS

The results were saved and transferred From HDFS to local system application Microsoft Excel, where the results were graphically generated. The reports of visuals were created and thoroughly analysed to discover patterns followed at various locations. To find answers to our Research Questions the query run inside HIVE and their interpretations are discussed in this section.

HIVE query for Research Question 1 of Bangalore:

```
SELECT rest_type, count(rest_type)
FROM Bangalore
GROUP BY rest_type;
```



Tree Graph 1: Visual Representation of preferences found in Bangalore.

INFERENCE

Delivery restaurants, followed by Dine-Out restaurants, are plentiful in Bangalore and are widely favoured by the people living in the area. Other styles of restaurant are scarce, indicating that Bangalore residents prefer to eat easily available cuisine, most likely due to their hectic work schedules. This is Precisely scrutinised in order to see whether the same pattern is pursued in Bangalore spaces.

In order to find answer to second Research Question following query is used

```
SELECT distt, rest_type, count(*)
FROM Bangalore
GROUP BY distt, rest_ type;
```

Location	Delivery	Dine-out	Desserts	Cafes	Buffet	Drinks & nightlife	Pubs and bars
BTM	1794	1053	196	100	39	45	52
Banashankari	463	302	59	24	7	8	0
Bannerghatta Road	910	514	116	42	17	18	0
Basavanagudi	638	446	109	46	15	12	0
Bellandur	665	386	80	27	30	20	19
Brigade Road	695	645	134	83	57	78	77
Brookefield	860	490	86	35	33	14	0
Church Street	686	700	137	87	60	80	77
Electronic City	563	507	71	24	22	21	21
Frazer Town	653	358	87	46	14	11	16
HSR	1000	522	114	48	21	14	22
Indiranagar	849	626	149	82	38	58	58
JP Nagar	1147	683	156	62	25	23	0
Jayanagar	1375	695	173	76	29	23	0
Kalyan Nagar	664	475	90	54	11	15	0
Kammanahalli	676	486	96	55	0	16	0
Koramangala 4th Block	1501	898	166	108	45	61	0
Koramangala 5th Block	1525	927	178	45	38	58	65
Koramangala 6th Block	1394	860	172	103	36	58	0
Koramangala 7th Block	1525	963	183	105	39	59	64
Lavelle Road	628	750	132	83	65	86	0
MG Road	739	648	141	79	54	75	75
Malleshwaram	546	367	89	29	22	23	20
Marathahalli	860	618	98	29	32	22	0
New BEL Road	374	275	44	29	4	7	7
Old Airport Road	709	441	108	53	27	42	45
Rajajinagar	454	440	102	22	17	20	24
Residency Road	614	661	131	78	59	77	0
Sarjapur Road	647	432	84	31	26	21	20
Whitefield	788	611	112	38	0	36	35

Table 1: Results of Hive Query for Research Question 2

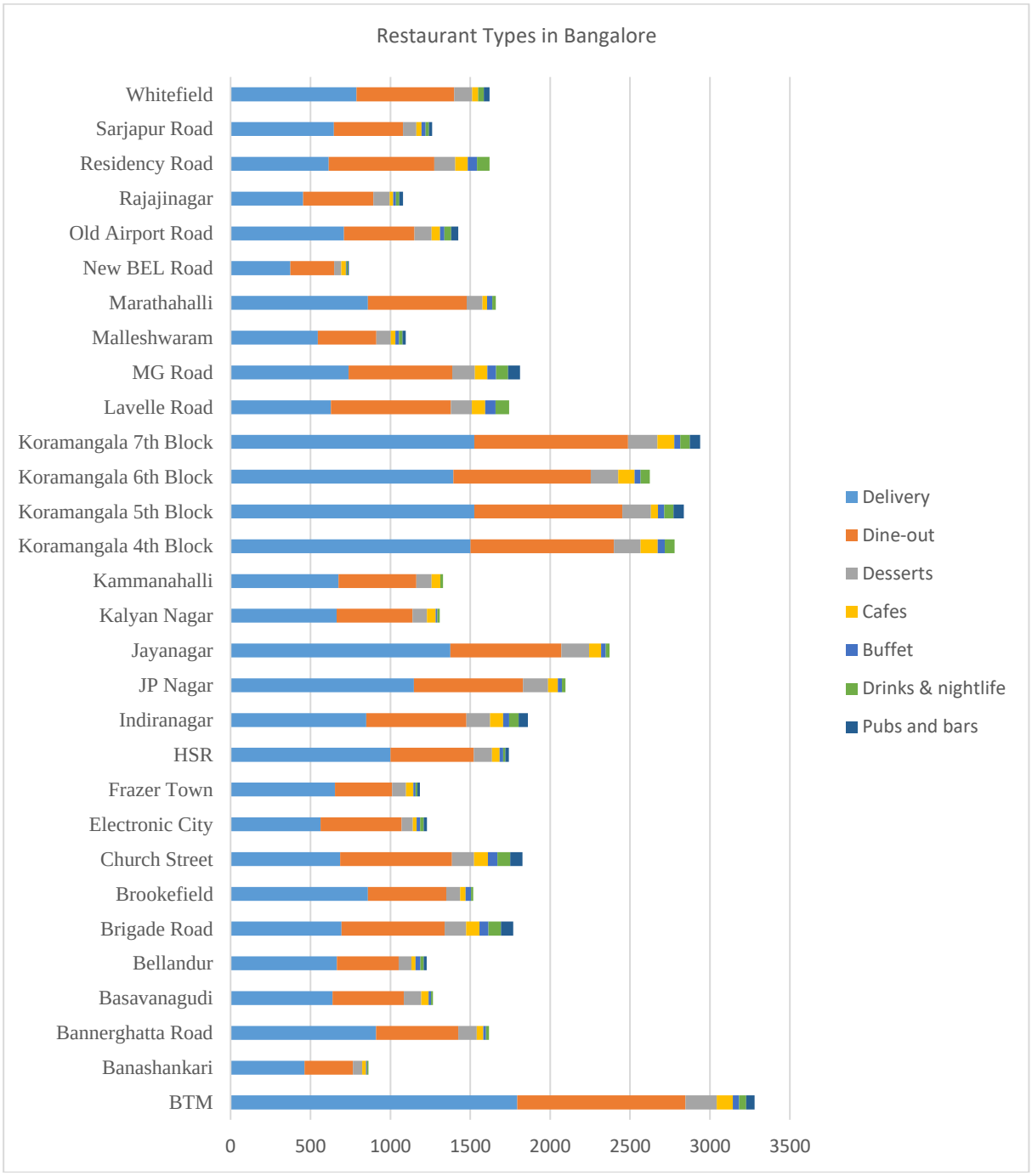


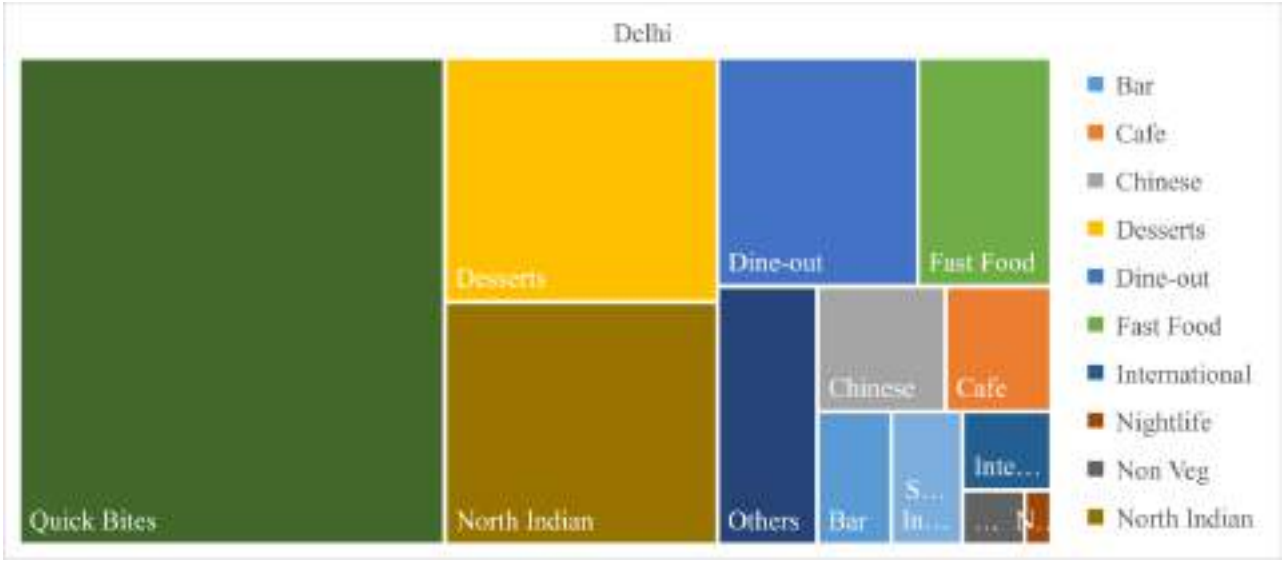
Figure 2: Visual Representation of various Restaurants found in various sectors in Bangalore

INFERENCE

According to the study of the data, consumers in Bangalore favour delivery and dining out above other restaurant alternatives. This trend was shown to be true in 29 of the locations investigated for the Zomato dataset. As a result, it's possible that a restaurant that offers both delivery and dine-in is the most popular in Bangalore.

Same procedure is followed to determine Delhi residents' preferences. In order to find answer to our Research question 1 the following HIVE Query is implemented. HIVE query for Research Question 1 of Delhi:

SELECT rest_type, count(rest_type)
FROM Delhi
GROUP BY rest_type;



Tree Graph 2: Visual Representation of preferences found in Delhi

INFERENCE

In Delhi, Quick Bites are the most popular meal, followed by North Indian, Desserts and Dining out. People in Delhi, like those in Bangalore, love to consume instantly accessible food and dine out, and north Indian cuisine is the favoured choice after short eats. Desserts, on the other hand, cannot be overlooked in Delhi, and they are an essential component of any meal. As a result, restaurants should include sweets on their menus.

To precisely find whether the same pattern is followed in the districts of Delhi the following Hive query is implemented For Delhi:

SELECT distt, rest_type, count(*)
FROM Delhi
GROUP BY distt, rest_ type;

Area	Quick Bites	Dine-Out	Desserts	Fast Food	Bar	Café	Chinese	Inter national	Night Life	North Indian	South Indian	Others	Non Veg
Central Delhi	139	69	33	16	14	10	7	2	3	30	2	20	4
East Delhi	249	18	70	28	8	11	12	2	0	51	11	23	6
Faridabad	138	20	34	16	3	7	4	1	1	31	2	9	3
Greater Noida	438	94	146	62	14	16	31	9	0	172	26	56	9
Gurgaon	327	102	111	52	20	28	34	16	8	181	24	56	6
New Delhi	147	63	48	29	13	24	15	4	2	47	3	22	0
North Delhi	53	11	22	13	3	4	6	22	0	16	2	7	0
North East Delhi	96	21	29	11	4	6	7	1	0	27	3	15	1
North West Delhi	320	36	112	60	10	9	35	6	0	100	16	32	5
Shahdra	75	4	30	4	4	0	0	0	0	13	0	2	1
South Delhi	293	95	113	50	25	42	31	32	4	95	21	52	3

South East Delhi	140	30	40	18	6	10	12	9	1	32	6	11	1
South West Delhi	277	58	82	30	3	16	15	5	2	54	13	40	4
West Delhi	330	45	100	54	16	10	25	13	0	117	10	31	6

Table 2: Results of Hive Query for Resaerch Question 2

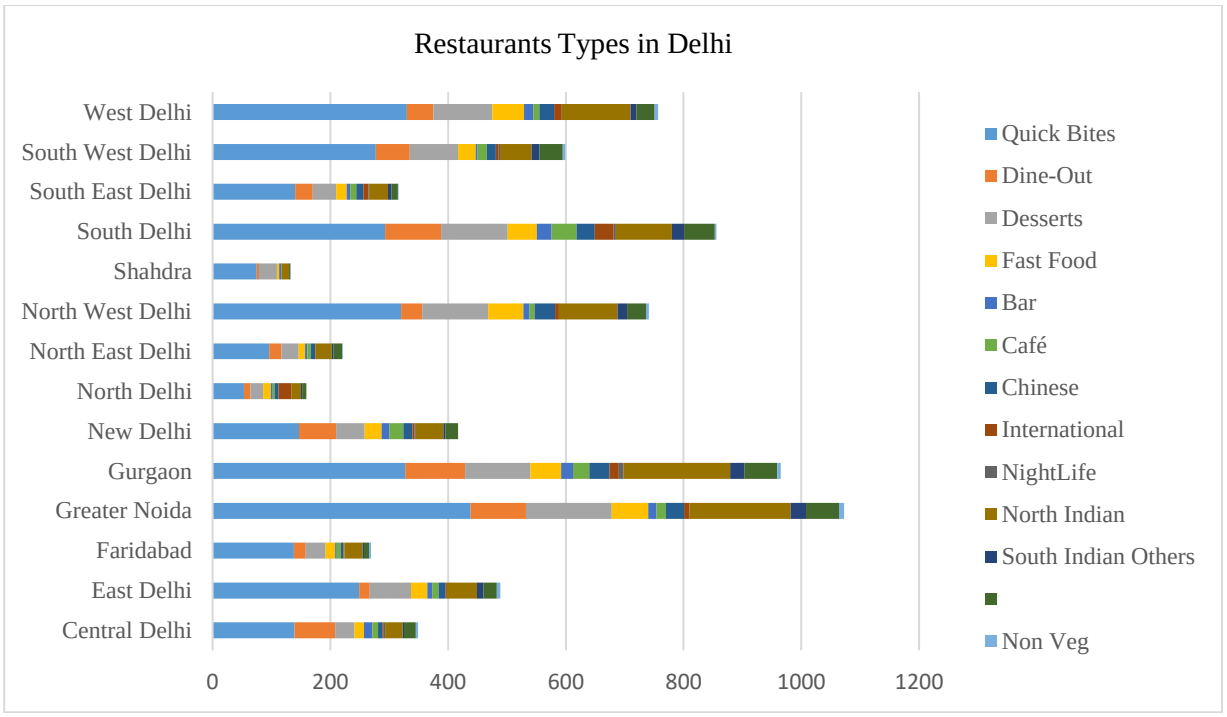


Figure 3: Visual Representation of various Restaurants found in various sectors in Delhi

INFERENCE

After thoroughly examining the districts of Delhi, no other underlying pattern emerges. The most popular meal in Delhi is fast snacks, followed by North Indian desserts and dining out. People in Delhi, like those in Bangalore, like eating fast food and dining out, and north Indian cuisine is the preferred option after a quick bite. Desserts, on the other hand, are a must-have in Delhi and are an integral part of any dinner. Restaurants should thus include sweets on their menus. Individual assessment is discussed in [8,9].

HIVE query for Research Question 1 of Mumbai:

```
SELECT distt, rest_type, count(*)
FROM Mumbai
GROUP BY distt, rest_ type;
```

Tree Graph 3: Visual Representation of preferences found in Mumbai

INFERENCE

Mumbai residents like fast meals followed by dine-out and desserts. Other cuisines make up a small percentage of the total, implying that Mumbai residents, like those in Delhi and Bangalore, prefer readily available food. Dessert should be served.

In order to find answer to second question for Mumbai following HIVE Query is used

SELECT rest_type, count(rest_type)
FROM Mumbai
GROUP BY rest_type;

Area	Quick Bites	Dine-O Ut	Desserts	Fast Food	Bar	Café	Chinese	Inter national	Night Life	North Indian	South Indian Others		Non Veg
Mumbai Port Zone	22	9	17	2	1	0	4	0	0	0	2	0	0
Mumbai Zone 1	501	289	134	45	22	16	23	12	1	62	25	25	6
Mumbai Zone 10	267	152	111	66	26	21	40	16	2	99	29	32	1
Mumbai Zone 11	340	211	152	48	28	30	39	20	1	71	39	30	3
Mumbai Zone 12	112	62	28	3	2	0	7	1	0	10	4	2	0
Mumbai Zone 2	38	29	25	13	5	0	1	1	0	3	2	8	0
Mumbai Zone 3	198	119	99	42	14	8	14	16	1	36	15	16	1
Mumbai Zone 4	23	12	8	3	2	4	0	1	1	0	1	2	0
Mumbai Zone 5	125	84	48	25	14	6	24	6	0	45	19	12	2
Mumbai Zone 6	143	100	64	29	13	3	14	6	0	26	11	10	3
Mumbai Zone 7	91	82	46	16	4	9	6	3	0	13	6	12	0
Mumbai Zone 8	121	64	47	26	9	11	14	3	2	17	12	8	0
Mumbai Zone 9	173	186	124	44	25	36	46	24	3	56	19	28	3

Thane Zone 1	13	8	4	1	2	0	1	0	0	0	0	2	0
Thane Zone 2	63	51	21	5	3	4	2	0	0	5	7	1	0
Thane Zone 3	197	110	54	24	5	10	10	2	1	25	14	6	0
Thane Zone 4	80	28	18	3	1	3	2	2	0	5	5	3	0
Thane Zone 5	317	165	84	29	12	10	19	10	2	43	26	26	2

Table 3: Results of Hive Query for Resaerch Question 2

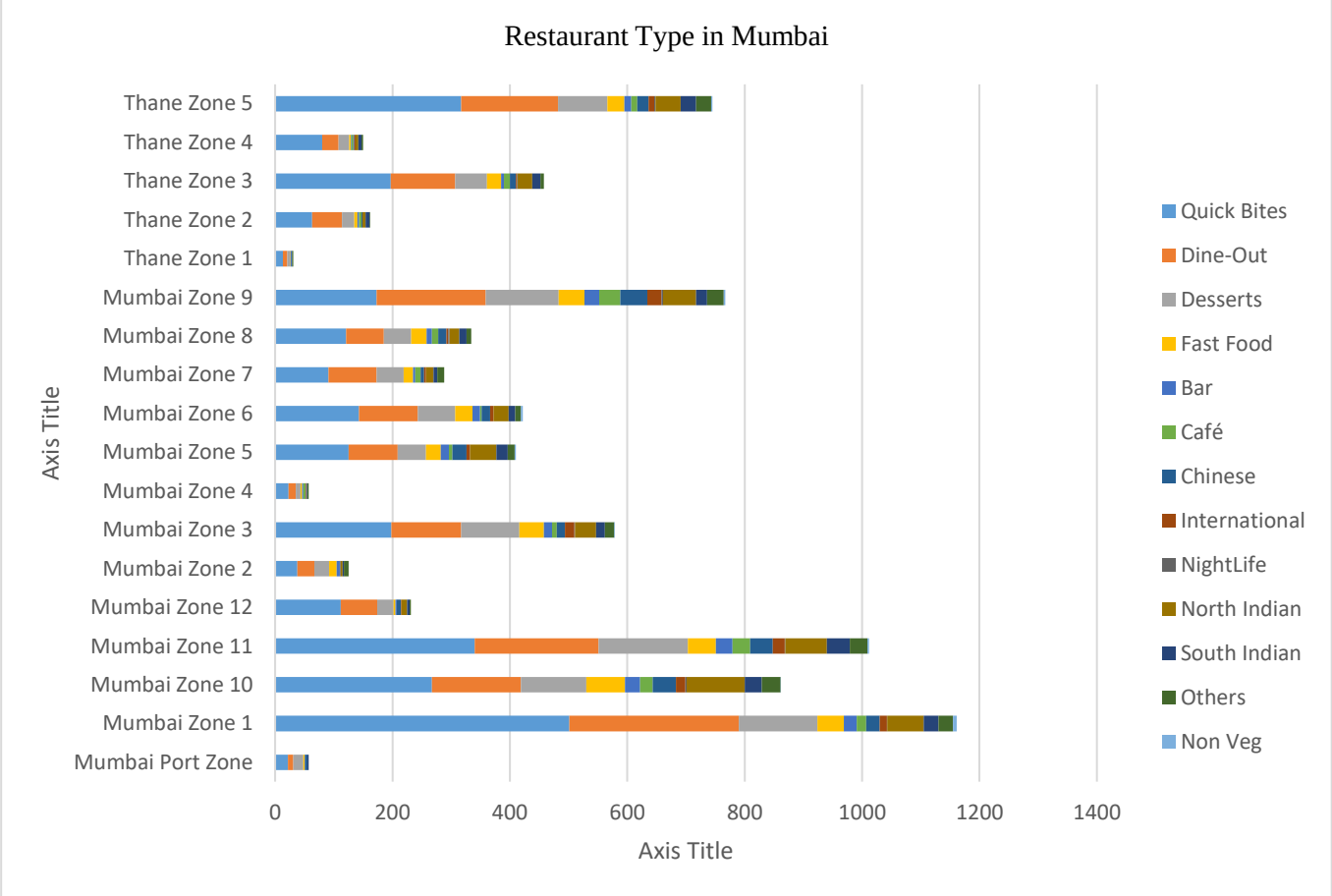


Figure 4: Visual Representation of various Restaurants found in various sectors in Mumbai

INFERENCE

Mumbai residents choose fast eats and dine-out, followed by desserts. Other cuisines contribute very less, and it may be concluded that Mumbai residents prefer to eat outside, in places like Delhi and Bangalore, where food is readily available. Dessert is an essential component of every meal, and Mumbai residents recognise this. Desserts can thus be included on the menu. Individual assessments are discussed in [8,9].

V. CONCLUSIONS

Food is an essential component of Indian culture. Food is something that Indians feel connected about, whether it's a daily meal cooked with love for the home or unique festive gastronomic treats served during festivities. Home-cooked meals have always been a symbol of pride for Indians. However, rising urbanisation, a greater exposure of Western influence, more women entering the workplace, and rising disposable money all added to the restaurant industry's expansion. As citizens began to travel a long distance, there was an increase in the number of cafes that could provide them deliciously prepared meals.

Restaurant operators must make suitable judgments when picking a site because the location has a significant impact on the restaurant's success and shifting locations is costly. We investigated three major metropolitan cities of INDIA to analyse the impact of restaurant type and location on restaurant success in this study. The pre-processed data is then classified according to its similarity. People are said to dislike spending time outside and to be fussy eaters, as indicated by the fact that only a small

percentage of the population chooses other sorts of eateries. People who prefer to eat out do not appear to like spending time in the kitchen.

According to the study of the data, consumers in Bangalore favour Delivery and Dining Out above other restaurant alternatives. This trend can be seen in 29 of the 30 sites in the Zomato dataset. As a result, it's possible that a restaurant that offers both Delivery and Dine-Out is the most popular in Bangalore. According to the data, people in Delhi and Mumbai choose Quick Bites and Dining-Out above other restaurant options. Desserts, on the other hand, must be acknowledged for their value. This pattern was observed across the board in the Zomato dataset. As a result, in Mumbai and Delhi, a restaurant that provides both Quick Bites and Dine-Out may be the most popular. Desserts are available as an option. Other criteria, such as cost, cuisines, and reviews, may be considered in future research.

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Role of Deep Learning in Medical Imaging

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Abstract—**Imaging methods are employed to seize the irregularity of the human main body. For the analysis and diagnosis of these irregularities, captured snapshots have to be understood. Most of the informative data of medical images are usually finished by clinical professional's methods. However, the limited availability of human specialists with rigid estimate methods provides inhibits effectiveness on image information. Convolution neural networks (CNNs) are a powerful method for image information. It is a standard deep studying method and may assist train machines in a way to recognize and discover objects. Nowadays, a deep learning-based study is nicely utilized in numerous fields of information. A complete survey of packages of CNNs in clinical image information has been explained in this paper. The primitive goal of this survey is to encourage researchers to substantially observe CNNs of their studies, research work, and diagnosis purpose.**

Keywords: **Feed-forward Neural Network; Convolutional neural network, Deep learning, Medical image analysis, classification**

I. INTRODUCTION

Deep Learning (DL) is a promising examination bearing in the AI (ML) region. Through using the DL procedure, computational models can become familiar with the features and portrayal of information with an interaction of extraction. In major applications like image recognition, voice recognition, medical image detection, and numerous different areas, all things considered, [1, 2]. Deep learning is turning out to be increasingly precise and has advanced to perform numerous perplexing undertakings and accomplish loads of incomprehensible forward leaps [3-6]. This review will present the use of CNN innovation in breaking down clinical images. CNN even perform better than deep neural network because of some reasons such as CNN being a feed-forward neural organization over convolution computing that is proposed by the natural responsive field component. It uses the convolution part to expand the utilization of neighborhood data and influence by basic planar structure while DNN is one of the least complex neural networks and in this, every neuron has a place with an alternate layer and is associated with all neurons in the past layer. A signal is communicated single direction from the information layer to the yield layer. It is a contribution to vector structure, disregarding the construction data of the plane. In the field of image processing, the plane data is exceptionally critical, so CNN meets better observation as compared to DNN in clinical image analysis [7]. Loss of living souls can be forestalled or the clinical injury experienced in a physical issue or an illness may be reduced through the ideal certainty of medical image irregularities. Clinical anomalies incorporate tumors [8], tuberculosis and interstitial lung infections [9], heart illnesses. Diagnosis and visualization include the comprehension of the images of the affected region acquired utilizing the computed tomography method. Image understanding includes the recognition of peculiarities, learning their border areas, and assessing their sizes and seriousness. The scant accessibility of human specialists with harsh estimate systems limit the effectiveness of image comprehending and shapes, designs of the clinical peculiarities are profoundly factor [10]. This makes analysis very challenging in any event, for specific doctors [11]. Accordingly, human specialists frequently feel a requirement for help instruments to support exact comprehension of clinical images. This is the inspiration for an intelligent image-getting framework. These frameworks that exploit machine learning (ML) procedures are quickly advancing as of late. ML methods incorporate basic various techniques such as clustering, tree learning [12], k-implies nearest neighbor (K-NN), support vector machines (SVMs) [13], and others are restricted Boltzmann machines (RBMs) [14] and random forests (RFs) [15]. Feature extraction is a pre-essential part for ML methods to work efficiently and these features are for the most part obscure. An intelligent machine is required to learn these extract features for picture comprehension and concentrate it all alone. One more attractive, insightful, and effective model is the CNN model, which naturally learns the required features and extricates in the medical domain. This popular model is designed by convolutional filters for the essential capacity is to determine and extricate vital features. This model began acquiring notoriety in 2012, because of AlexNet [16] and crushed all the other displays with a record exactness and low blunder rate. This model has been utilized by corporate giants for offering bury net types of assistance, programmed labeling in different images, item recommendations, home and self-ruling vehicles [17]. This model has some significant utilization in image and signal preparing and information analytics. It also become significant advancement when GoogleNet utilized it to recognize the disease at a precision of 89% while human pathologists could accomplish the exactness of just 70% [18].

II. LITERATURE REVIEW

The investigation of machine learning is enlivened to some degree with the investigation of the human brain. Many years ago, Reddy et. al [19] gives the perceptive ideas of the mind which has engaged in a ton of consideration of specialists with the explanation of the historical backdrop of a human attempting to get familiar with the human brain. McCulloch et. al [20] brought the previous MCP neural organization model takes into consideration the public. Rosenblatt et. al [21] presented the perceptron dependent on this previously designed MCP model to do the grouping job. After a long period, Minsky et. al [22] distinguished a critical defect in this defined model that shows the perceptron can't deal with nonlinear arrangement issues. In [23] defined the defect which upset the ensuing advancement of neural organization. Rumelhart et. al [24] created some modifications in this defined model for the improvement of neural organization. It presented the back proliferation algorithm just as the entire inferred

cycle and the actuation sigmoid function to manage the irregular issues. Lawrence et. al [25-27] introduced the CNN model prompted a sharp increment number of individuals into the examination of profound learning. Hochreiter et. al [28] found the Long Shot Term Memory Organizations model. Baudat et. al [29] performed experimentally on ReLU, the neural organization to manage learning issues. CNN plays a vital role for image understanding and based on these methodologies are put in the pioneer leading body in getting difficulties of images, like a biomedical test, Brain Tumor Segmentation (BRATS), Multimodal Brain Tumor Segmentation challenge [30], and also difficulties in pattern recognition method [31] and few challenges faced in Ischemic Stroke Lesion Segmentation method. The process of segmentation in skin cancer images has been explained in [32]. CNN is also applicable in clinical image understanding applications like recognition of tumors and to classify different types of tumors such as benign or malignant, and also used for the detection of skin lesions [33], identification of colon malignant growth [34], heart problems[35], breast cancer identification [36], and so on. Additionally, CNN-based techniques are utilized to measure the different types of illnesses in the chest like the CheXNet method[37, 38]. An audit of various deep learning methods applied in clinical imaging has been introduced in [39]. An intensive survey of profound learning strategies for the division of different MRI images is explained in [40]. A review of different deep learning methods for the process of image segmentation, their accomplishments, and also with difficulties associated with clinical image segmentation has been introduced in [41]. The main target of this review is to give a comprehensive outline of utilizations and procedures of various CNNs methods and also used in the different fields of clinical image consideration. This study incorporates the various research papers based on different operations of CNN models in clinical image understanding.

III. CNN CLASSIFICATION METHODS

In the beginning phase, as a result of the absence of preparing information and complexity, it becomes very difficult to prepare high realization CNN. Nonetheless, in the last few years, the examination on the CNN model has encountered a few notable forward leaps, started to get top-of-the-line results, and stood out of the world by the presentation of ReLU, alongside the recorded chance accomplished by the GPU method and large information. There are few exemplary structures of CNN in its improvement history is described in [42].

A. AlexNet

This method is invented by Krizhevsky et. al [43]. There is some restricted GPU limit around then, so double GPU preparing was utilized, and the organization was divided into two sections appropriately. Notwithstanding, a single GPU may be undoubtedly prepared AlexNet, therefore the two sections are to be joined with the improvement of GPU. The whole organizational construction of this model comprises multi convolutional layers and an all-out profundity of 8 layers [44, 45]. There is an unmistakable interaction of direct transformation between layers and a straightforward understanding of each defined layer according to the structure model. And afterward at the time in dropout section where some data has been arbitrarily dropped to get new neurons. The utilization of dropout data helps to diminish overfitting and to upgrade the speculation of this model since it causes to rely less upon the part of neighborhood features.

B. *VGG-NeT*

It is a notable profound CNN model created by Simonyan et. al [46]. This model expounds on the connection between the profundity and execution of the CNN model[47]. VGG-Net makes 16-19 layers with stacking the convolutional layer and the greatest pooling layer. This model has been a broadly utilized organization to remove image features. The development of this model is it utilizes a 3x3 convolution bit and 2x2 pooling bit to further develop execution through extending network structure. The developing number of organization layers doesn't bring about a blast in the number of boundaries. In the interim, one 5x5 convolutional layer, one 7x7 convolutional layer has been used and also consisted of many multilayers. At the time of preparing, this model first trained the organization of the first level, and afterward instates the unpredictable models over and over utilizing the heaviness of the organization first level, so that the assembly speed improves along with this training.

C. *GoogLeNet*

It is an exemplary deep learning model which is also known as the inception method and proposed by Szegedy et.al [48]. It may be used more layers simultaneously to bring heaps of adverse consequences and previously many constructions referenced use computing the profundity of the organization to accomplish better preparing execution. For example, overfitting, slope vanishing, angle blast, and soon to origin further develops the preparation results by proposing another way which is utilizing processing assets, all in all, extricating more highlights for a similar measure of computation [49, 50]

D. RESNET

This model was designed by He et. al [51] by using a residual Unit with effectively prepared the 152-layered structure neural model and provide the best outcomes. In the meantime, the number of boundaries was lower than VGG-Net, without standing any impact. The construction of this model can enormously accelerate the preparation of the ultra method of DNN with the wonderful precision value. The underlying motivation of this model comes when the profundity of a neural organization is constantly expanding, a debasement issue happened. Initially, it implies the rise in precision value and afterward arrives at immersion level, a while later the ceaseless increment of profundity provides the model arrives at impregnate precision value. With the addition of a few planning layers that essentially won't cause the expansion of an error on the preparing set. Using compatible guides to move the past layer of yield straightforwardly to the next layer was the motivation for ResNet U-NeT.

E. U-Net

This model act as a classical style of full convolutional organization. This model is constructed in a U-shaped form structure with allowable data during the time spent down examining and also precisely to find the comparing up-inspecting measure[52]. This model predominantly utilizes SoftMax cross-entropy shortfall to manage the issue that comparative objective limits of clinical images are difficult to be perceived. Also, loads are combined to every pixel in the given target capacity for making this organization furthermore ready to recognize the various boundaries.

IV. CNN APPLICATIONS IN MEDICAL IMAGE CLASSIFICATION

Different types of CNN models may be utilized in the field of image classification such as to recognize the human face and also to monitor the human patient condition. The accompanying given content presents the utilization of these different models for ordering the human patient conditions in various main body parts.

TABLE I

References	Organ	Preprocessing method	Datasets	Architecture	Performance metric results
[54]	Brain	Geometric normalization of CT images	3-D datasets	Conv ×5, with 3-D convoluted data	Accuracy results is 95.6% for normal class
[55]	Brain	Skull stripping, spatial smoothing	ADNI dataset	LeNet	Accuracy results is 96.86%
[56]	Brain	Data augmentation	Radiopedia data and brain tumor data	VGG-19 transfer learning	Accuracy results is 94.58%, sensitivity and specificity are 88.41%, 96.58%
[57]	Eye, retinopathy	Color normalization	Kaggle	Conv ×10, FC ×3 with softmax classifer	Specifcity 95% but less sensitivity 30%
[58]	Breast	Threshold tissue from white background and patch-based classification	Camelyon16 Dataset	GoogLeNet	AUC 92.5%, sensitivity 70.5%
[59]	Skin	Illumination correction step, removal of noise using gaussian flters	publically available dataset (University Medical Center Groningen)	(Conv, ReLU, maxpool) ×2, FC, softmax	Specific Sensitivity is 81%, specifcity is 80%, accuracy is 81%
[60]	Cell	Extraction of grayscale patches, segmentation and binarization	MNIST dataset	LeNet	Sensitivity, specifcity, calculated by SVM is 78%, CNN gives 89%

V. CONCLUSION

The difficulties in image information concerning clinical imaging are pointed out in this survey. Different types of image information obligations have been introduced. Briefly, CNN and its diverse additives are also mentioned. The methodologies used by the analysts to deal with the exceptional problems in medical image understanding have been overviewed. Different image information errands have been presented. This survey gives an exhaustive view on CNN methods in the scientific field and consists of its growing history, crucial running system, essential design, exemplary engineering, and programs in scientific image investigation. A growing quantity of instances reveals that CNN can look into and locate the secrets and techniques of a few difficult-to-understand scientific fields. Ordinarily, CNN ought to viably can assist analytic programs for assessing an ever-growing quantity of infections in human beings later on.

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A Survey and Analysis of Feature Selection Techniques in Intrusion Detection System

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***Abstract*— One of the most serious risks to computer security is unauthorized intrusion into a computer or network. Intrusion detection systems have been developed to provide early warning intrusion so that defensive action can be taken to prevent or minimize damage.When an intrusion is detected quickly enough, before any damage or data becomes affected, the intrusion may be identified and expelled from the system.The selection of features is an essential factor for developing machine models.Irrelevant data features reduce model accuracy and lengthen the training time required to develop the model.The examination of several feature selection techniques has been covered in this paper.**

***Keywords*— Intrusion Detection System, Feature Selection, Survey of IDS, Feature Selection techniques, Approaches for IDS**

I. INTRODUCTION

One of the most publicized threats to security is the intruder, also referred to as hacker and viruses. There are mainly three classes of intruders, masquerader, misfeasor and clandestine user. The masquerader is probably an outsider, the misfeaser is usually an insider, and the underground user may be an insider or an outsider.The intruder's purpose is to acquire access to a system or to expand the number of system-accessible privileges.In general, the invader needs to obtain information that must be safeguarded. This information is sometimes in the form of a password for users.An intruder can login to the system and use every privilege granted the legal user by knowing another user's password. There are two techniques to secure the password file:

A. One way function:

The system only stores the value of a user password function. The system converts this password and compares it with the stored value when the user presents a password.In practice, the system usually performs a one-way transformation in which the password is used to generate a key for the one-way function and in which a fixed-length output is produced.

B. Access control:

There is only one or very few accounts accessing the password file.In such case, the main line of defense is intrusion detection [1]. Intrusion detection detects anomalous activity patterns or patterns which are known to correspond with intrusions.An effective intrusion detection can serve as a deterrent, so acting to prevent intrusions.ID allows the collection to be used for the strengthening of intrusion prevention facilities. Intrusion detection.

Basically, there are two intrusion detection approaches [2]:

1)Statistical Anomaly Detection: This involves collection of data relating to the behavior of legitimate users over a period of time. Then statistical tests are carried out to establish whether the behaviour is not a legitimate conduct of the user with a high degree of confidence.

2)*Rule-based Detection:* Rule-based detection involves an attempt to define a set of rules that can be used to decide that a given behavior is that of an intruder.

This review paper is divided into the following sections: Section 1 provides an overview of intrusion detection system. Section 2 depicts literature survey. Section 3 discusses various feature selection techniques and their role in IDS. Section 4 shows the comparative analysis of these techniques. Section 5 is concerned with the conclusion of the paper.

II. LITERATURE SURVEY

Ambusaidi et al. [3] proposed a mutual information based algorithm that analytically selects the optimal feature forclassification. This feature selection approach based on mutual information may handle data functions that depend on the linear and non-linear data. In the instance of network intrusion detection, its effectiveness is assessed. An IDS is created utilising the functions specified by the suggested functional selection technique, called Least Square Support Vector Machine IDS (LSSVM-IDS). LSSVM-IDS performance is assessed utilising three data sets for intrusion evaluation: KDD Cup 99, NSL-KDD and Kyoto 2006+.

Acharya and Singh[4] have presented an IDS model with a functional technique based on intelligent water drops (IWD). In order to evaluate selected features, the IWD algorithm is used for the selection of features, a feature-based optimising algorithm together with a support vector machine.The experiments are conducted using KDD CUP'99 dataset. The experimental findings suggest that the model proposed performs better than the existing approaches in terms of higher detection rate, poor false alarm and increased accuracy (KNN, ACO, SVM, RST).

Aljawarne*et al.* [5] have designed a hybrid model to calculate the threshold of the intrusion scope based on the optimal characteristics provided for training in the network transaction data.. The results from the experiment show that the hybrid technique had an important impact in deciding the scale of the association characteristic, on reducing the computation and time complexity involved. The accuracy of the proposed model for the bilge- and multi-class NSL-KDD data sets was measured by 99.81% and 98.56%, respectively. The following classifiers are included in the hybrid algorithm: J 48, Meta Pagging, RT, REPTree, AdaBoostM1, Stump Decision and NB.

Shahbaz*et al.* [6] proposed an efficient feature selection algorithm that considersthe correlation between a subset of features and the behavior classlabel.The two correlation metrics used to quantify the dependency level between the features and class labels are correlation-based FS and symmetric uncertainty (SU).The proposed feature selection technique is compared with other well-known feature selection algorithms namely: CFS, IG, GR and chi-squared on NSL-KDD dataset. The results indicate that the proposed technique has considerably less training time while maintaining accuracy and precision.

Zhou *et al*. [7] proposedanIDS framework based on the feature selection and ensemble learning techniques. The first stage is for dimensionality reduction a heuristic algorithm called CFS-BA which finds an ideal subset based on the correlation between characteristics. Then, an ensemble approach that combines C4.5 is introduced, Random Forest (RF), and Forest by Penalizing Attributes (Forest PA) algorithms. In conclusion, voting technology combines the chances of basic students to recognise attacks. Experimental results employing NSL-KDD, AWID, and CIC IDS2017 datasets show that under numerous metrics, the proposed CFS-BA-Ensemble method is capable of performing better than other related and state-of-the-art methodologies.

Kang *et al.* [8] proposed a feature selection algorithm to select optimal feature subsets for intrusion detection systems to detect denial service attacks. Proposed algorithm is based on a local search algorithm, one of the representative meta-heuristic algorithms for solving computationally hard optimization problems. In particular, accuracy is used to quantify the goodness of the feature subset in cost terms by applying the K-means clustering Algorithm in the training data set. Comparisons with a feature set constituted by all 41 features are performed using a multi-layer-perceptron over the NSL-KDD data set to assess the performance of proposed algorithm.

The wrapper FS algorithm for IDS was proposed by Alazzam*et al.* [9]. This algorithm uses the pigeon-inspired selection optimizer. A new method is provided, which compares the standard way of binarizing intelligent algorithms for continued swarm binaries. A continuous pigeon inspired optimizer. Three common sets: KDDCUT99, NLS-KDD and UNSW-NB15 were used to assess the proposed approach. The proposed technique overcame many feature selection strategies in terms of TPR, FPR, accuracy and F-score from state-of-the-art related research. In addition, the proposed approach of cosine similitation is faster than the sigmoid method in order to binarize the algorithm.

Farahani [10] is proposing a proposed CCFS method of cross-correlation function selection, which is compared to a cuttlefish algorithm and MIFS features with four different classifiers: supporting the vector machine (SVM), naive bays (NB), decision tree (DT) and neighboring K nearest to the north. The CCFS method is proposed and compared with the MIFS features (KNN). The experimental findings using the data set KDD Cup 99, NSL-KDD, AWID and CIC-IDS2017 show that in comparison with both methods of different classifications the suggested method performs better in terms of accuracy, recall and F1 scores.

Ren et al. [11] suggested a successful IDS with a double-part optimization of hybrid data: data sample and selection of a feature dubbed DO IDS. For data sampling is used to remove outliers, the GA to optimize the sampling ratio and, as assessment criterion, the RF classification to get the optimum training dataset. The GA and RF are again used for the optimal function subset in the feature selection process. Lastly, an RF-based intrusion detection system is developed using the ideal data collection of training and the desired functionality. The trial is conducted on the dataset UNSW-NB15.

A selection-based network intrusion detection system was introduced by Hamed*et al.* [12**].** For the testing of the proposed model it uses the ISCX 2012 data set. Since new attacks now attempt to distribute the attack packets to NIDS over long periods, the system is built to handle only a few samples and many features.

In SVM, Gauthama Raman *et al.* [13] submitted an adaptive and resilient intrusion detection method for defining and selecting parameters using hypergraph-based GA. Hyper - Hypergraph's clique property was used to produce the initial population to strengthen the search for the optimum solution and prevent the local minimum trap. HG-GA employs its weighted goal function to maintain the balance between maximizing the detection rate and lowering the false alarm rate and optimizing the amount of characteristics.The HG-GA SVM performance was assessed using the intrusion dataset of NSL-KDD in two scenarios, and (ii) informative characteristics obtained from HG – GA.

In order to improve ML based IDSs, Fitni and Ramli [14**]** used the ensemble method and feature selection strategy. It was mainly because of the advantages of different algorithms. Entire learning with a higher detection precision than other classifiers has been observed in the CSE-CICIDS2018 dataset. In order to increase performance, the contents were successfully eliminated from the data set. The Spearman ranking correlation coefficient helped to choose 23 of the 80 elements of the original data set. Increasing the performance of machine-oriented IDSs was found by the implementation of the EL and FS. With a reasonably low detection time, the accuracy of the proposed model was 98.8 per cent. Specifically, from 34 min 2 sec to 10 min 54 sec the suggested methodology reduces detection times.

III. FEATURE SELECTION TECHNIQUES

Feature selection is a technique for minimizing data dimension while performing predictive analysis. In machine learning, the purpose of feature selection is to determine the best set of characteristics that allows one to develop meaningful models of researched phenomena. Machine learning feature selection strategies can be broadly categorized into the following categories:

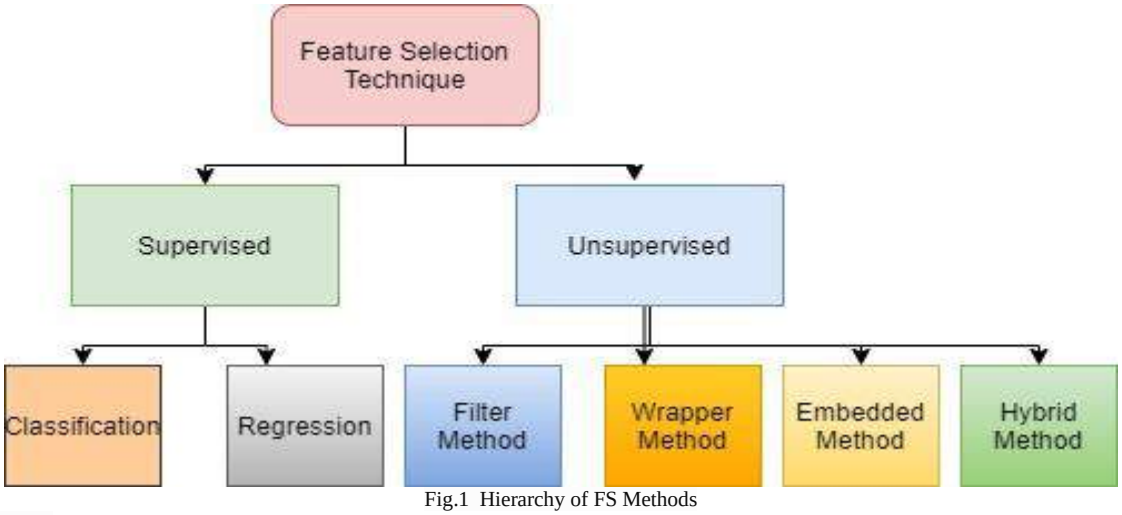

Fig.1 Hierarchy of FS Methods

A. Supervised:

This technique can be used to identify the relevant characteristics to improve the effectiveness of supervised models such as classification and regression.

B. Unsupervised:

This can be used for unmarked data. These techniques from a taxonomic point of view are categorized as:

1)Filter Methods: The variable ranking methodology is utilized in this method to select the variables for ordering, and the selection of features is independent of the classifiers used. The term ranking refers to how valuable and crucial each element is predicted to be for classification. As a pre-processing step, it basically picks subsets of variables independent of the predictor.Before classification, the ranking approach can be used to filter out the less significant features in filtering. It performs the feature selection task as a pre-processing phase that does not include an induction approach. The following are some examples of filter methods [3]

Chi-square Test: This method is used to test the independence of two events in general. If we have a dataset for two occurrences, one may collect the observed count and the predicted count, and this test analyses how far apart the counts are.

In order to construct a new model of intrusion detection, Thaseen et al. [15] merged individual classifications such as SVM, MNB, and LPBoast. The model performance is analysed using the NSL-KDD dataset, which is an enhanced DARPA intrusion dataset version. For determining the best attribute sub-set, a chi-square feature selection is made. After this, the ideal subset of SVM, modified Naive Bayes and LPBoost ensemble were provided for each classifier.A weighted majority-voting technique predicts the final results of classification. DoS and R2L assaults with 99% precision, 98% sample and 100% U2R accuracy can be detected.

*Information Gain:*Information gain (IG) is a metric that evaluates how much information a feature provides about the class. In this way, one may pick which property is the most helpful in discriminating between the courses to be learned within a certain number of trainings.

*Variance Threshold:*This feature selection strategy removes every feature that does not satisfy a certain threshold variance. In general, it eliminates all the features with the zero variance, meaning that all the features have the same value in all the samples[16].

2) Wrapper Methods: Researchers Ron Kohavi and George H. John popularized the Wrapper Methodology in 1997. The learning machine of interest is used as a black box in this method to score subsets of variables based on their prediction capability. The feature subset selection algorithm exists as a wrapper around the induction algorithm in the wrapper approach. The large number of computations necessary to obtain the feature subset is one of the technique's key limitations. The following are some instances of Wrapper Methods:

*Recursive Feature Elimination (REF):*REF is a functional selection approach that matches a model and eliminates the weakest function until the specified number of features is met. The features here are classified by the attributes of the model coefficient.

*Sequential FS:*This naive approach begins with a null set and then adds one feature to the first step that shows the maximum value for the objective function. From the second step on, the other features are added individually to the current subset and thus the new subset is evaluated. This procedure is repeated until the desired amount of features have been added.

*Genetic Algorithm (GA):*Genetic algorithms are a heuristic optimization strategy based on evolutionary concepts. Each conceivable solution is represented as a set of bits (genes) or chromosomes, and via the use of selection and reproduction operators, the quality of the solutions increases over time to favour more fit solutions. A genetic algorithm is often used to chromosome encoding two types: one is used by a chromosome-coding method according to the clustering, while another specifies an integer-coding chromosome in the cluster center.

Vijayanand et al. [17] proposed an ID system that includes a GA-based FS and several SVM classifiers. The suggested approach selects the informative features of each attack type rather than the features that are common to all attacks. The proposed system is assessed using intrusion datasets created by simulating a wireless mesh network in Network Simulator 3 and taking into account characteristics such as packet delivery ratio, latency, and so on. The proposed feature selection algorithm's performance is evaluated by comparing it to MI-based feature selection strategies utilizing developed intrusion datasets and standard datasets, namely ADFA-LD and CICIDS2017.

*3)Embedded Methods:*This strategy attempts to combine the efficiency of both previous methods and selects variables throughout the training process and is typically unique to individual learning machines. This procedure essentially knows what the most accurate aspect of the model is. Below are some instances of embedded methods:

*Lasso Regression (L1 Regularisation):*Least Absolute Shrinkage and Selection Operator (LASSO) is a linear model which estimates sparse coefficients and is useful in some contexts due to its tendency to prefer solutions with fewer parameter values.

*Ridge Regression (L2 Regularisation):*The L2 Regularisation is also known as Ridge Regression or Tikhonov Regularisation which solves a regression model where the loss function is the linear least squares function and regularisation.

*Elastic Net:*This LR model is trained with L1 and L2 as regularisers, allowing for the learning of a sparse model with few non-zero weights, similar to Lasso, but retaining the regularisation properties of Ridge.

*Tree based Methods:*These methods like RF and Gradient Boosting give us the importance of selecting features. Feature importance indicates which features are more essential in influencing the target feature.Farnaaz et al. [18] built a model for intrusion detection system using random forest classifier. To evaluate the performance of our model, experiment is conducted on NSL-KDD data set.The proposed approach is evaluated using NSL KDD data set. We compared our random forest modelling with j48 classier in terms of accuracy, DR, FAR and MCC.

4)Hybrid Methods: The great advantage of hybrid approaches is that they may make the most out of other methods of selection and thereby lessen their disadvantages.This can result in high performance and accuracy better computational complexity than wrapper methods.

Ben Brahim et al. [19] presented HIB-CSS, a hybrid technique based on cooperative subset search. In its filter step, the suggested approach employs instance learning. The primary goal is to shorten the feature subset selection process by minimizing the number of wrapper evaluations while retaining high performance in terms of accuracy, stability, and subset size.

IV. ANALYSIS

A comparative analysis of previous studies done on feature selection techniques is shown in TABLE I.

TABLE I
Analysis of Previous Studied FS Methods

Reference	Year	Technique	Parameters
[20]	2016	HIB-CSS	Min MCE, SFS, Stability
[3]	2016	LSSVM-IDS	F-measure, Accuracy
[15]	2018	Chi-square	Accuracy
[16]	2018	GA	Accuracy
[17]	2016	RF	FP, TN, TP, FN
[13]	2017	GA, SVM	Accuracy, detection rate, False alarm rate, runtime analysis
[14]	2020	Ensemble Learning, chi-square test and Spearman's rank correlation coefficient	Accuracy, Precision, recall, Time, F1-score

V. CONCLUSION

A good system for intrusion provides precise and effective grading outcomes.The capacity to develop an intrusion detection system is a crucial capability.Feature selection is a broad and complex area, and numerous studies have been conducted to determine the best ways.This paper studied and discussed various feature selection methods and also shown comparative analysis between them in a tabular manner.

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Blockchain and its applications

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Abstract— **Blockchain is a distributed, transparent, immutable and decentralised technology. It is considered as the most disruptive technology that has the potential to change the world. Blockchain is a network of nodes without any central authority. It is a variant of distributed ledger technology. It uses various technologies including cryptography, hashing, digital signature and time stamping to ensure that blockchain is tamper proof. Features of blockchain make it applicable to various financial and non financial domains. This paper tries to present the concept of blockchain and its various application areas.**

Keywords— **Bitcoin, Blockchain, Distributed Ledger, DLT, Ethereum.**

I. INTRODUCTION

Blockchain is a variant of distributed ledger technology. Distributed ledger technology is based on the network of databases that allow the participants to enter data into the databases without the intervention of any third party.[1] The design is such that, participants can have concurrent access to the information. It ensures a high level of trustworthiness as the network of databases can be easily audited to check for the past transactions and also, any change in historical data required a high level of computational power which is not quite possible as of now. Blockchain is a most popular form of distributed ledger technology where the data is cryptographically signed. Blockchain can be compared with TCP/IP, latter popularised sending of bidirectional messages via email, while former is popularising sending of bidirectional financial transactions without the need of any third party via bitcoin.[2] In 2008, bitcoin was introduced in a white paper written by Santoshi Nakamoto.[3] Bitcoin was introduced as peer to peer digital currency where monetary transaction can take place without the intervention of third party.[3] Bitcoin was mainly responsible for the popularisation of the blockchain technology. Bitcoin used various concepts like hashing, digital signature, time-stamping among others. Bitcoin popularised blockchain by using it in financial domain but now blockchain being immutable, decentralised and distributed have gained popularity in various domains like supply chain [4], healthcare[5], insurance, digital identity management and many others. Many different types of blockchain have emerged recently but most of the blockchain retrieved their structure from bitcoin. This paper will discuss the structure of bitcoin blockchain in section 2, need for blockchain will be discussed in section 3 followed by generations of blockchain in section 4. Types of blockchain are discussed in section 5. Usecases are discussed in section 6 and paper is concluded in the last section.

II. STRUCTURE OF BLOCKCHAIN

Blockchain have mainly three components namely node, miner and block.

A. Block

It is the basic main component of blockchain. Block is divided into two sections, one is header section and another is body section. Every block consists of:

1) The data to be stored: The transactions that are to be stored in the blockchain are kept in the body section of the block
2) Nonce: Nonce is the value that when hashed along with the block, satisfy a particular condition like some numbers of zeros proceeding in the hash of the block.
3) Difficulty level: Difficulty level defined the number of zeroes preceding the block hash that is required. More number of zeroes means more difficulty.
4) Merkle tree root: All the transactions are hashed together to obtained the merkle hash. The merkle hash is used to ensure that no transaction is tampered with in the block.
5) Hash of the previous block : The hash of the previous block is included in the current block.

B. Miners

The miner is special software used to calculate extremely complicated problem of finding nonce. Nodes are registered on the blockchain by installing miner software. Mining block results in receiving bitcoin as reward. Every block contains hash of the previous block along with other details like difficulty level, merkle root and transaction data. To publish block in the blockchain the miner has to compete with all the other miners in the blockchain. Every miner node in the blockchain receives the various

verified transaction through gossip protocol. These verified transactions are kept in the transaction pool that is maintained by each node. One the transaction in the transaction pool reached the size of I block that is 1 MB the miner nodes try to publish their blocks. Every miner node that wants to publish block will have to compete with all the other miner nodes to compute a nonce value. Nonce is added to the block and resulting hash of the block satisfies the condition specified by difficulty level. Difficulty level condition can be like block hash should be preceded by 17 zeros. So, miner has to find value of nonce which can make the hash of the block such that it starts with 17 zeros.

C. Nodes

Blockchain technology is distributed and decentralised. It consists of various nodes. Nodes can be said to be any computational device that keeps a complete copy of blockchain. Nodes participate in the mining process and also the nodes have the complete copy of blockchain referring to that, nodes approve the various transaction done in the network.

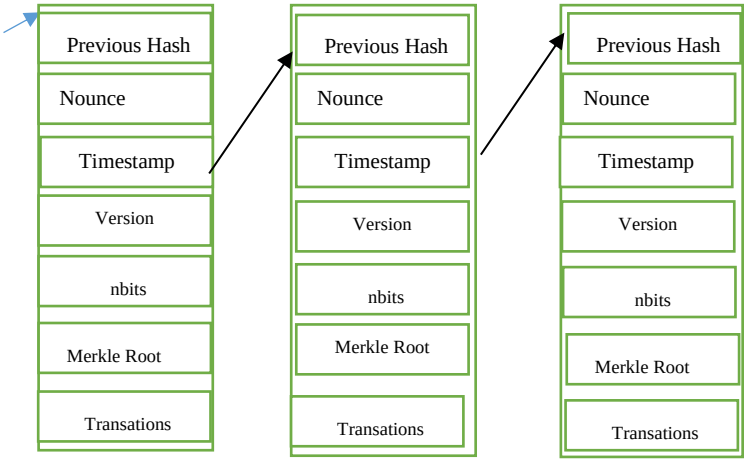

Fig. 1 Structure of the block chain

III. NEED FOR BLOCKCHAIN

Blockchain ensure a high level of trustworthiness. It provides an effective way to share data with the guarantee that it is tamper free. Mostly the data in the digital world in stored in the centralised servers. The safely of the data relies on the safety of the servers. Sometimes insiders are also involved in the malicious activities. This can lead to losses to the data owners. Blockchain with its features can be a good candidate to replace the existing infrastructure of storing data on centralised servers.

- Transparency is ensured as blockchain is available on every node on the network. Data cannot be altered once entered into the block as, It will not be validated by the other nodes.
- Transaction cost is reduced as it is a peer to peer network where transaction takes place without any third party.
- Decentralisation is ensured as; there is no central authority in blockchain. Nodes in the network collectively maintain the network.
- Complete backdate audit is possible as, data from the starting is available on the nodes of blockchain. In case of any doubt, data can be referred.
- It ensures data non repudiation as transaction is time stamped and digitally signed.

IV. GENERATION OF BLOCKCHAIN

Blockchain has come a long way from its introduction in 2008 [1]. Blockchain is now in its 3th generation.

1) First Generation: It started with introduction of bitcoin by Santoshi Nakamoto[3]. Bitcoin is peer to peer network. It is the first popular application of blockchain. Bitcoin enables users to send and receive e-cash without intervention of any third party. It also introduced first crypto currency to the world

2) Second Generation was started with introduction of ethereum. Bitcoin is decentralised and without any specific central authority. It does not require any third party to authenticate the transfer and provided security in the form of anonymity. There is a limitation in bitcoin, it allows only send receive and transfer operation. Ethereum overcome this limitation by introducing the concept of smart contract. Smart contract are conditions embedded in the ethereum blockchain which

triggers some transactions. For example if milk is received then only pay the e-currency to the deliveryman. By introduction of smart contract. Ethereum found application in various non financial domains.[10]

3) Third Generation: The first and second generation had some novelty, the third generation tried to solve some of the drawbacks of their predecessors. Both first and second generation faced limitation in scalability. Polkadot/Ethereum tried to provide a solution to scalability problem.[11]

V. TYPES OF BLOCKCHAIN

Blockchain can be classified into 3 categories

- Public blockchain: These type of blockchain is open to public. Anyone can register in the bitcoin blockchain and become a node in the network. Every node is able to read, write and audit the chain. There is no discrimination among anyone, every node can mine block. Consensus algorithm is used to manage the blockchain. Proof of work and proof of stake are two consensus algorithms that are used. Bitcoin and ethereum[10] are public blockchains.[7]

- Private blockchain: Private blockchains are controlled by an owner or organisation. The owner/organisation has all the powers only he/she can read write into the blockchain. Private blockchain can also give selective access to users to read/ write. It is more like an centralised system. Since only selected people are given permission to access the blockchain, it is also called as permissioned blockchain. Bank blockchain is an example of private blockchain[8]

- Consortium blockchain: In these blockchain there are more than one decision makers unlike private blockchain. Same kind of organisation can group together and create a consortium, where selected member organisation can be given the right of writing into the chain while other members can just view the blockchain. Energy web foundation is an example of consortium algorithm.[8]

TABLE I
TYPES OF BLOCKCHAIN

S.no	**Comparision of different types of blockchain**			
	Types of blockchain	**Who can view details**	**Who can mine blocks**	**Example**
1	Public	All nodes	All nodes)	Bitcoin , Ethereum
2	Private	Owner and permissioned nodes	Owner and permissioned nodes	Bank blockchain
3	Consortium	Only selected member organisation	All nodes	Energy web foundation

VI. BLOCKCHAIN USE CASES

Blockchain has found application in various domains some of the application areas are discussed below:-

1) Money Transfer and Payment Processing: The most basic application of blockchain is money transfer and processing. Blockchain can transfer crypto-currency from one person to another without the intervention of the third party. It saves on the transaction processing fees of the bank and also it is very fast and convenient.

2) Supply Chains: Blockchain can be used to monitor supply chain inventory. Enterprises are able to track inventories in real time as well as monitor the inefficacies in the supply chain.[10]

3) Sharing of Data: Since some organization data remain unused this data can be sold to the desired buyers. Blockchain can acts as a communication channels between the buyer and seller. Crypto currency IOTA has launched Data marketplace beta version for data sharing

4) Protection of Royalty and Copyright:: Copyright and Royalty information can be kept on blockchain for future references and it will aid in removing piracy from the music industry

5) Digital voting: Blockchain can be used for digital voting as blockchain is immutable the votes are secure and cannot be tampered with [16]

6) Digital IDs: In many 3rd world countries there are many people who don't have any identity proof. Blockchain can provide then with a digital ID without any requirement of address proof or any other kind of document.[13]

7) Transfer of Real Estate, Land, and Auto Title: All the registries and the land sale deal records can be kept on the blockchain for future references. This will avoid any kind of tampering with the records and blockchain can also help in verifying the historical data regarding the land sale and purchase.[15]

VII. CONCLUSIONS

As the world is developing to become a smart economy where everything is available at the click of the mouse, there is a growing concern regarding the security of the data. Mostly the data is stored online in centralized server which is prone to hacking and other malicious activities. Blockchain with its properties like immutability transparency, decentralized and distributed nature serve as a good candidate for storing and using data. Blockchain has a great future. It is been considered as the most disruptive technology that has the potential to change the face of computing. This paper is an attempt to introduce the concept of blockchain and its various properties to the fellow researchers and provide a basic understanding of the concept.

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Design of Efficient Hybrid Ternary Organic Solar Cell Using P3HT:CZTS:PCBM Blends for WSN Applications

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***Abstract*— The performance of organic solar photovoltaic (OSVs) have been showing huge advancement over last few years which attained the major attention of research community. Significantly, the proposed research work also focusses on organic solar cells (OSCs), because they have considered as very promising next-generation green technology owing to their low price, light weight, and flexibility. Hybrid OSCs with high conversion efficiency from different blends have been investigated in this manuscript. There are basically two hybrid OSCs have been designed and analysed in the study. One cell has optimized as "binary structure" hybrid OSC, developed from P3HT Poly(3-hexylthiophene) (donor-1): PCBM ([6,6]- Phenyl-C61-butyric acid methyl ester) (acceptor) blends with ratio of 1.0:1.0 that achieved power conversion efficiency (PCE) of 4.72%. The second one has been simulated from P3HT (donor-1): CZTS (Copper zinc tin sulfide) (donor-2): PCBM (acceptor) blends as "ternary structure" with ratio of 0.9:0.1:1.0 and attained PCE of 7.67 %. For the wider absorption of sun light spectrum, the quantum dots (QDs) of CZTS with the size of 1.25 nm and 2 nm have been blended which resultants improve the PCE from 4.72% to 7.67%. The research work has been determined the addition of QDs at nanoscale have responsible for higher efficiencies.**

***Keywords*— Energy Harvesting, Exciton Formation, Hybrid Organic Solar Cells, PCBM, Photon Absorption, Quantum Dots.**

I. INTRODUCTION

Solar power is one of the foremost renewable power resources. Among all the non-conventional sources, light energy is the most abundant and unlimited energy resources which comes from the Sun [1]. Light energy is the best emerging energy source on the globe and harnessing it in significantly way will become necessity of near future. An organic solar cell (OSC) is a photovoltaic device that utilize electrical characteristics of an organic material through a light absorption procedure, thereby originating charge transport mechanism within the material [2]. This principle contributes to the production of electrical power from solar light. Polymer solar cell is a common type or an example of OSC [3]. OSCs have little bit different architecture from inorganic solar cells. Unlike inorganic solar cells, the variance is in generation of current. In OSCs, the effective current is generated by excitons (hole and electron pair) instead of only electrons. Here a question is raised that what is an exciton? So, exciton is a tightly bounded electron and hole pair together by coulomb forces of attraction.[4] Therefore, same as valence and conduction band in inorganic materials, in OSCs have Highest Occupied Molecular Orbital (HOMO) and Lowest Unoccupied Molecular Orbital (LUMO). The potential difference between HOMO and LUMO is described as the energy band gap [5]. The performance of third generation solar cells been improved using a number of advances [6]. Fundamentally, these aspects fall into two categories; improvement in short circuit current density (Jsc) and open circuit voltage (Voc). The second aspects have also been considered better yield Fill Factor (FF) leading to higher power conversion efficiencies (PCEs) [7]. Many of these advances have been attained by utilization of inorganic nanoscale material systems in organic structures [8][9], essentially rendering these devices quoted as "hybrid". Hybrid solar cell consists advantages of both inorganic and organic semiconductors. Hybrid PV cells have organic materials that combine conjugated polymers used as the donor and transport holes that absorb light and inorganic materials has been utilized as the acceptor and electron transporter in the structure [10]. The hybrid PV devices have a potential for scalable solar power conversion not only low cost by roll-to-roll processing, also forming the photoactive layer by mixing organic materials as high electron transport materials [11]. The two materials are gathered in a heterojunction-type photoactive layer shown in fig. 1 below, which can have a better PCE than a single material. These hybrid organic-inorganic PV systems are metal oxide-organic, carbon nanotubes (CNT)-organic and semiconductor nanowire-organic systems [10]. The remainder of this manuscript is organized as follows, the design considerations of binary and ternary hybrid organic solar cells are presented in Section 2. Section 3 depicts the materials and theoretical equations for this work. The outcomes of the simulated solar cells are elaborated in Section 4 with research discussions. Finally, the conclusions of this study and future aspects are summarized in Section 6.

II. ORGANIC SOLAR CELLS

Organic Solar cells have been a topic of research focus in recent decades as they are a cost-effective renewable energy source due to their integrity with flexible, large-scale and high throughput roll-to-roll production [12] [13]. Over 10% PCE has been stated in both polymeric and small molecular solar cells. Recent progress in OPVs has been driven by the development of new

donor–acceptor photoactive materials and novel device architectures. The PCE of single junction OPV cells has reached 8% for both polymeric and small molecular solar cells. In particular, OPV cells with bulk heterojunction architecture (BHJ), in which the photoactive layer consists of a bi-continuous blend of an electron donor and an electron acceptor, has allowed PCEs over 8 %. Electron donor and electron acceptor materials, with ideal properties are requisite for reaching high PCE's [14]. Moreover, OSCs can be classified on the basis of layer structure as: Single layer OSCs, Bilayer OSCs, Bulk Heterojunction OSCs [15]. The basic steps of operation of organic solar cells includes the absorption of light by organic semiconductor molecules generating electrostatically bounded electron hole pair called excitons, in order to split the excitons, OSC generally prefers a heterojunction of two materials with different electron affinities, this causes the key difference in working mechanism of organic solar cells compared to inorganic alternatives [16]. Thus, the next important step is the diffusion of excitons from where they are generated to the heterojunction interface, where it under goes splitting into free charges and then they are transported to the corresponding electrodes of different work function [16].

D. Binary P3HT: PCBM blends OSC without QDs

The research work has been designed hybrid binary OSCs structured from P3HT (donor): PCBM (acceptor) with blends ratio of 1.0:1.0 in the active layer. The layered structure diagram given below in fig. 1 for binary hybrid P3HT: PCBM blends OSC. Glass, ITO (Indium tin oxide), Al (aluminium) and PEDOT:PSS (poly(3,4-ethylenedioxythiophene): polystyrene sulfonate), are used as transparent surface, transparent electrode (anode), the back contact (cathode), and hole transporting layer (HTL), respectively.

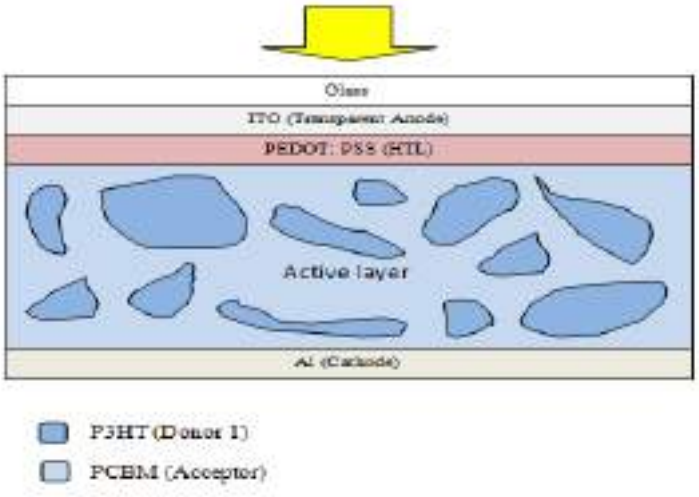

Fig. 2 Layered structure diagram for binary P3HT: PCBM blends BHJ-OSCs

E. Ternary OSC using P3HT: CZTS: PCBM blends

The further research work has been simulated hybrid ternary OSCs structured from P3HT (donor-1): CZTS (donor-2): PCBM (acceptor) with blends ratio of 0.9:0.1:1.0 by altering the active layer. The CZTS (donor-2) has utilized as quantum dots (QDs). The layered structure diagram and energy level for different materials are given below in fig. 2 and fig. 3, respectively.

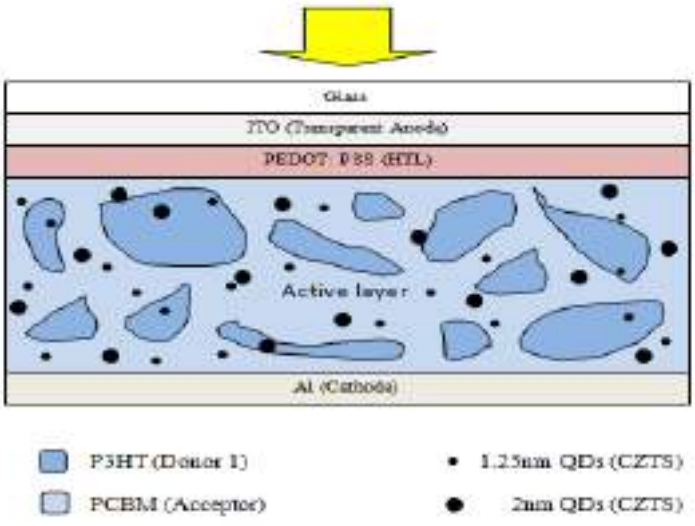

Fig. 3 Layered structure diagram for Ternary P3HT: CZTS: PCBM blends BHJ-OSCs

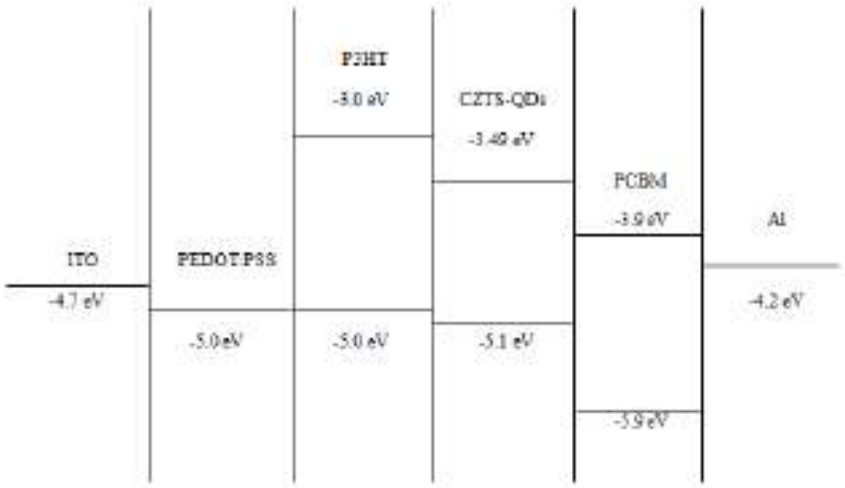

Fig. 4 Energy level diagram for ternary hybrid P3HT: CZTS: PCBM blends BHJ-OSCs with layered structure.

III. Materials and Theoretical Design

F. CZTS Quantum Dots

The Copper zinc tin sulfide (CZTS or Cu2ZnSnS4) with direct band gap energies (ranging from -3.49 eV to -5.1 eV) has been used as QDs with different radius for the tuning of bandgap. The different radius size of CZTS QDs (from 0.25 nm to 10 nm) have been considered for better absorption properties, because different size of QDs radius having different absorption properties. The band gap energy of CZTS QDs is 1.61 and having a dielectric constant of 6.7 [17]. The absorbance peak of CZTS has been achieved at 625 nm with 90 nm Full Width at Half Maximum (FWHM) length.

G. PCBM Organic Material as Acceptor

PCBM: [6,6]- Phenyl-C61-butyric acid methyl ester has been applied as an acceptor material. PCBM has better electron mobility and very high electron affinity. PCBM provides rapid and efficient exciton dissociation and charge transfer. The PCBM material's band gap energy having 2.0 eV with HOMO level and LUMO level is -5.9 and -3.9 eV, respectively, with a dielectric constant of 3.5. The absorbance peak of PCBM has been achieved at 690 nm with 130 nm FWHM length [18].

H. P3HT Organic Material as Donor

The Poly(3-hexylthiophene) (P3HT) is semiconducting organic polymer which has been applied as donor material in the active layer for BHJ-OSCs. P3HT has really low ionization potential so it can easily release electron after absorbing photon having energy equal or greater than its bandgap energy. The P3HT material's band gap energy having 2.0 eV with LUMO level and HOMO level is -3.0 eV and -5.0 eV respectively, with dielectric constant of 3.53. The absorbance peak of P3HT has been achieved at 525 nm with 150 nm FWHM length [19].

I. Design Equations

The various photonic equations have been solved in this study. The findings of this work mainly associated with the famous 'Brus Equation', which has been utilized to determine the emission of energy in QDs. The open circuit voltage (Voc) for binary OSC has been calculated from following equation.

$$V_{OC,binary\ OSC} = (1/e)\left(|E^{DONOR}HOMO| - (|E^{ACCEPTOR}LUMO|)\right) - 0.3\ V \quad (1)$$

$$V_{OC,Ternary\ OSC} = \frac{f_{d1}}{f_{d1}+f_{d2}} V_{OC1} + \frac{f_{d2}}{f_{d1}+f_{d2}} V_{OC2} \quad (2)$$

Where, V_{OC} is the open circuit voltage

$e = 1.6 \times 10^{-19}$ C

$E^{DONOR}HOMO$ = -5.0 eV for P3HT

$E^{ACCEPTOR}LUMO$ = -3.9 eV for PCBM

V_{OC1} is the open circuit voltage of P3HT: PCBM

V_{OC2} is the open circuit voltage of CZTS: PCBM

f_{d1} fraction of donor 1 P3HT

f_{d2} fraction of donor 2 CZTS

$$G_{D1,2,3}(\lambda) = exp\left(-4log_2\left(\frac{\lambda - E_{g1,2,3}}{W_{D1,2,3}}\right)^2\right) \quad (3)$$

Where, G (λ) Absorption profile

1,2,3 = for donor 1, donor 2, donor3

λ = solar spectrum wavelength = 250nm to 4000nm

E_g = wavelength at absorption peak = 525 nm

W_D = full width at half maximum (FWHM)= 150 nm

$$A(\lambda) = 1 - exp\left(-\frac{L_{device}}{L_{eff}(\lambda)}\right) \quad (4)$$

Where, $A(\lambda)$=Absorption Spectrum for hybrid BHJ-OSC

L_{Device}= Thickness of active layer = 200 nm

$L_{eff}(\lambda)$ = Effective absorption length

$$\dot{n} = \dot{p} = \frac{1}{L_{Device}} \int \frac{AM\ 1.5(\lambda) \times IQE \times A(\lambda)}{E_{ph}} d\lambda \quad (5)$$

Where, $AM\ 1.5(\lambda)$= Solar spectrum

IQE= Internal Quantum efficiency

$\dot{n} = \dot{p}$ = Electron/Hole generation rate

L_{Device}= Thickness of active layer = 200 nm

$L_{eff}(\lambda)$ = Effective absorption length

$$J_{sc} = q \times \dot{p} \times L_{Device} \quad (6)$$

Where, J_{sc}=Short circuit current density

q= Electron charge

$\dot{p}$= Hole generation rate

L_{Device}= Thickness of active layer

$$FF = \frac{V_m \times J_m}{V_{OC} \times J_{SC}} \quad (7)$$

Where, FF = Fill Factor

V_m = Maximum Voltage

V_{OC} = Open Circuit Voltage

J_m = Maximum Current Density

J_{SC}= Short Circuit Current Density

$$\eta = \frac{FF \times V_{OC} \times J_{SC}}{P_{in}} \quad (8)$$

Where η = Power conversion efficiency

P_{in}= power of incident light = 1000 W/m^2

FF = Fill Factor = 0.85

V_{OC} = Open Circuit Voltage = 0.81 V

J_{SC}= Short Circuit Current Density = 112 A/m^2

IV. Results and Discussion

In ternary hybrid OSCs, short circuit current density has been executed from absorption profile, absorption length, absorption spectra and generation rate of electrons and holes. Significantly, the parameters of QDs for emission of energy have been calculated from Brus equation. Here donor 1 is P3HT, donor 2 is CZTS QDs with radius size 1.25 nm, donor 3 is CZTS QDs with radius size 2.0 nm and like as have different absorption at-tribute. The open circuit voltage (VOC) for binary and ternary OSC has been calculated from equation 1 and equation 2. Here, absorption properties of QDs was considered, so here all different sized QDs considered as individual donor material. For this case it can be said that three different donors were blended together. Resultant absorption has impact of all these donors. Absorption Profile G (λ) of QDs has been calculated from equation 3. By substituting all values in the above equation for donor 1 (P3HT), donor2 (CZTS QDs with 1.25 nm Radius) and donor 3 (CZTS QDs with 2.0 nm) to calculate the absorption spectrum graph through MS Excel and MATLAB which has been depicted in the following fig. 4, which described absorption profile for P3HT donor and CZTS QDs. The maximum peak for P3HT donor shows in solid blue line, the first peak for CZTS QDs (1.25 nm radius) in straight black line and last peak for CZTS QDs (2 nm radius) as solid green line. The absorption profile for different materials depends on absorption peak, FWHM and wavelength of solar spectrum.

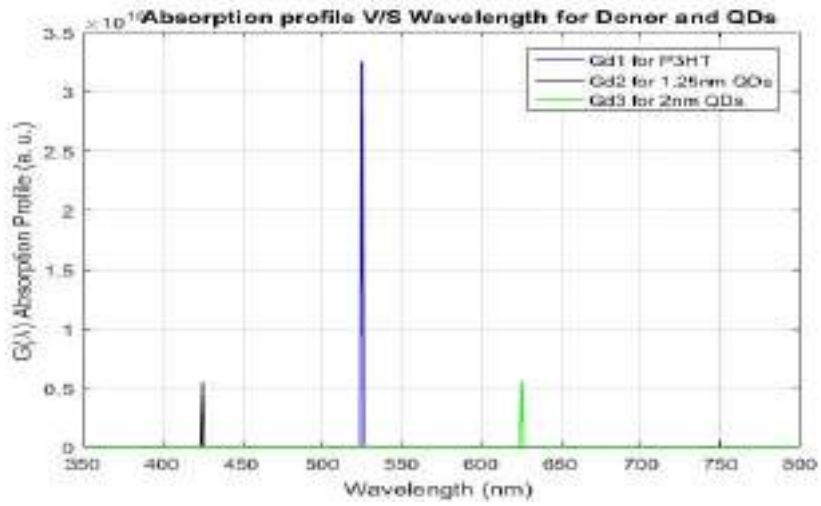

Fig. 5 Graphical representation of Absorption Profile G (λ) for P3HT and CZTS QDs

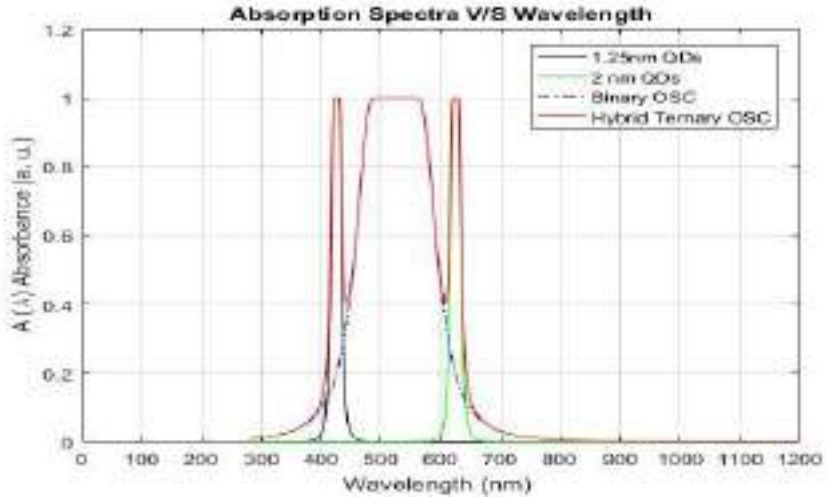

Fig. 6 The graphical representation of Absorbance Spectra

The further step is determination of flux generation of electrons and holes from absorption spectrum and absorption length of donors and QDs. The absorption length L (λ) of QDs has been obtained from the equation 4. The next step to calculate short

circuit current density has executed absorption spectrum from the above equation 5 by substituting values. By substituting all values in the above equation for absorption spectrum graph which has been shown in the fig. 5, which described the absorbance spectra for binary P3HT: PCBM blends OSC, as well as ternary P3HT: CZTS: PCBM blends OSC and CZTS QDs. The absorption spectra for different materials depends on absorption length, fraction of the materials in blends and wavelength of solar spectrum. The different coloured lines present in the plot legend depicts absorbance spectra for different donor and QDs materials. The blue dash-dotted line shown the absorbance for binary OSCs due to P3HT: PCBM blends which covers the wave-length slot from 450 nm to 610 nm. The black solid line described for 1.25 nm CZTS QDs and green straight line for 2 nm CZTS QDs that wavelength slot from 420 nm to 440 nm and 610 nm to 630 nm respectively. Here, the ternary hybrid OSCs structured by adding P3HT donor, CZTS QDs with 1.25 nm radius and 2 nm, and PCBM acceptor. The absorption spectra for optimized ternary hybrid OSCs described in the following fig. 5 with legend of solid red line which covered wavelength width of 410 nm to 630 nm. The Electrons/Holes generation rate can be calculated from the equation 5. Fig. 6 represent the flux of generated hole/electron in different donor materials at respective absorbed wavelength. The legend of graph, different lines represent the attribute of different donor materials.

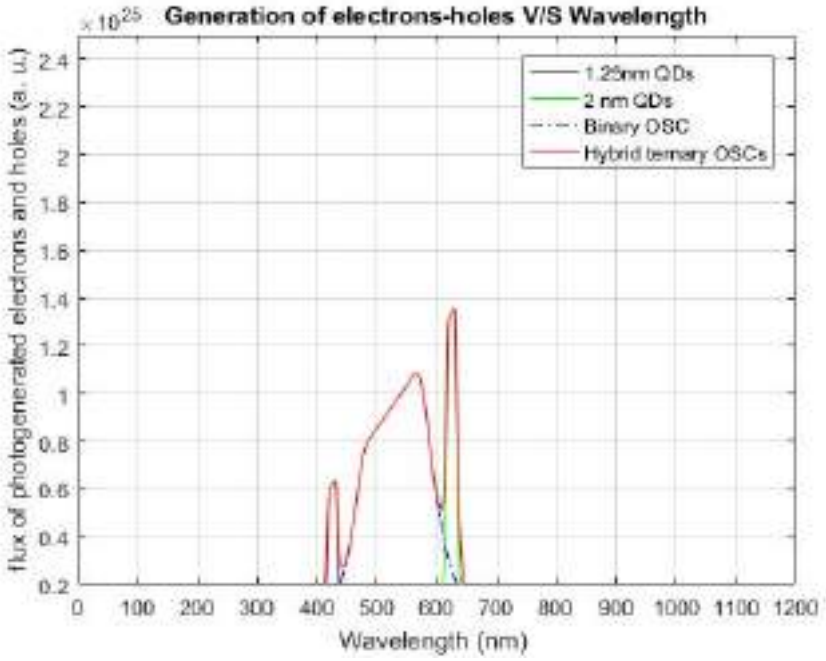

Fig. 7 The graphical representation for generation of electrons-holes

The generation of electrons and holes for different materials depends on absorption spectra, internal quantum efficiency, effective absorption length and solar spectrum. The different colored lines present in the plot legend depicts generation of electros and holes for different donor and QDs materials. The blue dash-dotted line shown the generations for binary OSCs due to P3HT: PCBM blends which covers the wavelength slot from 430 nm to 620 nm. The black solid line described the 1.25 nm CZTS QDs and green straight line for 2 nm CZTS QDs that wavelength slot from 410 nm to 430 nm and 610 nm to 630 nm respectively. Here, the ternary hybrid OSCs developed by adding P3HT donor, CZTS QDs with 1.25 nm radius and 2 nm, and PCBM acceptor. The generation of electrons and holes for optimized ternary hybrid OSCs described in the following fig. 5 shows red solid line with wavelength width of 410 nm to 630 nm. Finally, the short circuit current density has been calculated by substituting values in the equation 6.

TABLE II
COMPARISON OF VARIOUS PERFORMANCE PARAMETERS

S. No.	Parameters	Voc (V)	Jsc (A/m^2)	FF (%)	PCE (%)
1.	This Work (Binary OSC)	0.8 V	68.53	86	4.72
2.	This Work (Ternary OSC)	0.81 V	68.53	84	7.67
3.	[20]	0.62 V	18.76	51.6	3.51
4.	[21]	0.57 V	10.5	60	3.47
5.	[22]	0.57 V	10.3	63.6	4.15
6.	[23]	0.61 V	121.41	69.4	5.15

The fill factor (FF) for binary OSC has been intended from equation 7. The parameters have been substituted in the above equation and we attained FF = 0.86 or 86%. The PCE for binary OSC has been obtained from above equation 8. By substituting

these all values, PCE of binary bulk-heterojunction OSCs is 4.71%. The all performance parameters for binary P3HT: PCBM blends and ternary hybrid P3HT: CZTS: PCBM blends OSCs has been shown in below plot fig. 7.

	Voc	Jsc	FF	PCE
P3HT:PCBM	0.8000	68.5391	0.8607	4.7196
P3HT:CZTS:PCBM	0.8100	112	0.8439	7.6562

Fig. 8 All performance parameters for binary P3HT: PCBM blends and ternary hybrid P3HT: CZTS: PCBM blends OSCs

V. Conclusion and Further Work

The comparative analysis between binary P3HT: PCBM blends BHJ-OSC and ternary hybrid P3HT: CZTS: PCBM QDs blends BHJ-OSC. The open circuit voltage (VOC) for both (binary P3HT: PCBM blends and ternary hybrid P3HT: CZTS: PCBM QDs blends) OSCs having 0.8 V and 0.81 V respectively, that reveals QDs in the ternary hybrid OSCs slightly increase in the VOC. From the graph, it has been concluded that the short circuit current density (JSC) for both (binary P3HT: PCBM blends and ternary hybrid P3HT: CZTS: PCBM QDs blends) OSCs is 68.6931 A/m2and 112 A/m2 respectively, that drastically increased with QDs. The Fill Factor (FF) has been observed for both (binary P3HT: PCBM blends and ternary hybrid P3HT: CZTS: PCBM QDs blends) OSCs is 0.8607 and 0.8439 respectively, that slightly decreases with QDs. The overall performance in terms of PCE for both (binary P3HT: PCBM blends and ternary hybrid P3HT: CZTS: PCBM QDs blends) OSCs having from 4.71 % and 7.65 % respectively, that shows enhancement in performance of ternary hybrid BHJ-OSC.

The further work will extend to fabricate ternary hybrid OSC with improved performance parameters and also comparing with the previous outcomes in this field like their electron and hole diffusion lengths, PCE, open circuit voltage and short circuit current. For better power PCE, some antireflection coating and self-cleaning mechanisms can be explored that will leads to reduce reflection losses and transmission losses by trapping more light energy.

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A Review on Comparative Study of Different Textile Substrate Materials in Textile Microstrip Patch Antenna Design

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***Abstract*—This review paper focuses on latest advancements in the field of wearable textiles microstrip patch antennas and pays attention to the adequate requirements of wearable textile microstrip patch antenna during designing. The desirable performance characteristics and choice of various textile materials which can be used while designing of wearable textile antenna has also been covered in this paper. The effect on using several different flexible textile materials as substrate in wearable textile microstrip patch antenna design on the antenna performance characteristics –radiating frequency, return loss (S_{11}), gain (dBi), radiation pattern and bandwidth have been analyzed. It also covered the Specific Absorption Rate analysis as well as bending analysis of various textile microstrip patch antennas. The research papers which have been considered for the study and analysis of textile antennas have been simulated in CST Microwave Studio or HFSS (High Frequency Structure Simulator) and papers have been practically implemented and tested using Network Analyzers.**

Keywords—WBAN, Textile Antenna, CST, Dielectric constant, SAR, substrate.

I. INTRODUCTION

Wireless wearable communication is a field of increasing research interest because of the several applications in fields like functional clothes for healthcare and fitness monitoring [1], in mobile communication, satellite communication [2] and smart skin to name a few. In the traditional wearable systems, battery and antenna takes large space. But due to the latest advancements in fabrication technologies, now days the size of the wearable computing systems are getting miniaturized and textile materials are being used in fabrication of antennas. The advantages of textile materials from conventional substrate materials are that they can undergo multiple bending and hence is unobtrusive [3]. The various features like effective cost, low profile & weight and easy realization makes the textile antennas more advantageous. There are a large number of ways to enhance the bandwidth of textile antennas, by increasing substrate's height, by using substrate of low dielectric constant, by reducing ground plane, by making use of parasitic element etc. [4] As the low value of dielectric constant helps in reducing losses related to surface wave and improving impedance bandwidth of antenna so generally the textile materials having a very low dielectric constant is preferred for designing a textile microstrip patch antenna. The various features comfort of making different geometries, smaller size, light weight and the planar structures of textile microstrip patch antennas made them the best option for integration into clothes [5] . Thus, the development of flexible and wearable antennas is an interesting area that needs to be studied, since the substrate materials (paper, polymers, and textiles) and the fabrication methods are completely different from the ones used for traditional and mechanically rigid antennas.

This paper is organized as follows: Section II covers the structure of microstrip patch antenna. Section III includes the different types of materials along with their characteristics which can be used to design textile microstrip patch antennas. The various parameters which affect the antenna performance, also that needs to be taken care of while designing textile antennas are included in Section IV. Analysis of Specific Absorption Rate and Bending are included in Section V and Section VI respectively. Section V presents the effect of variations in dielectric constant on the textile antenna performance. Finally, a conclusion has been drawn in the last.

II. STRUCTURE OF MICROSTRIP PATCH ANTENNA

A microstrip patch antenna basically consists of: Radiating patch (perfect electric conductor- PEC), substrate (dielectric material of permittivity -ε r), ground plane (perfect electric conductor- PEC). The substrate is sandwiched between the radiating patch [2] and the ground plane i.e. the radiating patch resides on the top of the substrate and ground plane on the bottom side of the substrate as shown in Fig 1. The patch is generally made of conducting material such as copper or gold having minimal resistance and it can be of any shape such as square, rectangular, triangular, circular, circular ring and elliptical [5]. Usually, square, rectangular and circular shapes are most common because of their ease of fabrication and analysis. The radiating patch and feed line is usually etched on the dielectric substrate. The feed line is used to feed the electrical signal from the port to the patch for radiating it in form of EM waves from the surface of patch. Fig 1 shows basic structure of microstrip patch antenna consisting of a patch of length 'L', width 'W' and thickness 't' on the top of the substrate of height 'h' with ground plane at the bottom side of substrate of same thickness 't' as that of the patch.

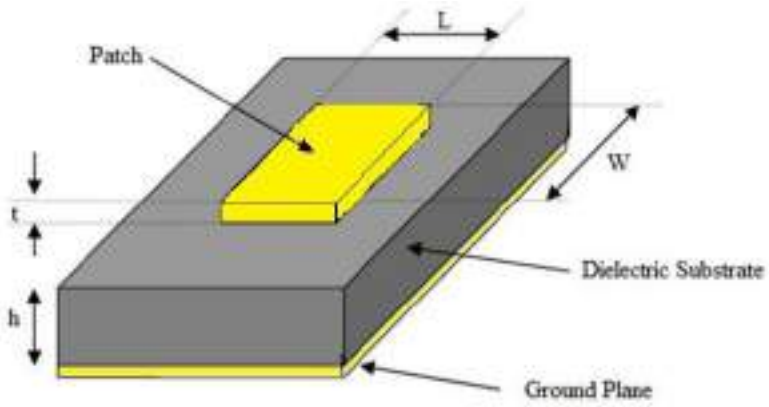

Fig1. Structure of Microstrip Patch Antenna

III. MATERIAL USED FOR DESIGNING OF TEXTILE MICROSTRIP PATCH ANTENNA

The first step while designing the textile microstrip patch antenna is the selection of material which is used to design the antenna. The basic properties which need to keep in while designing textile antenna is the permittivity or dielectric constant and loss tangent of the substrate material. The permittivity of substrate specifies its capability to pass electric field, while loss tangent allows the dielectric losses in dielectric material [2][3].Three most important characteristics of substrate- dielectric constant, thickness and loss tangent must be measured and controlled so as to reach the specifications of the different applications [6]. The several textile materials both conducting as well as non-conducting used by various researchers along with their properties have been tabulated in Table I.

Table I. Comparison of different textile materials

Application	**Quantity**				**Conductive material used**
	Material for substrate	***Thickness (h) (in mm)***	***Dielectric constant*** (ε)	***Loss tangent*** **(tanδ)**	
WBAN applications [7]	Dacron	-	3	.025	Perfect electric conductor (PEC)
GPS [8]	Jeans fabric	1	1.7	.025	WECF adhesive copper sheet
Medical Monitoring applications [9]	Flannel	3	1.7	.025	High quality conducting thread
Satellite Applications [10]	Denim	0.7	1.6	.02	Copper
Spacesuit applications [11]	double-layered Peltex70 ultrafirm stabilizer	1.51	1.19	-	Less EMF nickel–copper polyester ripstop
Tracking and navigation [12]	Wash cotton	3	1.51	-	Annealed copper
	Curtain cotton	3	1.47	.04	
	polyester	2.85	1.44	-	
	polycot	3	1.48	.04	
Tracking, search and rescue communication purposes [13]	Felt	2	1.22	.02	Shieldit Super textile (Ni and Cu coated polyester)

IV. VARIOUS PARAMETERS THAT NEED TO BE IN MIND WHILE DESIGNING TEXTILE ANTENNA

The textile patch antennas must have minimum magnitude of following parameters so that they can be practically used in communication systems.

A. Return Loss

It is the ratio of the power that comes back towards source of the antenna after getting reflected to the total power given the antenna.Generally as per IEEE guidelines reflection losses in textile antennas should always lie below -10 dB, which shows that only 10% of power given to antenna is reflected back towards source, while 90% power is transmitted / radiated [2].

B. Acceptable gain:

The antenna gain shows its ability to concentrate radiated power towards a desired side in comparison with the isotropic antenna's radiated power towards the same side. The textile antenna must have gain value around 4dB or more than 4dB without considering the effects of bending and crumpling [14].

C. Adequate Directivity:

Directivity generally shows the antenna capability to direct energy in a specified direction. For practical purposes, its value should always be equal or greater than 3dBi under normal conditions [14].

D. Impedance bandwidth :

The bandwidth defines the frequency band under which antenna can operate effectively. It always depends upon the application for which antenna is designed. For practical purposes, -10dB bandwidth of antenna is always preferred over -3dB bandwidth. One more point which is important that bandwidth of antenna should not be changed even under bending and crumpling situations [5].

E. Radiation Efficiency:

The total amount of power radiated by antenna to the total amount of power given to the antenna gives the efficiency of antenna. The desired value of radiation efficiency for textile patch antenna is above 90% and need to maintain under bending & crumpling conditions.

F. Voltage Standing Wave Ratio (VSWR):

Under the situation, when load does not absorb the incident power completely and reflects back due to impedancemismatch of source load, then both forward signal and reverse signal mixes, which forms the standing wave pattern of voltage towards the line. VSWR is generally measured in terms of maximum to minimum ac voltage along the transmission line. In textile antennas, its acceptable value is always less than 2 at resonant frequency [3].

G. Radiation Pattern:

It represents the coverage area of antenna in free space. The radiation pattern basically shows the radiated field's strength quality in several directions at a certain distance from the antenna [2]. Textile Patch antenna radiation pattern must show minimal fluctuations in terms of half power beam width and side lobe level.

H. Impedance:

The antenna input impedance and port impedance must perfectly matched for transferring maximum amount of power. For this reason, the feed line of appropriate width needs to be used for matching the impedance of antenna with port impedance [2].

I. Selection of material for conducting Patch and ground :

High conductivity, flexible structure, minimum copper losses, homogeneous sheet resistances [13] are the desirable charactersticks for conducting elements used in textile antenna designing. Moreover, these also should have good adhesive properties with the substrate used in antenna design. Various conducting materials such as zelt, high quality conducting thread, perfect electric conductor (PEC) Copper foil tape (CFT), Ni and Cu plated polyester fabric, shield It fabric etc. can be used for the designing of textile patch antenna.

J. Selection of substrate material:

In designing of textile patch antenna, substrate is very crucial. The textile material used for substrate must have low thickness and permittivity. Permittivity should lie in range1.05 to 1.9 while the loss tangent should lie in range of 0.0001 to 0.025. Various textile materials which can be used as substrate are already mentioned in TABLE I along with their properties.

V. Specific Absorption Rate

The rate of absorption of EM waves by human body is called specific absorption rate (SAR). The most commonly considered SAR limits while evaluating antenna performance are 1.6W/Kg provided by IEEE for any 1g of tissue and 2W/Kg for any 10g of tissue by ICNIRP (International Commission on Non Ionizing Radiation) [15][16]. The effect of body influence on the performance of wearable textile microstrip patch antenna and the amount of Specific Absorption Rate (SAR) absorbed by human bodies are two main parameters considered for on-body measurement for wearable antennas. It is always desired to design and employ the textile microstrip patch antenna in the wireless communication systems which should not have any influence on its performance by the presence of human bodies around it.It has been found that efficiency as well as gain of textile patch antenna reduces to half of its value when antenna is kept on human body. It has been experimentally proved that by employing the high thickness textile substrate and additional layer of fabric tends to reduce SAR [15]. It was experimentally proved by employing cotton of different thickness – 1mm, 3mm and 10mm between the textile antenna and human body and it was observed that as the thickness of cotton increase leading to better isolation between the antenna and human body, the SAR magnitude dropped from 10.4W/g to 3.12W/g [16]. Thus, it was concluded that the placement of cotton between the textile antenna and the human body leads to reduction of Specific Absorption Rate (SAR). It was also observed that simulated SAR rapidly increases for textiles with conductivities lower than 1 x 10^4 S/m. However, above this threshold value SAR saturates. Moreover, antenna topology and size of ground plane also plays a crucial role to ensure that whether antenna is operating under SAR limits or not. Because these

provides shielding to the user from antenna radiations [16]. Generally at higher frequencies SAR will be higher due to intrinsic properties of human bodies. Even human phantom models are also available to perform the SAR analysis: Homogeneous model and voxel model and used by various researchers for SAR analysis.

VI. EFFECT OF BENDING ON TEXTILE ANTENNA PERFORMANCE

The performance of textile microstrip patch antenna when subjected to different bending angles (like 20 degrees, 40 degrees,60 degrees, 80 degrees etc.) or different bending radius have been analyzed by various researchers.

D. Ferreira et al. presented a study on effect of bending on a textile microstrip patch antenna made up of denim substrate.The obtained gain of textile antennawas 4 dBi and half-power beam width (HPBW) of 70 degrees in the flat position of the body. It was seen that the gain decreases by 2 dB while HPBW increasedby 25, when subjected to a wrist equivalent bending (202 degrees angle) [17]. Hung-Chi Yang et al.presented a textile semi-triangle shaped wearable dual band monopole patch antenna [18] using a denim fabric.Foam cylinders of radii 3cm and 6 cm were used to check the performance of the textile antenna on wrist and arm position. It was observed that VSWR remained unchanged < 2, while gain and efficiency degraded when antenna was placed on the body. ShuvashisDey et al. carried out the bending analysis of three microstrip patch antennas made of Dacron, fiberglass and fleece, respectively and was concluded that the bending leads to drop in return loss to-12.71dB, the deviation in resonant frequency towards lower side and increase in side lobe level (SLL) [19].

It has been observed that bending across the width of microstrip patch antenna causes frequency towards downward offset. While bending across length causes upward frequency offset because current flow is aligned with antenna length and the magnetic field is aligned with antenna width. Hence, if bending is done across antenna length, one can expect higher impact on the performance.

VII. VARIATIONS IN ANTENNA PARAMETERS WITH THE USE OF DIFFERENT DIELECTRIC MATERIALS

The employment of different dielectric materials as substrate in the microstrip patch antenna design affects the antenna performance in different ways. Hung-Chi Yang et al.presented a textile semi-triangle shaped wearable dual band monopole patch antenna [18] using a denim fabric. M. I. Ahmed et al. used three textile materials Goch, Jeans and Leather as substrates for designing the three textile wearable antennas for Bluetooth application [8]. Shahid Bashir et al. proposed a dual band wearable PIFA designed to operate at 2.4GHz and 5.8GHz [19]. N. Gupta et al.,designed and fabricated a triple band stacked textile antenna employing jeans and foam substrate. The achieved value of directivity was 6.123dBi at 3.924 GHz [20].V. Kumar Singhet al.designed, fabricated and measured a dual-band textile antenna with partial ground plane and printed slot using jeans as a substrate [21].Peak gain of 5.7 dB and stable radiation pattern was achieved by the proposed antenna. G. Montiet al.proposed a wearable logo-antenna to track the portable wearable accessories. Leather was used as a substrate [22].Mohd.I.Jais et al. designed, fabricated and tested a textile antenna with capabilities of beam steering, intended to use for WBAN applications[23]. Mohd. E. Jalilet al. evaluated atriple bandtextile dipole antenna having fractal Koch, in terms of return loss, gain and radiation pattern on the behalf of resonant frequency and bandwidth [13]. Denim jeans was the substrate used along two separate conducting materials-copper foil tape and shield It fabric. A comparison analysis of a few recent research papers using different textile materials as a substrate in terms of different performance parameters has been done in TableII.

TABLE II. PERFORMANCE BASED COMPARISON OF DIFFERENT TEXTILE ANTENNAS

Parameters	**Paper 1 [15]**	**Paper 2 [24]**	**Paper 3 [22]**	**Paper 4 [25]**	**Paper 5 [28]**
Material for substrate, patch and ground plane	Denim, patented Cu and Ni plated polyester fabric	Felt and Cu sheets	PET and Jeans	Felt and two types of conducting materials-Cu foil tape (CFT) and Shieldex (SH)	Polyester substrate and Copper sheets as conducing medium
Dielectric Constant (ε_r)	1.6	1.2	2.5 (PET) 1.7(Jeans)	1.2	2.1
Resonant frequency (GHz)	2.39 (simulated) 2.39 (measured)	2.45 (free space) 2.47 (on body)	2.42 (PET) 2.71 (Jeans)	2.45	2.4
Gain (dBi)	4.6 (simulated) 3.8 (measured)	3.6 (measured) 3.1 (simulated)	1.40 (measured PET) 1.21 (Measured Jeans)	4.48, 1.47 and 0.64	2.9
Bandwidth (MHz)	140	152	372(PET) 444(Jeans)	2.31%	109%

Return Loss (dB)	-16 (simulated) -17.7 (measured)	-24 (free space) -18 (on body - chest)	-18.92 -15.02	-33.30 (flat position) 28.48 (On arm with clothes) -21.08 (On arm without clothes)	-16.27
VSWR	< 2	< 2	< 2	< 2	< 2

From the table II it has been concluded that:

a) The band width of antenna increases as the dielectric constant of textile substrate decreases.

b) Gain is inversely proportional the dielectric constant of textile substrate.

c) Felt provides the best reflection coefficient (-33.30 dB) and gain 4.48 in flat position of body like chest.

d) Copper foil tape (CFT) can be usually preferred as a conducting material to form the ground plane and the radiating patch due to its high conductivity and low thickness.

VIII. CONCLUSION

In this paper, the performance analysis of the different textile microstrip patch antennas employing different textile materials (felt, jeans, cotton, polyester, fleece etc.) in terms ofreturn loss, gain, bandwidth and VSWR have been observed.The paper also focus on the basic requirements of textile microstrip patches antennas, the various textile materials employed in the textile antennas and their characteristics. It has been concluded that the textile antenna bandwidth, gain and directivity can be improved by employing textile substrate of low dielectric constant.

Further, it has been concluded from the textile antenna bending analysis research work carried out by the various researchers that the bending of textile antennas leads to drift in the operating resonant frequency, little distortion of radiation pattern and increase in side lobe level.It has also been seenthat the employment of textile antenna in close vicinity to human body leads to increase in SAR (Specific Absorption Rate) and decrease in antenna return loss, gain, efficiency and bandwidth. The placement of cotton between the textile antenna and human body leads to decrease in SAR and improvement in return loss and antenna bandwidth but the antenna gain and directivity decreases.

This survey will encourage to design and built a novel, dependable, reliable, and secure wearable textile antenna. These textile antennas can be used in a wide range of applications like WBAN, tracking, telemedicine, navigation, public safety and defence etc.

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Hybrid Beamforming Technique for OFDM millimeter Wave MIMO Systems

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***Abstract*— Upcoming wireless communication services like concept of smart cities, connected vehicles, augmented reality and Internet of Things (IOT) will revolutionize the society. With the implementation of these applications and services, it is expected that around 50 billion devices will be serving the society in near future. Hybrid beamforming for massive MIMO systems is considered as fundamental backbone to enhance system capacity of next generation communication systems to meet the increasing demands of data traffic in near future. In this paper, a manifolds based hybrid beamforming technique is proposed which produces near optimal performance in terms of spectral efficiency for wideband OFDM millimeter wave massive MIMO environment. The proposed technique need less hardware resources, which in turn results faster processing, lower cost and lower power consumption and makes it more suitable for practical implementation.**

***Keywords*— Hybrid Beamforming, Hybrid Precoding, Multiuser massive MIMO, millimeter Wave Communication, Spectral Efficiency.**

I. INTRODUCTION

Wireless connectivity has become essential part of day-to-day lives across the Globe, as new services and applications are launched frequently to ease the everyday tasks. The society has witnessed the revolution in streaming media; now a day's music/movies on demand, cable TV, etc. are delivered over the internet. Concept of smart cities, connected vehicles, connected machines, Internet of Things (IOT) will further revolutionize the society [1]–[4]. With the implementation of these applications and services, it is expected that around 50 billion devices will be serving the society in near future which include human to human, machine to machine, human to machine and machine to human communication. The bandwidth hungry applications like: augmented reality, connected vehicles, connected machines, ultra-high definition video streaming, etc. will need increased capacity, seamless connectivity, low latency and high service quality almost on every part of globe [5]. Therefore, to meet continuously increasing demand of data traffic with seamless connectivity and service quality, the capacity of current network has to increase exponentially. The communication industry experts and researchers form different part of global are investigating different technological aspects of wireless technology to meet this foreseeable growth in data traffic in near future.

Millimeter Wave Systems are capable of providing high data rate to meet the increasing demands of data traffic in near future. The shorter wavelengths associated with millimeter waves ranging from 30Ghz to 300 Ghz allows the designers to fabricate comparatively large number of antennas in small physical dimensions. It enables the use of large number of antennas for building massive multiple-input-multiple-output (MIMO) systems capable of providing sufficient gain to overcome heavy path losses associated with millimeter waves [6]–[10]. Massive MIMO Systems attracted the attention of academia and industry, as they are well suited for enhancing the capacity of modern communication systems. However, before the practical implementation of massive MIMO systems, few challenges need to be addressed. The conventional MIMO systems used analog beamforming in radio frequency (RF) domain which applies phase shifts before each antenna element. Analog beamforming requires relatively resources and is cost effective but at the same time, it is incapable of providing required flexibility for massive MIMO systems. The conventional fully-digital beamforming in baseband is capable of providing optimal performance but it requires separate RF chain having amplifiers, mixers, etc. as cascaded components for each antenna element, which results in high cost as well as high power consumption. Hybrid beamforming proposed by [11] is the answer to shortcoming of both traditional approaches. It is capable of providing near optimal performance and requires relatively less hardware, which leads to comparatively less cost as well as power

consumption.

The hybrid precoder and decoder design is considered as two separate sub-problems [12]. In addition, here it is important to point that maximization of spectral efficiency to achieve near optimal performance is a problem of minimizing Euclidean distance between the hybrid precoder and the optimal digital precoder [11]. This further renders the problem to matrix factorization problem of digital precoder, which is a product of two matrices representing digital baseband precoder and analog RF precoder respectively. In addition, here it is important to point that analog phase shifters impose as unit modulus constraint on analog RF precoder matrix. Hybrid beamforming combines the both, digital precoding at the baseband and analog precoding in RF domain and requires very less number of RF chains as compared to fully-digital beamforming. The minimum number of RF chains must be equal or greater than the number of data streams transmitted.

In this paper, a comparatively low complexity hybrid beamforming technique based on complex oblique manifold is proposed, which reduces processing time without degrading spectral efficiency.

II. System Model

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

K. Notations

In this paper the lower-case letters (a,b,c,….) represents scalars, bold lower-case letters **(a,b,c,…)** represents vectors, bold capital letters **(A,B,C,…)** represents matrices, $\boldsymbol{A}^{\dagger}$ represents Moore-Penrose pseudo inverse of **A**, $\|\ldots\|_{\boldsymbol{F}}$ represents Frobenius norm.

L. System Model

Consider a single user millimeter Wave massive MIMO system as presented in Fig-1. The system model consists of a transmitter with N_t transmitting antennas, which communicates N_s data streams with receiver having N_r receiving antennas. To enable the multi stream communication, the transmitter and receiver are equipped with number of RF chains denoted by N_{RF}^t and N_{RF}^r respectively. The number of RF chains used are subject to constraint $N_s \leq N_{RF}^t \leq N_t$ and $N_s \leq N_{RF}^r \leq N_r$. In this hybrid beamforming massive MIMO structure, the hybrid precoder consists of $N_{RF}^t \times N_s$ digital baseband precoder $\boldsymbol{F}_{BB}$ followed by $N_t \times N_{RF}^t$ analog RF precoder $\boldsymbol{F}_{RF}$. The transmitted signal by transmitting array is given as.

$$\boldsymbol{x} = \boldsymbol{F}_{RF} F_{BB} \boldsymbol{s} \tag{1}$$

Here s represents the $N_s \times 1$ symbol vector such that $\mathbb{E}[\boldsymbol{s}\boldsymbol{s}^H] = \frac{1}{N_s}\boldsymbol{I}_{N_s}$ and normalized total transmitted power is subject to constraint $\left\|\boldsymbol{F}_{RF}\boldsymbol{F}_{BB}\right\|_F^2 = N_s$

Analog RF precoder is realized using phase shifters only such that all nonzero elements of F_{RF} satisfy unit modulus constraint. i.e. $\left|(\boldsymbol{F}_{RF})_{i,j}\right| = 1$.

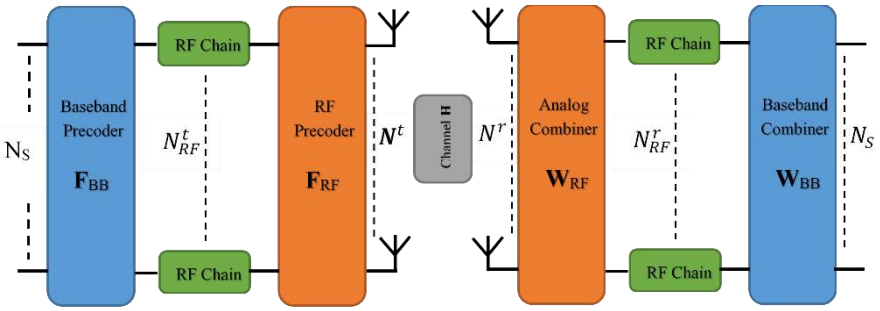

Fig. 9 Single user massive MIMO system

M. Problem Statement

The general objective of hybrid precoding algorithms is given by

$$\begin{aligned} &\text{minimize } \boldsymbol{F}_{RF}, \boldsymbol{F}_{BB} \quad \left\|\boldsymbol{F}_{opt} - \boldsymbol{F}_{RF}\boldsymbol{F}_{BB}\right\|_F \\ &\text{subjected to} \quad \begin{cases} \left|(\boldsymbol{F}_{RF})_{i,j}\right| = 1 \\ \|\boldsymbol{F}_{RF}\boldsymbol{F}_{BB}\|_F^2 = N_S \end{cases} \end{aligned} \tag{7}$$

N. The Proposed Hybrid Beamforming Techniquesa

As elaborated in previous section, all nonzero elements of $\boldsymbol{F}_{RF}$ must satisfy unit modulus constraint. i.e. $\left|(\boldsymbol{F}_{RF})_{i,j}\right| = 1$. When $\boldsymbol{F}_{RF}$ matrix is represented in vector form i.e. $vec(\boldsymbol{F}_{RF})$, it form a complex oblique manifold $\mathcal{OB}(m, \mathcal{C})$ with $m = N_t \times N_{RF}^t$. Here $\mathcal{OB}(m, \mathcal{C})$ is the product of m complex circles and is represented as

$$\mathcal{OB}(m, \mathcal{C}) = \{\boldsymbol{X} = [x_1, .., x_m] \in \mathcal{C}^{n \times m} : \|x_1\| = .. = \|x_m\| = 1\} \quad (3)$$

Therefore, the hybrid-precoding problem (2) is translated into problem on complex oblique manifold. So the hybrid-precoding problem (2) can be reformulated as

$$\min_{vec(\boldsymbol{F}_{RF}) \in \mathcal{OB}(m,\mathcal{C})} \left\|\boldsymbol{F}_{opt} - \boldsymbol{F}_{RF}\widehat{\boldsymbol{F}}_{BB}\right\|_F^2 \quad (4)$$

Here, $\widehat{\boldsymbol{F}}_{BB} = \boldsymbol{F}_{RF}^{\dagger}\boldsymbol{F}_{opt}$, when the precoding problem represented by (4) is extended to multicarrier OFDM massive MIMO systems with K as total number of subcarriers, it can be represented as

$$\min_{vec(\boldsymbol{F}_{RF}) \in \mathcal{OB}(m,\mathcal{C})} \sum_{k=0}^{K-1} \left\|\boldsymbol{F}_{opt}(\mathrm{k}) - \boldsymbol{F}_{RF}\widehat{\boldsymbol{F}}_{BB}(k)\right\|_F^2 \quad (5)$$

To minimize the objective function using manifolds, the Euclidean gradient $\nabla f(\boldsymbol{x}^k)$ and Riemannian gradient ξ^k are calculated in the direction of steepest decent, using standard Riemannian Steepest Descent

III. Simulation Results

In this section, the performance parameters for the proposed technique are numerically evaluated in a propagation environment as described further. The propagation environment has number of clusters $N_{cl} = 5$ with $N_{ray} = 10$, number of rays in each cluster with angular spread of 10 degrees and total number of subcarriers k=128. The azimuth and elevation angles of departure and arrival follow Laplacian distribution with uniformly distributed mean angles in [0, 2π]. The antenna array used is uniform rectangular array with omnidirectional antenna elements. Spectral efficiency for the proposed technique is evaluated as performance parameter. All results are averaged over 1000 iterations.

O. Case-1

As first case, the spectral efficiency of proposed hybrid beamforming technique is evaluated for commonly referred massive MIMO scheme in literature with

$$N_t = 144, N_r = 36, N_{RF}^t = N_{RF}^r = N_s = 4$$

i.e. a massive MIMO system with 144 transmitting antennas, 36 receiving antenna and 4 streams as well as RF chains. The graph of obtained spectral efficiency vs SNR is presented in Fig. 2.

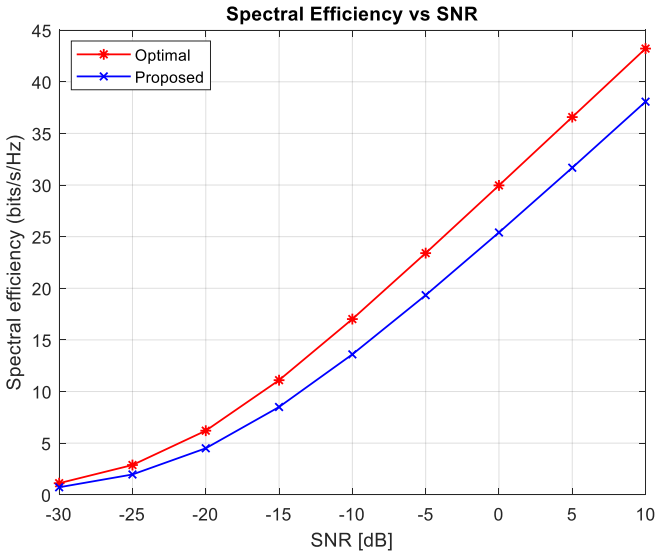

Fig. 2. Spectral efficiency when $N_t = 144, N_r = 36, N_{RF}^t / N_{RF}^r / N_s = 4$

P. Case-2

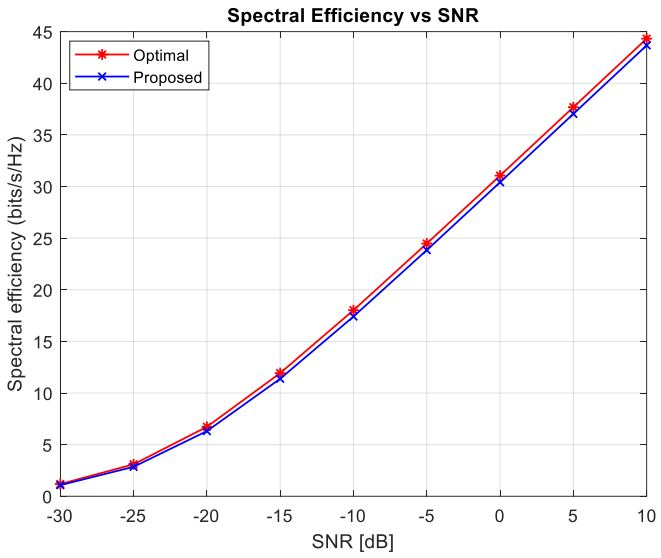

Fig. 3. Spectral efficiency when $N_t = 144, N_r = 36, N_{RF}^t / N_{RF}^r = 8,\ N_s = 4$

As second case, the spectral efficiency of proposed hybrid beamforming technique is evaluated for commonly referred massive MIMO scheme in literature with

$$N_t = 144, N_r = 36, N_{RF}^t = N_{RF}^r = 8, N_s = 4$$

i.e. a massive MIMO system with 144 transmitting antennas, 36 receiving antenna, 4 data streams and 8 RF chains. The graph of obtained spectral efficiency vs SNR is presented in fig. 3.

IV. Conclusions

In the previous section, the performance analysis of proposed technique is carried out terms of achieved spectral efficiency in multicarrier OFDM millimeter wave massive MIMO communication environment. The proposed technique produces near optimal performance in terms of spectral efficiency and requires much less hardware for implementation. Therefor it's more suitable for practical implementation as it need less computational resources, which in turn results faster processing, lower cost and lower power consumption.

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Design of Web Based Temperature Monitoring System Using TCP/IP Networking Protocol

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***Abstract*— This Paper presents the design of internet based real time temperature controller using the TCP/IP networking protocol in LABVIEW (laboratory virtual instrumentation engineering workbench). It deals with client server operation in which server control the temperature based on the information provides by the client to avoid overheating. The temperature from temperature sensor is read and provides the temperature value to server. The client use the TCP protocol for providing the value of set point to server and accordingly server perform controlling actions.**

***Keywords*— Client, Internet, LabVIEW, ON/OFF, Server, Temperature, TCP, VI**

I. INTRODUCTION

In today's technology real time control at remote becoming very interesting. Using internet technology to control the real time process various technology have been developed. In LabVIEW various networking protocols can be used such as TCP (transmission control protocol), IP (internet protocol), DS (data socket protocol) and UDP (user datagram protocol) that provide remote control of process. The real time process can be controlled remotely on internet by using various technologies. LabVIEW is one of these platforms which can effectively control real time process [1]. The system is to control the real time process variable on internet by utilizing client server technique [2]. In this system the control variable is temperature. The main goal is that server needs to keep the temperature inside a wooden case to a certain specified point instructed by client. Fig.1 presents the block diagram of internet based temperature monitoring system. As from diagram the real time variable temperature is sense by the sensor and provides the value to server PC using DAQ. Now, the sensor provides the output in electrical form so that server PC performs the conversion of this electrical value to temperature by using equation 1.

$$Temp.(PV) = 6 \times V_{in} + 60 \quad (1)$$

Where PV – Process variable

V_{in} – input voltage from sensor.

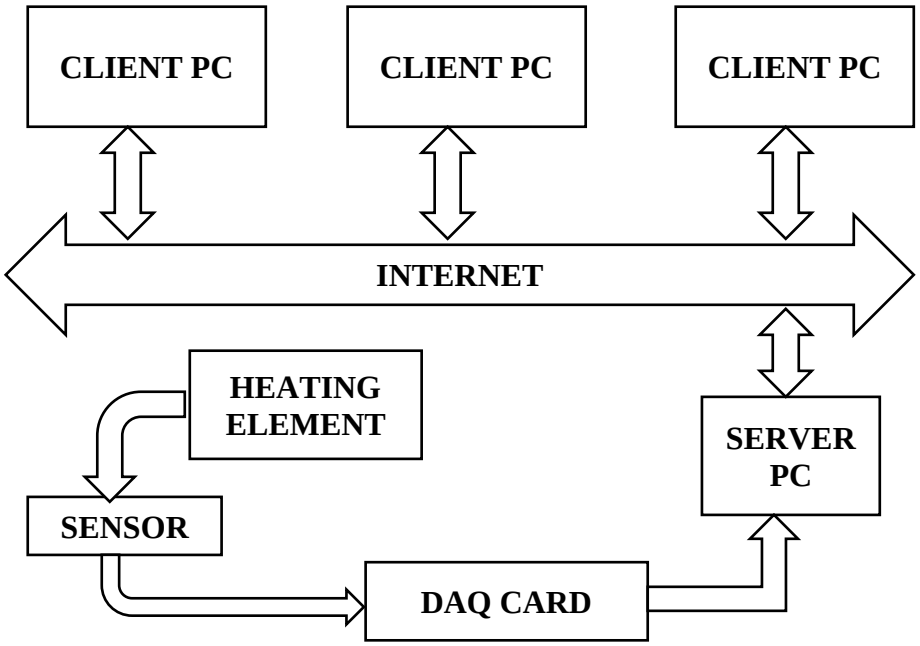

Fig. 10 *Block diagram of internet based temperature monitoring system*

The temperature value is transmitted to client PC using TCP communication. After getting the temperature value the client transmits the set point value to server PC. According to the value of SP, ON/OFF controller perform the various actions.

Related work done in this field is addressed in section II. Section III describes the proposed control logic used for operation. Programming done in LabVIEW and virtual instrumentation (VI's) used is described in section IV. Simulation results are presented in section V. Section VI describe conclusion

II. Related Work

There are various networking protocols that help to enhancing the networking area in automation field. LabVIEW enhance their capability in control field [3]. A system is described in which by utilizing DS protocol temperature of a bulb can be controlled by using ON/OFF controller and also generate its algorithm[4][5]. A system is described in which by utilizing DS protocol and digital temperature actuator/sensor temperature can be controlled [6]. A system is described by utilizing ON/OFF controller to control liquid nitrogen to its specified point but this system has some shortcomings [7]. A technique is proposed to control the speed of motor using PI-PID controller by utilizing various algorithms [8]. A system is described to control the position of motor by using various algorithm and PID controller with the help of DAQ [10]. TCP internet protocol can also be utilized to control the real time process in LabVIEW with the help of DAQ [11] [12].

III. Proposed Control Logic

The ON/OFF controller will make decision based on difference between the Temperature measured by sensor and the set point specified by the client. This difference is error and given by equation 2.

$$error\ difference = SP - Temp.(PV) \quad (2)$$

After finding of error, next temperature can be maintained in following ways shown in flow chart in fig.2.

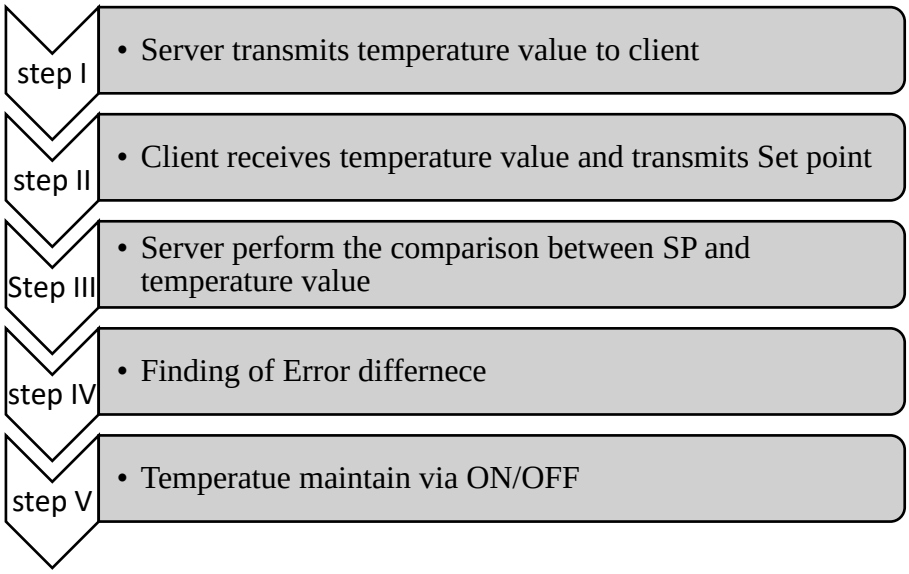

Fig. 11 *Flow chart of proposed system*

The Algorithm of proposed control logic is designed in such way that it should accurately control temperature at remote location. Table I describing the algorithm for maintains the temperature process.

TABLE III
Algorithm For On/Off Process

Case	Fan ON	Fan OFF	Within limit	Out of limit
Case I – Error > 0 and Temperature(PV) > Low limit	OFF	ON	ON	OFF
Case II - Error > 0 and Temperature(PV) < Low limit	OFF	ON	OFF	ON
Case III - Error < 0 and Temperature(PV) < High limit	ON	OFF	ON	OFF

Case IV - Error < 0 and Temperature(PV) > High limit	ON	OFF	OFF	ON
Case V - Error = 0	OFF	OFF	ON	OFF

IV. PROPOSED DESIGN

LabVIEW is graphical programming language in which there are two windows one is the front panel and other is block diagram. Front panel contains all inputs and outputs that are controls and indicators respectively and block diagram have all the connection, logics behind the working of process. It contains all the mathematics, processing tools etc. to implement the logic. In this logic, there are two LabVIEW programs one for client and other for server. The maintained of temperature achieved by ON/OFF of fan. So on server side there are four indicators namely Fan ON, Fan OFF, within limit and out of limit. Fig. 3 presents the LabVIEW Block diagram of the client.

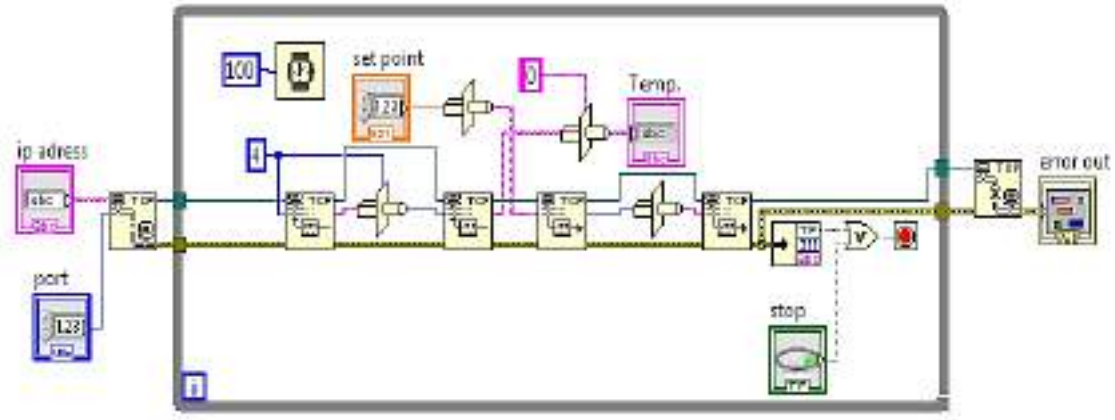

Fig. 12 *Block diagram of client*

TCP is networking protocol used for communication between client and server over the internet. It's little bit complicated to set up TCP connection but have many advantages over DS protocol. TCP VI's are shown in fig.3 used for client PC. TCP open connection has input of IP address and port number. The appropriate timing function is provided. After that TCP write VI which has string and connection id from TCP open connection. Type cast VI is utilized for converting string input from integer type to string format[13]. The next VI of TCP read which has three terminals namely no. of bytes to read, connection id and modes [14]. TCP close connection VI is called when the transmission is over. In TCP server block diagram TCP listener VI is used which has input listener id and called inside the loop. While loop is utilized in the block diagram of server so that process can be repeated for next connection. Similar to TCP client PC TCP read and TCP write functions are utilized. And when communication is over then TCP close connection is called.

V. SIMULATION RESULT AND DISCUSSION

The front panel of the proposed system for three cases out of five as demonstrate in table 1 has been discussed in this section. The control and indicators values for case I have been shown in fig. 4. In this case, the temperature value is less than the set point specified by the client so that error will be positive and as a result the fan ON and OFF indicator will be OFF and ON respectively. The temperature value is high then low limit thus within limit indicator will be switch ON and other indictor remains OFF.

The control and indicators values for case II have been shown in fig.5. In the case II, the value of temperature is more than the set point specified by the client so that error will be negative and as a result the fan ON and OFF indicator will be ON and OFF respectively. The temperature value is less then high limit thus within limit indicator will be switch ON and other indictor remains OFF. The control and indicators values for case IV have been shown in fig.6. In the case IV, the value of temperature is more than the set point specified by the client so that error will be negative and as a result the fan ON and OFF indicator will be ON and OFF respectively. The temperature value is more than high limit thus out of limit indicator will be switch ON and other indictor remains OFF.

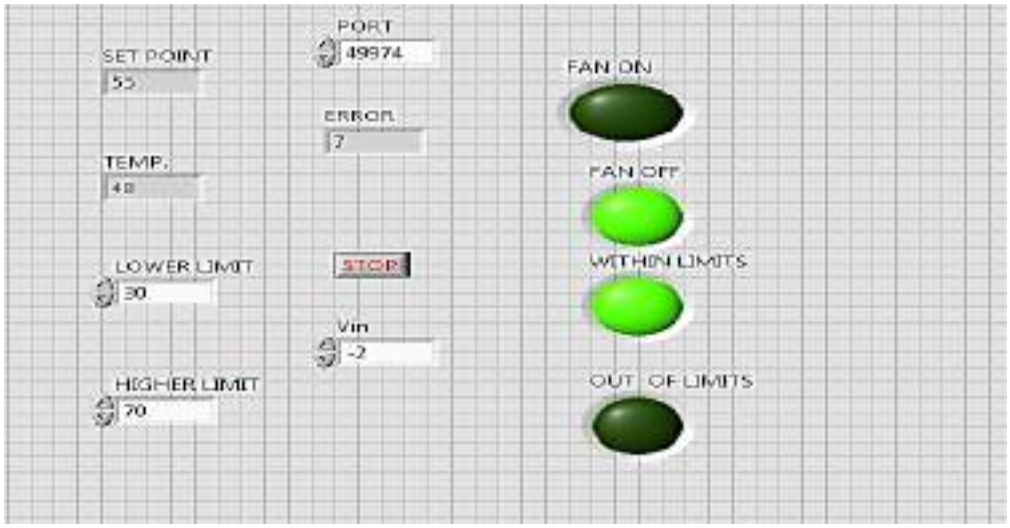

Fig. 13 *Front panel for case I of server*

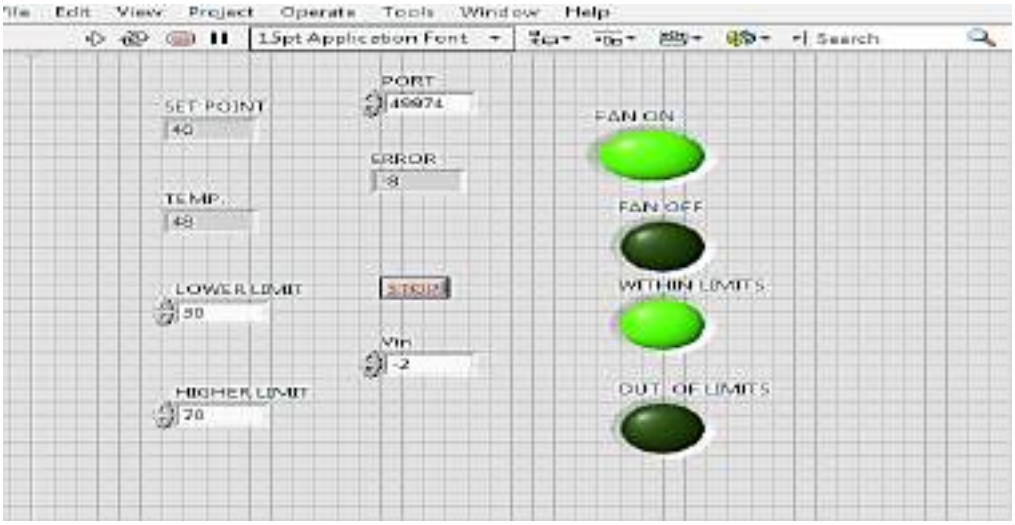

Fig. 14 *Front panel for case II of server*

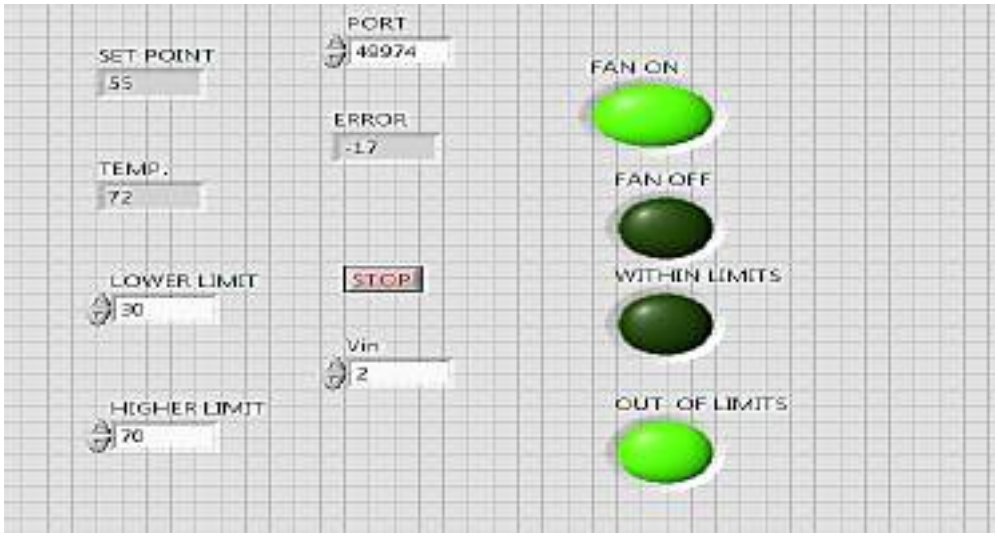

Fig. 15 *Front panel for case IV of server*

VI. CONCLUSIONS

In this paper, real time temperature client server based control system has been designed and analyzed which is easier, faster and accurate. In real time the process can be monitored and controlled using networking protocol at remote location. The system has been accurately designed, implemented and analyzed by transmitting real time data using IP address over the internet and reliable communication is done and expected results are obtained in LabVIEW. The future work in this field can be extended by means of File transfer protocol (FTP) instead of TCP protocol.

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A review paper on Hybrid Solar System with combination of Solar Photovoltaic System to increase the Battery Backup

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***Abstract*— Zero cost such as cost, cleanliness, availability and installation process of renewable energy has been fascinated by people due to this among of different renewable energy sources photovoltaic (PV) and wind turbines (WT) become very allured because of very high level of local availability in environment and easy process of installation as well as the cheapest source of produce electricity. This paper gives a new idea for configuration of the hybrid wind/photovoltaic electricity process. The variability in the solar and wind resources can solved by adding the two renewable resources into an optimum combination and the overall system makes more reliable and cheap to run. Generator's lifecycle, heating problems, and its efficiency is effected by harmonic distortions. This paper provides a review of challenges and opportunities / solutions of hybrid solar PV and wind energy integration systems. Voltage and frequency fluctuation, and harmonics are major power quality issues for both grid-connected and stand-alone systems with bigger impact in case of weak grid. This trend must be promoted for betterment of environment and increase the life standard as well as save money by use of solar wind hybrid system for production of electricity with no fed up of power cuts.**

Keyword— MPPT (Maximum power point tracking), PV (Photovoltaic), WECS(Wind strength conversion device), WT (Wind turbines) , DC (direct current), AC (alternating current) Renewable Energy Resources, Electricity Generation, Solar Energy, Wind Energy, Pollution Free Energy Smart Science

I. INTRODUCTION

The India data of renewable energy in power systems is increasing rapidly especially for solar photovoltaic (PV) and wind systems. The renewable energy counted for around 40.76GW in 2010 which was increased by 49 GW in 2015 and become at 136GW in 2021 with significant rise. The report highlighted that for the first time the PV installation capacity was more than the wind power capacity. After 2015, PV system had been increased as compare to wind energy, become 89 GW. Table summarizes some important selected indicators from that report and the previous year report which shows the global rapid increase of renewable energy.

Table 1 Important indicators for renewable energy

		2010	**2015**	**2021**
Renewable power installed capacity (with hydro)	GW	1.87	3.65	7.55
Renewable power installed capacity(without hydro)	GW	40.76	89.63	136.00
Solar PV installed capacity	GW	0.16	0.26	89.63
Wind power installed capacity	GW	20.35	23.08	38.78

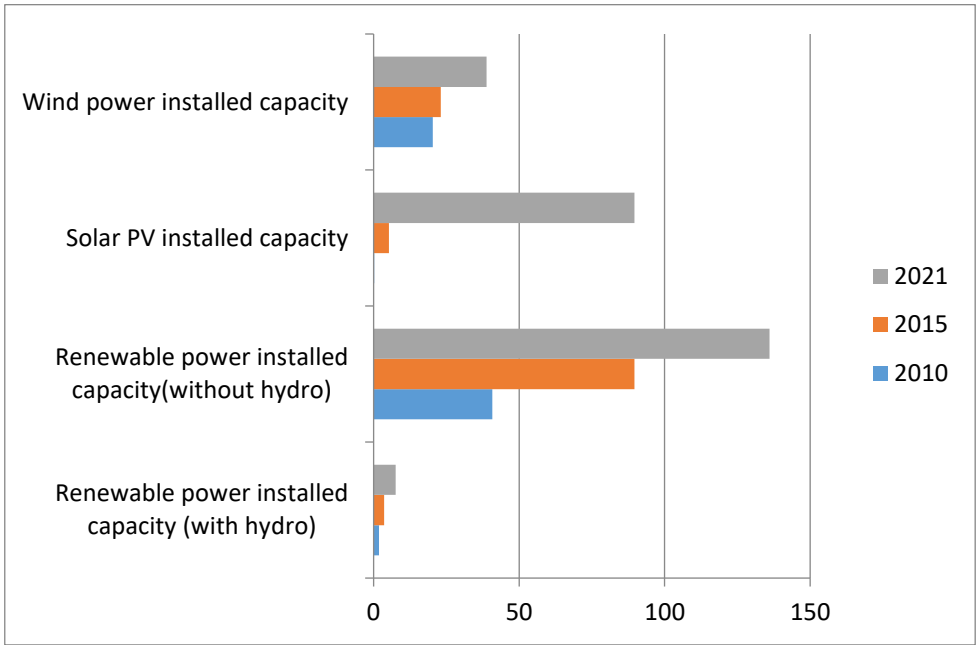

Fig1.Hybrid system with multi connected boost converter

The paper provides continue supply of electricity which is not possible with stand-alone PV system or other one by become Hybrid Model of Solar-Wind model.

The new coming world power generation relays on the fact that everyone will be able to generate and storage power, big power central will not be the only electricity generator units by year 2025. Many countries worldwide have make efforts to reduce fossil fuel dependency. Never the less, it is said by the international Energy Agency's world Energy Outlook 2013 that fossil fuel consumption will still dominate the power sector in 2035 [1] . In these efforts, governments have invested parts of their budgets to encourage the use of clean and renewable power sources such as biomass, geothermal, hydropower, solar, wind, tidal, and wave. Today, these renewable energy technologies are the fastest growing energy technologies (particularly wind and solar) and are cost competitive in a variety of grid, off-grid, and remote applications worldwide The growth of every renewable energy can be seen in figure 1, where the percentages per each type are listed according to [2].

II. SOLAR-WIND Hybrid Model

In particular for stand-alone applications, hybrid solar PV and wind generation system become very attractive solution. Combining the two sources of solar and wind can provide better reliability and their hybrid system becomes more economical to run since the weakness of one system can be complemented by the strength of the other one. The integration of hybrid solar and wind power systems into the grid can further help in improving the overall economy and reliability of renewable power generation to supply its load. Similarly, the integration of hybrid solar and wind power in a stand-alone system can reduce the size of energy storage needed to supply continuous power.

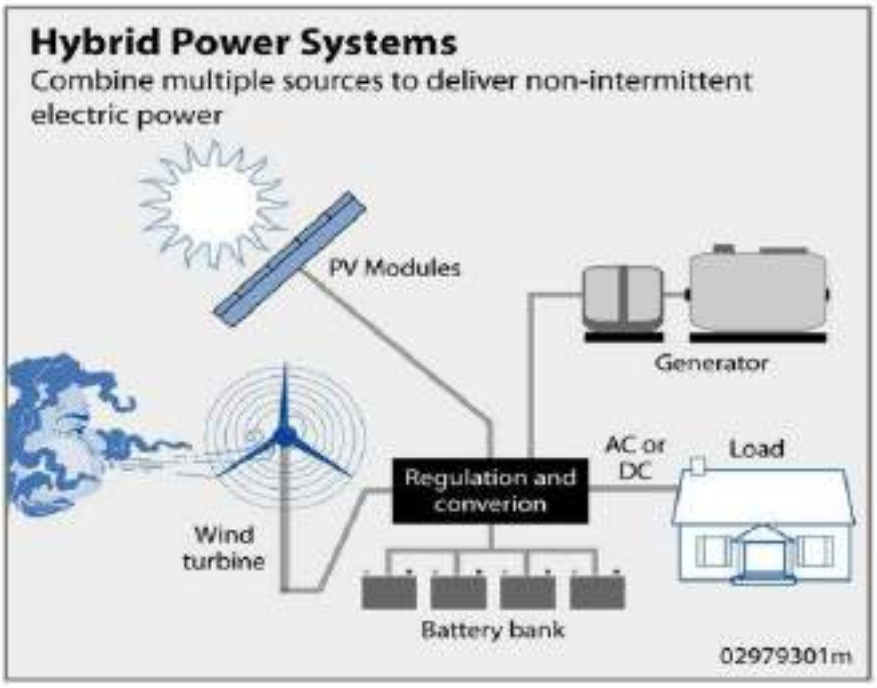

Fig 2 Hybrid Power System

2.1 Hybrid system with multi connected boost converter

With increasing concern of world warming and the depletion of fossil gasoline reserves, many are searching at sustainable strength solutions to hold the earth for the destiny generations. Apart from hydro power, wind and photovoltaic strength holds the most potential to meet our strength demands. Alone, wind energy is capable of offering big amounts of electricity however its presence is incredibly unpredictable as it can be right here one second and long past in every other. In addition, sun power is present in the course of the day but the solar irradiation levels vary due to sun intensity and unpredictable shadows solid by way of clouds, birds, trees, etc. The commonplace inherent drawback of wind and photovoltaic structures are their intermittent natures that cause them to unreliable. But, through combining these intermittent assets and through incorporating maximum power point monitoring (MPPT) algorithms, the system's electricity switch efficiency and reliability can be improved significantly.

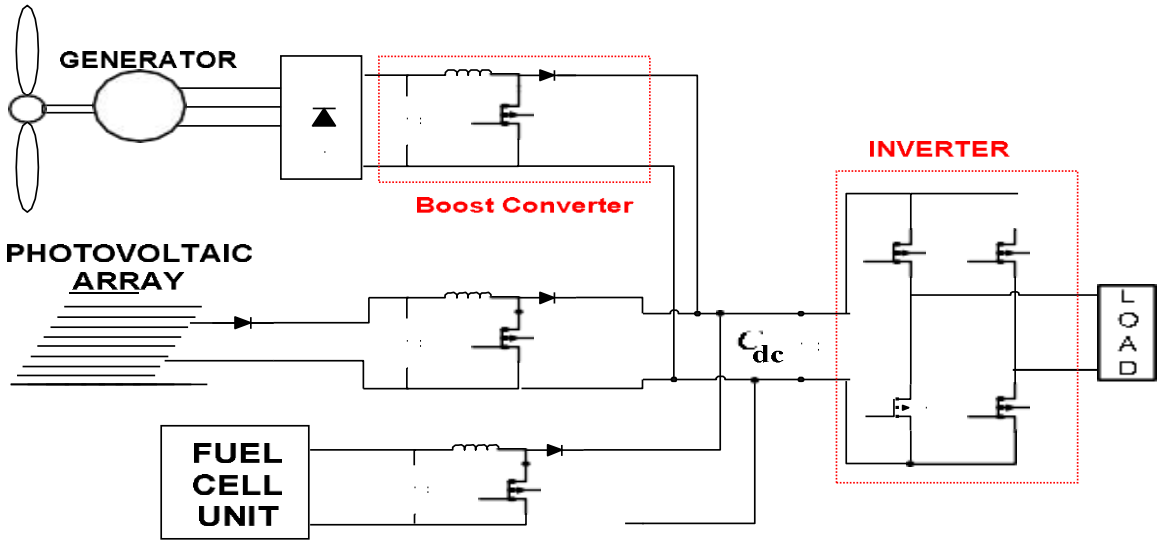

Fig3.Hybrid system with multi connected boost converter[2,6,9,15]

When a source is unavailable or inadequate in assembly the load needs, the alternative energy supply can atone for the difference. Several hybrid wind/PV electricity structures with MPPT control had been proposed and discussed in works [1]- [5]. Most of the systems in literature use a separate DC/DC increase converter linked in parallel in the rectifier stage

as proven in determine 1 to perform the MPPT control for every of the renewable energy power resources [1]-[4]. A less complicated multi- input shape has been suggested via [5] that combine the assets from the DC-quit even as nevertheless accomplishing MPPT for each renewable source. The shape proposed by using [5] is a fusion of the buck and buck-boost converter. The systems in literature require passive input filters to remove the high frequency present day harmonics injected into wind turbine generators [6]. The harmonic content material within the generator cutting-edge decreases its lifespan and increases the energy loss because of heating [6].

In this paper, an opportunity multi-input rectifier structure is proposed for hybrid wind/solar electricity systems. The proposed design is a fusion of the Cuk and SEPIC converters. The features of the proposed topology are: 1) the inherent nature of those converters removes the need for separate enter filters for C [7]-[8]; 2). It can aid step up/down operations for every renewable source (can help extensive tiers of PV and wind enter); three) MPPT may be found out for every source; four) character and simultaneous operation is supported. The circuit running ideas will be mentioned on this paper. Simulation effects are supplied to verify with the feasibility of the proposed device.

III. Schematic diagram of a hybrid solar–wind system.

According to many renewable energy experts, a small "hybrid" electric system that combines home wind electric and home solar electric (photovoltaic or PV) technologies offers several advantages over either single system. In much of the United States, wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when less sunlight is available. Because the peak operating times for wind and solar systems occur at different times of the day and year, hybrid systems are more likely to produce power when you need it.Many hybrid systems are stand-alone systems, which operate "off-grid" -- that is, not connected to an electricity distribution system. For the times when neither the wind nor the solar system are producing, most hybrid systems provide power through batteries and/or an engine generator powered by conventional fuels, such as diesel. If the batteries run low, the engine generator can provide power and recharge the batteries.

Adding an engine generator makes the system more complex, but modern electronic controllers can operate these systems automatically. An engine generator can also reduce the size of the other components needed for the system. Keep in mind that the storage capacity must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized to supply the electric load for one to three days

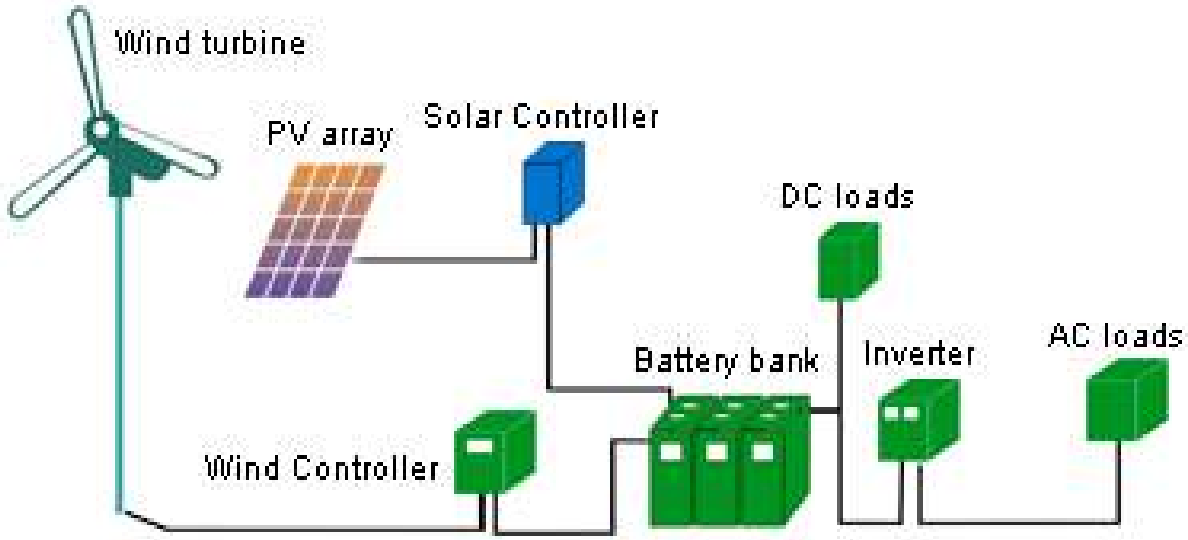

Fig 3(a)

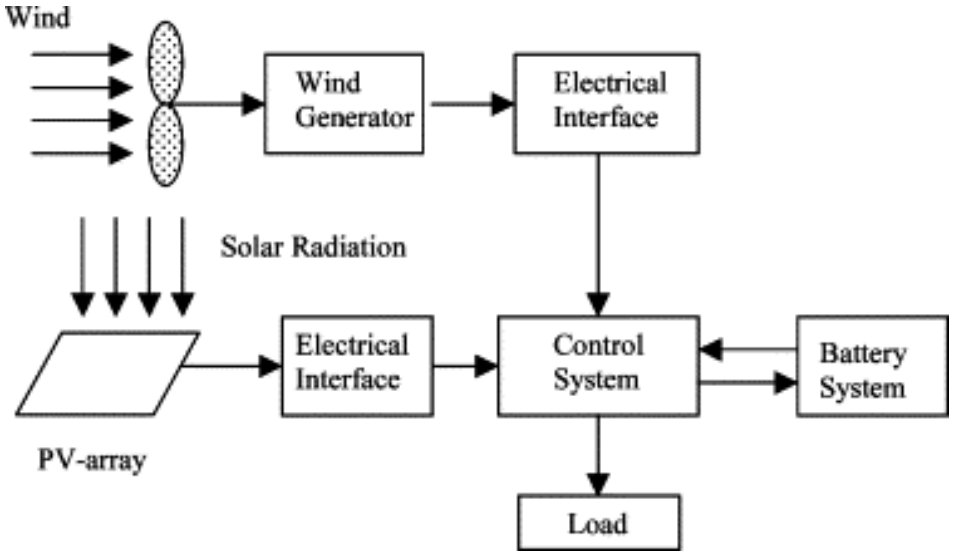

Fig 3(b)

Fig 4(a)(b) Schematic diagram of a hybrid solar–wind system [2,5,9].

The combination of renewable power assets, wind & sun are used for producing power called as wind sun hybrid gadget. This system is designed using the solar panels and small wind turbines generators for generating power. To better understand the operating of sun wind hybrid gadget, we should recognise the working of solar power system and wind power gadget. Solar electricity system can be defined because the device that uses sun electricity for energy generation with sun panels. The block diagram of solar wind hybrid machine is proven inside the determine in which the solar panels and wind turbine are used for power era. Wind electricity is likewise one of the renewable strength assets that can be used for producing electric electricity with wind turbines coupled with turbines.

Wind turbine may be described as a fan such as 2 or three blades that rotate because of blowing wind such that the axis of rotation ought to be aligned with the course of blowing wind. A equipment container is used for converting energy from one device to any other tool the use of mechanical approach; hence it's far termed as a excessive-precision mechanical device. There are one of a kind forms of wind generators, but the often used wind mills are horizontal axis mills and vertical axis mills. The wind strength conversion device (WECS) and photovoltaic system are paralleled in order to deliver electric energy to the burden, and the extra strength generated is supplied to the batteries. Once the strength is deficit, the batteries discharge to supply the shortfall in demand. The subsequent simulation determines the performance of a hybrid device.

IV. RESULTS FOR HYBRID PV-WIND SYSTEMS

Hybrid PV–wind power systems usually meet load demands well because of the good complementary effect of solar radiation and wind speed. For 150 or 450 Ah battery storage capacities, the wind turbines with 20KW to 60KW in morning and evening time when solar does not give power in this mean time, it works only during sunlight. So, Solar wind hybrid system is good to achieve high efficiency by renewable sources.

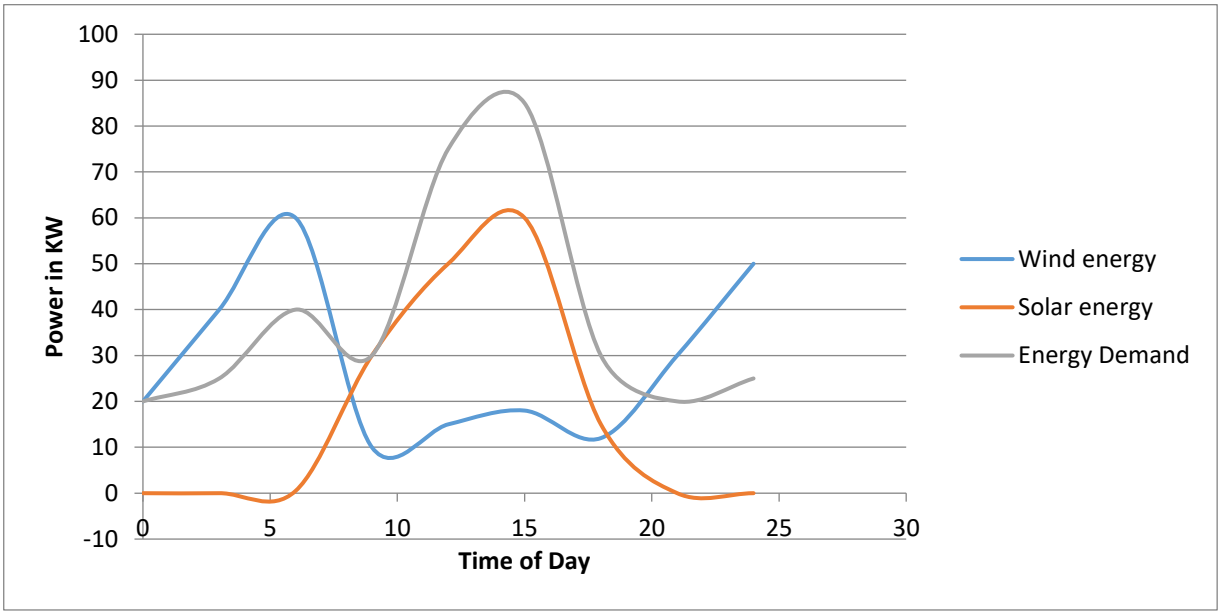

Fig 5 Daily accumulated solar radiation and wind power distribution in January.

Sun and wind resources are complementary over that year. The summer season offers exact sun irradiance however negative wind conditions, even as a surprisingly right wind source however terrible solar radiation happens in the wintry weather. For the each day distribution the outcomes are proven in Fig. On most days with high solar radiation, the wind energy is negative. Such periods usually final for 3–five days, as a consequence such complementary characteristics make the hybrid application extra dependable [11]. The above indicates that the combination of the two energy sources can offer a better utilization factor for the available energy.

For a typical day of sunshine, the radiation peaks at round 13:00, as shown in Fig. The available sun electricity is able to meet the weight profile and top load all through the daytime. For the wind distribution in Hong Kong, September to March provides the best wind speeds, which occur early within the morning, with the lowest within the afternoons. In other months, the wind speed in accurate wind exposure regions changes every day and continuously [6]. Hence, solar strength and wind energy assets can make amends for each other now not most effective for some days however additionally for the entire year.

V. ADVANTAGES, DISADVANTGES AND APPLICATION

5.1 Advantages

The benefits offered through the designed project are listed as,

- Reducing the drawbacks that are caused by the stand-free renewable and sustainable production system of electrical energy [8].
- Giving effective generation of electricity due to the usage of two or more renewable energy resources [5].
- As the microcontroller is not used in the design of the system, thus, a complication in testing the system is no more problem [5].
- There is no waste generation due to the utilization of renewable energy sources [14].
- Clean and environment-friendly energy is produced [8].
- Installation of the system is not complex after the development of the hybrid system [5].
- Installation requires a high cost but can be covered after aspecific time [18].
- If there is a problem in the system, then there is no need to install the new system. Change only the damaged part of the system [8].

5.2 Disadvantages

The disadvantages of the proposed hybrid system are listed

as follows,

- Installation cost is greater in terms of economics [5].
- As the system doesn't contain any controller action, therefore, the circuit design is complex [8].

5.3 Applications

There are lots of applications for solar-wind hybrid electricity generation system. Some of them are given below,

- The hybrid system can also be used for a household purpose [8].
- Used for traffic signals [5].
- Used for Street lightning [13].
- Used for diverse controlling systems [8].
- Used for triggering communication system [5].
- Used in the system of pump irrigation [5].
- The system can be upgraded by the need forelectricity generation [8].

VI. CONCLUSION AND FUTURE SCOPE

This Hybrid System is good for photovoltaic system to improve the battery backup and efficiency of solar system as well as life cycle of battery by give the regular uninterrupted supply to battery bank even in the absence of solar radiations means in night time. Moreover, it will also save money and resources of country with use of alternate sources of energy.

For hybrid renewable power device layout wide variety of latest technology are discussed within the literature, however because of some new troubles like parameters of renewable source fabric and design, constraints of load, generator, battery, converter, and cost characteristic, the system performance has reduced. These styles of issues must be attended properly, to remedy those shorted out. Table 7 affords some critical proposal and also scope in regards to potential research. This paper explains several hybrid gadget combos for PV and wind turbine, modeling parameters of hybrid machine issue, software tools for sizing, criteria for PV–wind hybrid machine optimization, and manage schemes for strength flow control. In this paper for the sizing reason of the hybrid gadget, 25 exclusive styles of computational software program gear are mentioned. Among most of these software gear, HOMER and GA, PSO gives greater feasible end result for hybrid machine layout. Any other approach for sizing of hybrid scheme which offers more promising end result, which includes genetic set of rules and PSO. As a minimum to acquire the operational performance, highest device reliability and right electricity flow management, manage strategies are recommended on this paper. Controller paintings as tracking entire hybrid machine and keep the requirement of load demand even as retaining gadget frequency and output voltage. Additionally, it's miles been positioned in which extensive variety of research paintings inside the community associated with hybrid renewable electricity gadget has been finished. A case study of various standalone hybrid system combos for a far flung area in India by means of using HOMER and evaluate fine superior hybrid device configuration together with PV–Wind–Battery–DG with respective general NPC, working fee, COE, and also emission. The most excellent hybrid gadget has following blessings.

This non-conventional power PV–Wind–Battery–DG hybrid strength method is to be had to be technically possible, emission a lot much less along with much less costly with years to come.

Its surroundings-pleasant dynamics enables or not it's a pleasing-looking replacement for complementing the strength gift interior geographical region areas.

Load call for is fulfilled in an top-quality manner.

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Design of H-Shape Microstrip rectangular patch antenna for satellite communication application

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***Abstract* - In this paper designs of Microstrip Patch antenna which consists of a rectangular patch etched on FR4- substrate with 50Ω feed. The rectangular patch has one circular cut at each corner. The simulated bandwidth with return loss ≥ 10 dB is 3.42–11.7 GHz. The Ku-band achieved by inserting H shaped slot in the rectangular patch. The simulated results of the proposed antenna indicate higher gain at the passband (Ku Band). The radiation pattern for Co-polar and Cross polar shown. The CST Microwave Studio is used to design and simulate the antennas behavior over the different frequency range.**

I. INTRODUCTION

In simplest terms, a satellite refers to an object which revolves around another object larger in size. As an example, earth's natural satellite is moon and the same is case with many other planets of our solar system [1][2].

Communication refers to the transmission, receiving and processing of information between two or more parties through various modes or channels. In case this communication happens between two stations located on the earth by means of an artificial satellite revolving around the earth, it is known as Satellite Communication. The carrier signals used in such a communication are electromagnetic waves. Various kinds of information, be it audio, video, photographs or any kind of data, can be sent via this method [3] [11].

Sputnik 1 was the first satellite launched by Soviet Union in 1957. India's first artificial satellite was Aryabhata, launched in 1975 by ISRO [3].

Nowadays the importance of satellite can be seen in various fields, for example television, mobile communication, reconnaissance, weather forecasting, cartography, etc. All the satellites have a common structure that consists of an outer body with various payloads enclosed inside. These payloads vary according to the type of satellite [4][14][15].

The communication satellites have transponder as one of the main payloads. The first ground station transmits a signal to the communication satellite revolving in the orbit. This transmission through a channel is called the uplink and the frequency at which the signal is transmitted is called the uplink frequency [5].

The transponder inside the satellite, changes the frequency band and the modified signal is transmitted back to the earth to the second ground station. This transmission through a channel is called the downlink and the frequency at which the signal is transmitted is called the downlink frequency [6][8][9][10][12][13].

II. RESEARCH WORK

The proposed design of rectangular microstrip patch antenna, shown in Fig. 1(a) and (b), is built on FR4 substrate with $e_r = 4{:}4$ and $tan\delta = 0.02$. The antenna dimensions (in mm) are: the substrate has $W_{sub} = 20.70$, $L_{sub} = 30$ and $h = 1.6$, the rectangular patch has width $W = 15$ and length $L = 14.5$, the microstrip feed line has$W_f = 2.85$ and $L_f = 13.5$, the partial ground plane has width $W_g = 20.70$ and length $L_g = 12.5$. To increase the antenna, gain and matching, the simulated Return Loss results show better impedance matching and high gain when adding one lower round step rather than two, a small enhancement in the impedance matching when adding one upper round step compared to that without upper steps over the whole frequency range, while adding ground slots improve the impedance matching at the higher frequency band [7].

The simulated Return Loss which is equal to –S11 (scattering parameter), shown in Fig. 2, for the proposed antenna, shows that with Return Loss ≥ 10 dB the antenna has BW 12.56–16.48. The best dimensions (in mm) intended for the proposed antenna are R1 = R2 = R3 =R4 =2. The suggested ground slot combines the triangle and square slot shapes. The simulated peak gain for frequency reaching 5.66 dB. The radiation patterns for the planned antenna are presented in Fig. 3 and Fig 4.

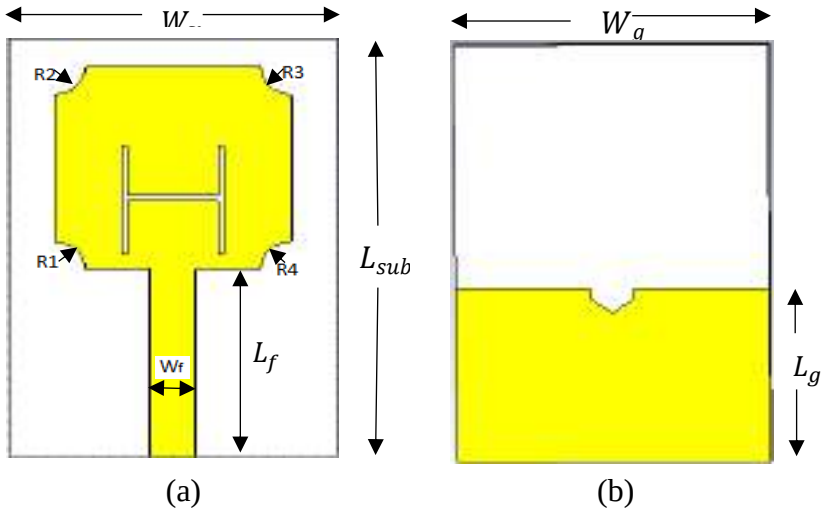


Fig 1: Front side and Back Side view of proposed rectangular microstrip patch antenna

III. S PARAMETERS

The proposed antenna model is designed and simulated in CST Microwave studio. The fabricated antenna is feed with 50Ω impedance. Fig. 2 shows the simulated and measured return loss of the proposed microstrip patch antenna at two resonant frequencies. The proposed antenna has operated at two different frequencies are 13.5 GHz, 15.5 GHz with return losses are -40 dB, -15.5 dB.

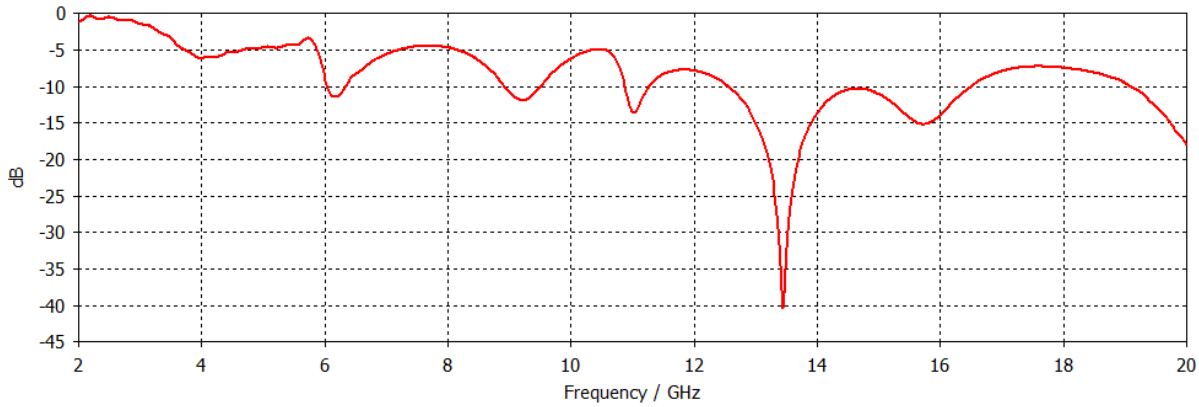


Fig 2: Measured S11 results of Microstrip patch antenna.

IV. RADIATION PATTERNS

The planned antenna radiation features shown in Fig 3 and Fig 4. The projected antenna worked with two resonant frequencies are 13.5 GHz and 15.5 GHz and co polarization and cross polarization (XP) are detected and cross (XP) are found at phi 90^0 for 8.3 GHz. The radiation patterns are perceived at is 0^0 and is 90^0.

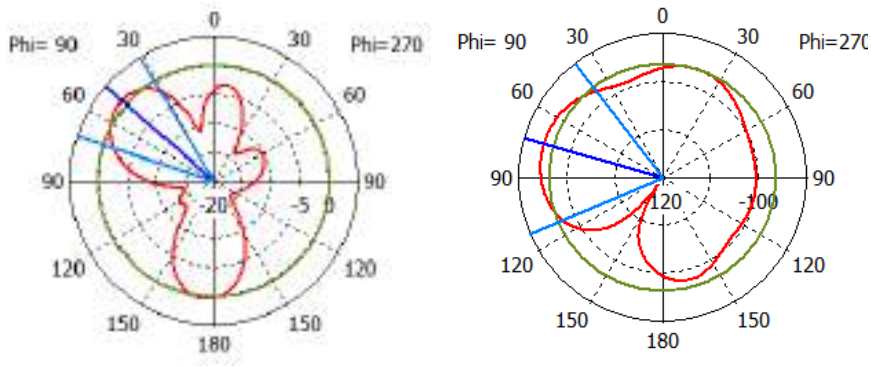


Fig 3: Far Field Realized Co-polarization gain and cross polarization gain at 13.5 GHz Aa phi 90 respectively.

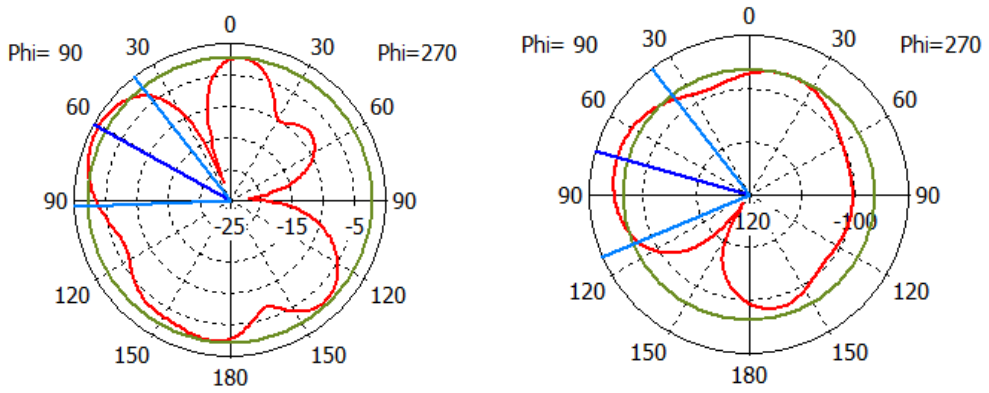
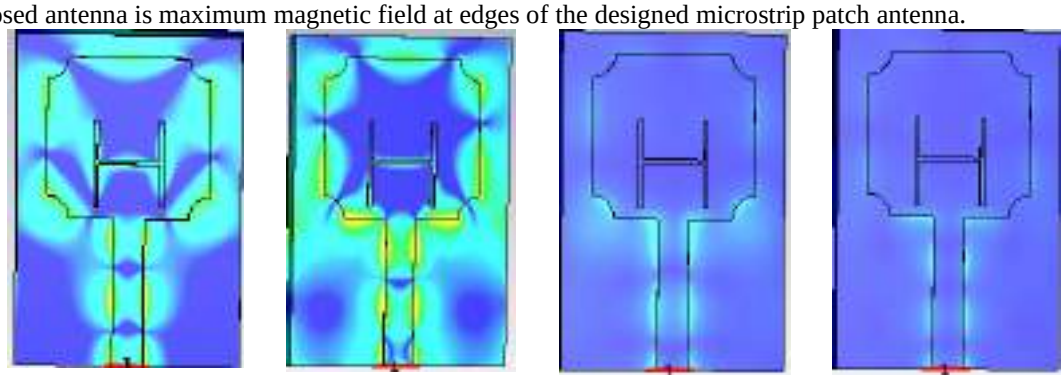


Fig 4: Far Field Realized Co-polarization gain and cross polarization gain at 15.5 GHz Aa phi 90 respectively.

V. E-FIELD AND H-FIELD DISTRIBUTION

The field distribution of the designed antenna at two resonant frequencies is shown in Fig 5. Where the maximum field distribution is observed at edges of the microstrip patch antenna. The E field distributions of 500A/m at two resonance frequencies. The H field of proposed antenna is maximum magnetic field at edges of the designed microstrip patch antenna.



(a) (b) (c) (d)

Fig 5(a) (b) (c) (d): E field distribution at 13.5GHz and 15.5 GHz and H field distribution at 13.5GHz and 15.5GHz respectively.

VI. CONCLUSION

H shaped microstrip patch antennas is designed to satisfy the requirements of the satellite communication systems and minimize the interferences from Ku-band applications. The microstrip patch antenna contains a simple rectangular patch antenna with 50 Ω microstrip feed. Surveys have been done to cut steps in the four corners of the rectangular patch and to add slots in the ground plane. The covered BW at Return Loss ≥ 10 dB is 12.56–16.48 GHz with good impedance matching. Slots are inserted in the patch to create rejection band at Ku-band frequency range. acceptable gain in the pass band frequency range is achieved. An approximate constant gain is achieved over acceptable frequency range.

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Effect of Co-Dopant on Band Gap Energy of Zinc Oxide Nanoparticles Synthesized via Co-Precipitation Method

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***Abstract*- Metal oxide nanoparticles are synthesized via different routes to obtain different absorption spectra and variable band gap energy. The approach is to enhance the optical properties that can be exploited for various applications. Here we report synthesis of Zinc Oxide nanoparticles (ZnO NPs) through co-precipitation method using precursor zinc acetate and Cetyltrimethyammonium bromide (CTAB) as capping agent and cobalt acetate tetrahydrate as dopant material. The synthesized ZnO NPs are of wurtzite structure having crystal size of 32.40 nm, 24.66 nm and 21.19 nm for undoped, cobalt doped (0.05 %) and cobalt doped (0.1 %) ZnO NPs respectively as depicted from X-ray diffractometry (XRD) analysis. The UV-visible spectroscopy absorbance spectra shows absorption peak at 365 nm, 372 nm and 380 nm for undoped and doped (0.5 % and 1 %) ZnO NPs respectively. The red shift in absorption spectra gives tunable band gap energy. The Energy Dispersive X-ray analysis (EDX) confirms doping of cobalt in ZnO NPs and Field Emission Scanning Electron Microscopy (FESEM) results suggest that the undoped ZnO nanoparticles are rod shaped, 0.5% Co-doped are rod and spherical shaped and 1% Co-doped are spherical shaped.**

***Keywords*: Co-precipitation, Dopant, Absorbance, Band Gap Energy, Tauc plot, Crystal size.**

I. INTRODUCTION

Among metal oxides, ZnO is a wide band gap semiconductor of band gap energy 3.37eV and is of the II-VI semiconductor group. The size and shape dependent properties of Zn NPs draw researcher's attention to synthesize these particles through different routes [1-2]. Various researchers have reported the synthesis of these particles in different ways. Flower shaped ZnO NPs synthesized through sol-gel method and the effect of variation in temperature on crystal size is examined [1]. Zinc Oxide Flake structure prepared by hydrothermal method [2]. Zinc Oxide Nanorods and Nano cones synthesized via hydrothermal method using SDBS and CTAB surfactants, which depicts that selection of surfactant alters the morphology [3]. Cobalt doped ZnO NPs prepared by sol-gel technique of hexagonal wurtzite structure and it was reported that the there is decrease in size with dopant concentration [4]. Zinc Oxide nanorods synthesized via thermal decomposition method [5]. The porous structure Zinc Oxide nanoparticles were synthesized [6]. Although the different methods are reported in earlier studies, it still remains a challenge for researchers to synthesize shape and size selective ZnO nanoparticles through low cost, simple and easy synthesis route for variable crystal size and band gap energy.

Here we have reported synthesis of ZnO nanoparticles via co-precipitation method, which is low temperature, simple and easy route. The CTAB assisted and cobalt (Co) doped (0.5% and 1%) ZnO NPs were synthesized. The as synthesised ZnO NPs were characterized by UV-visible spectroscopy, XRD, EDX and FESEM for absorbance, crystal size, chemical elemental and morphology (size and shape) analysis respectively.

II. EXPERIMENTAL

A. Materials

All the chemicals used in the synthesis process were of analytical grade. The chemicals i.e. Zinc Acetate, Cetyltrimethyammonium bromide, Sodium Hydroxide and Cobalt Acetate Tetrahydrate were purchased from Loba and used as received. Deionized water (D.I.) is used throughout the experiment.

B. Methodology

0.5 M (5.48g) of Zinc Acetate was added in 50 ml D.I water and stirred for 15 minutes, Then $5*10^{-3}$ M (0.036g) of CTAB was added in 20 ml D.I water and stirred for 15 minutes. After that CTAB solution was added in Zinc Acetate solution and stirred for 15 minutes. Then 2 M (1.6g) of NaOH was dissolved in 20ml D.I. water and added into above prepared solution drop-wise for making precipitate. Then the prepared precipitate was kept at 60 degrees centigrade heat for 4 hours with continuous stirring. After 4 hours the solution was placed at room temperature for 2 hours to cool down the solution and to settle down the precipitate. After this the precipitate was centrifuged for 3 times at 6000 rpm to separate the supernatant and pellet was collected in watch glass. By keeping the pellet in hot air oven for 5 hours at 60 degree centigrade, the powdered form of ZnO nanoparticles was prepared. With the same process the cobalt doped ZnO NPs were prepared i.e. 0.05gm Cobalt Acetate Tetrahydrate solution was added it in 10ml D.I water for 0.5% solution and 0.1gm was added in 10ml D.I water for 1% solution [1, 7, 8].

III. UV-VISIBLE SPECTROSCOPY

The optical analysis regarding absorption was carried out through the UV-visible spectroscopy. UV-visible spectra of nanoparticle sample differ from its bulk form. The UV-visible spectra of CTAB assisted ZnO NPs shows absorbance peak at 365 nm as shown in figure 1.

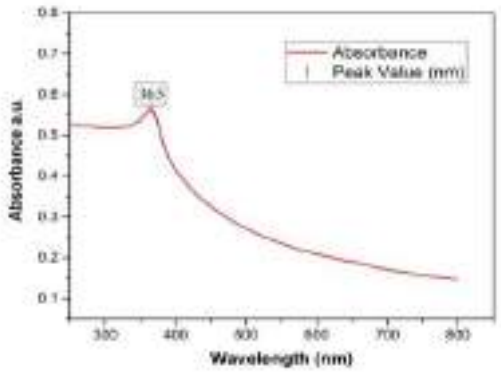

Fig. 1 Absorption spectra of CTAB assisted ZnO NPs

The UV-visible spectra of cobalt doped (0.5%) ZnO NPs shows absorbance peak at 372 nm as shown in figure 2.

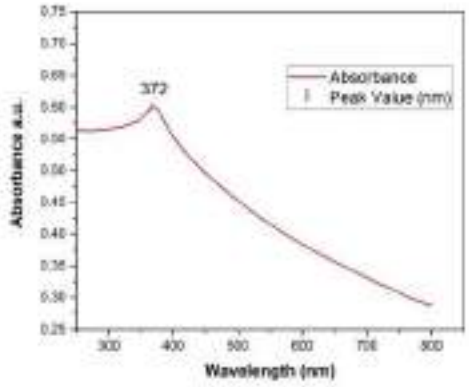

Fig. 2 Absorption spectra of Cobalt doped (0.5%) ZnO NPs

The UV-visible spectra of cobalt doped (1%) ZnO NPs shows absorbance peak at 380 nm as shown in figure 3.

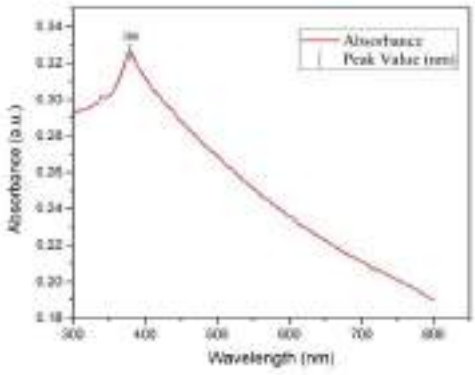

Fig. 3 Absorption spectra of Cobalt doped (1%) ZnO NPs

It was observed from the absorption spectra that there is red shift due to addition of the dopant in ZnO NPs.

III. TAUC PLOT FOR BAND GAP EVALUATION

The band gap energy in eV of as synthesised ZnO NPs was calculated from Tauc plot as shown in figure 4. The band gap energy for pure ZnO, 0.5% Co doped and 1% Co doped nanoparticles is 3.33 eV, 3.31 eV and 3.26 eV respectively. The UV-Visible absorption results were used to plot tauc plot using the following equation:

$$(2.303 * A * 1240/\lambda)^2 = k(1240/\lambda - Eg) \quad (1)$$

where A and λ are absorbance and wavelength respectively attained from the absorption spectra of the ZnO nanoparticles [9, 10]. A plot of Equation 1 gives an absorption curve whose tangent articulates the band gap energy of the nanoparticles.

The band gap energy decreases with increasing doping concentration which in turn increases the conductivity of nanoparticles and can be used for solar cell applications.

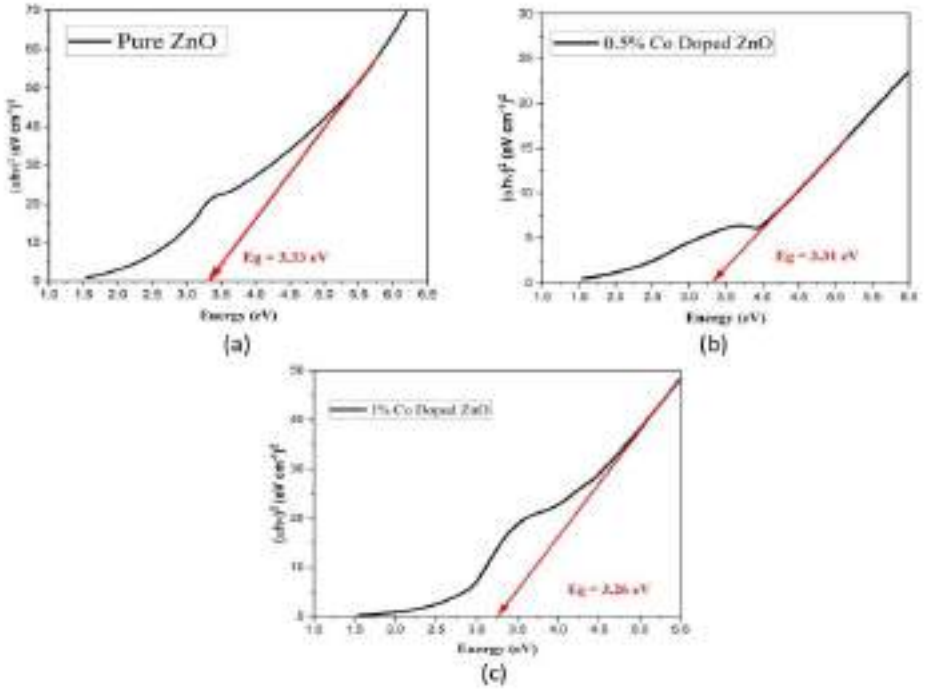

Fig. 4 Tauc plots for the evaluation of band gap of samples a) Pure ZnO b) 0.5% Co doped ZnO c) 1% Co doped ZnO

IV. XRD ANALYSIS

The crystal structure and phase purity of the synthesized CTAB assisted and Cobalt doped (0.5% and 1%) Zinc Oxide Nanoparticles was analysed by X-ray diffractometery (XPERT PRO, PANanalytical) with CuKα (λ = 1.542 A°). The 2θ values at 31.84°, 34.49°, 36.32°, 47.62°, 56.68°, 62.94°, 68.04°, 69.18°, and 77.04° can be assigned to miller indices planes (100), (002),(101), (102), (110), (103), (200), (112) and (202) respectively for CTAB assisted ZnO NPs as shown in figure 4. The XRD pattern has been compared with JCPDS data sheet/ICDD No. 36-1451, which clearly confirms formation of ZnO NPs of wurtzite hexagonal structure.

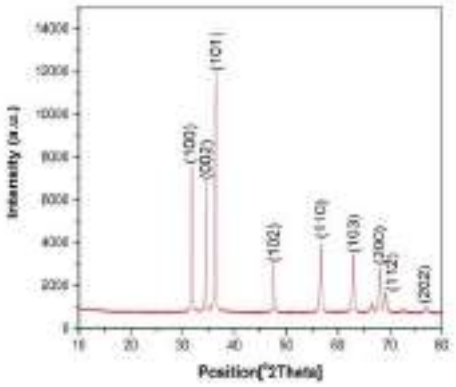

Fig. 5 XRD spectra of CTAB assisted ZnO NPs

The 2θ values at 31.87°, 34.49°, 36.31°, 47.60°, 56.65°, 62.93°, 68.01°, 69.12°, and 77.02° can be assigned to miller indices planes (100), (002),(101), (102), (110), (103), (200), (112) and (202) respectively for Cobalt doped (0.05 gm) ZnO NPs as shown in figure 5.

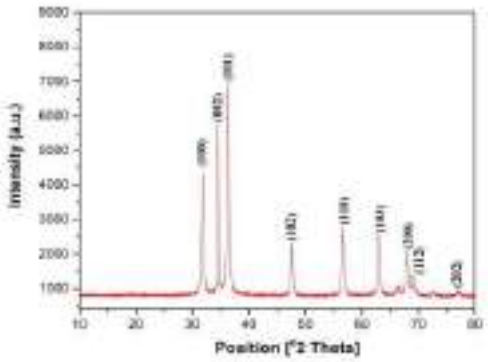

Fig. 6 XRD spectra of Cobalt doped (0.05 gm) ZnO NPs

The 2θ values at 31.92°, 34.56°, 36.41°, 47.67°, 56.73°, 62.99°, 68.07°, and 69.18°, can be assigned to miller indices planes (100), (002), (101), (102), (110), (103), (200) and (112) respectively for Cobalt doped (0.1 gm) ZnO NPs as shown in figure 6.

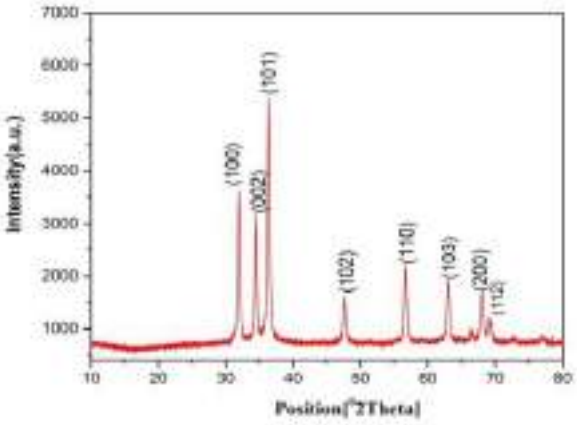

Fig. 7 XRD spectra of Cobalt doped (0.1 gm) ZnO NPs

There is decrease in the intensity peaks of XRD for cobalt doping as compare to the CTAB assisted ZnO NPs. Also the intensity peaks further decrease with increase in dopant concentration.

The crystallite size was calculated using Debey-Scherrer's formula [11]:

$$d = 0.9\lambda\beta \cos\theta \quad (2)$$

Where (d) is the crystallite size, (λ) is the wavelength of X-rays, (β) is the full width at half maximum (FWHM) of the diffraction peak and θ, the Bragg's angle. The average crystal size calculated for CTAB assisted, cobalt doped (0.5% and 1%) ZnO NPs is 32.40 nm, 24.66 nm and 21.19 nm respectively. This shows that there is decrease in the crystal size of synthesized nanoparticles on addition of dopant as well as increase in dopant concentration.

V. EDX ANALYSIS

The elemental analysis was carried out through EDX analysis to confirm the chemical composition of synthesized zinc oxide nanoparticles. As shown in figure 7, there are intensity curves confirming the presence of zinc and oxygen elements. The EDX spectra as shown in figures 8 and 9 confirm the presence of zinc and oxygen elements and also the presence of dopant cobalt in zinc oxide nanoparticles.

Fig. 8 EDX spectra of CTAB assisted ZnO NPs

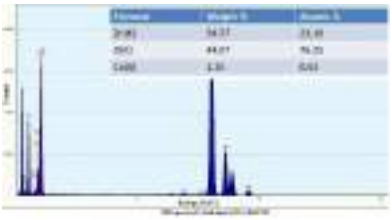

Fig. 9 EDX spectra of Cobalt doped (0.5%) ZnO NPs

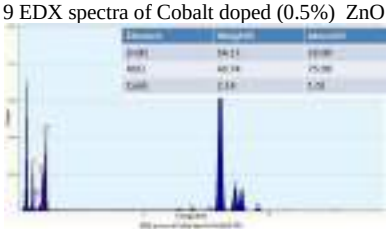

Fig. 10 EDX spectra of Cobalt doped (1%) ZnO NPs

VI. FESEM ANALYSIS

The Field Emission Scanning Electron Microscopy analysis was carried out to confirm the morphology (size and shape) of as synthesized ZnO NPs. The micrograph as shown in figure 10 suggests that the CTAB assisted ZnO NPs are of rod shaped having average diameter of 50 nm and length 150 nm.

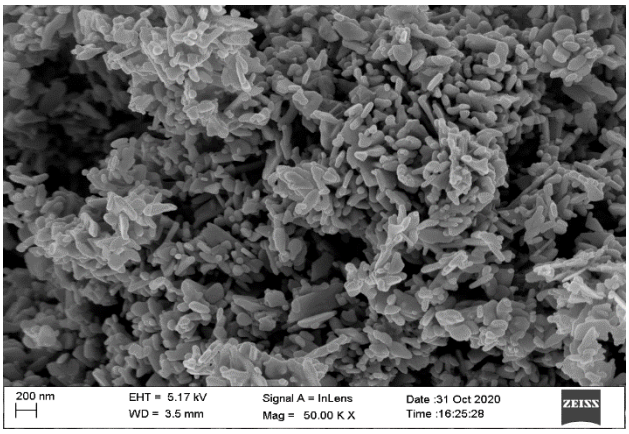

Fig. 11 FESEM micrograph of CTAB assisted ZnO NPs

The micrograph for Cobalt doped (0.5%) ZnO NPs as shown in figure 11 depicts that the nanoparticles are of spherical and rod shaped having average diameter of spherical 45 nm and rod shaped having average diameter of 42 nm and length of 137 nm. The figure 12 represents the morphology of Cobalt doped (1%) ZnO NPs, which provides that the synthesized nanoparticles are of spherical shape having average diameter of 39 nm. From this it has been concluded that there is effect on shape of zinc oxide nanoparticles as in case of undoped (CTAB assisted), the nanoparticles are of rod shaped. With the addition of dopant i.e. Cobalt (0.5%), the shape modified to rod and spherical and by increasing the dopant concentration i.e. Cobalt (1%), the shape changed to spherical. This confirms the effect on shape. The size of as synthesized nanoparticles also decreases with the addition of the dopant as well as with increase in the concentration. And these results are also in good aggrement with the XRD data, which depicts that there is decrease in the crystal size of the nanaoprticles with addition of dopant and variation in the concentration.

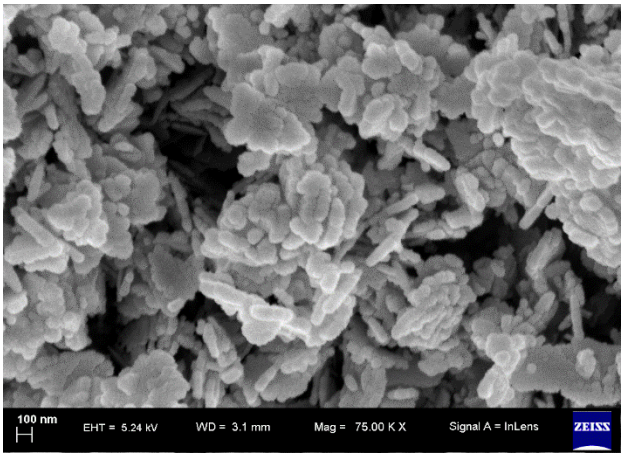

Fig. 12 FESEM micrograph of Cobalt doped (0.5%) ZnO NPs

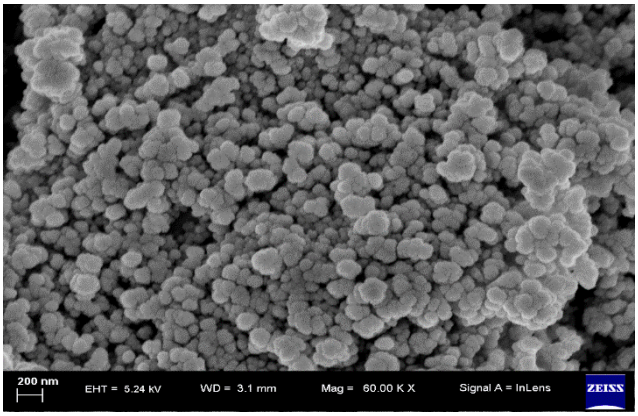

Fig. 13 FESEM micrograph of Cobalt doped (1%) ZnO NPs

VII. CONCLUSION AND FUTURE SCOPE

The metal oxide CTAB assisted and cobalt doped (0.5% and 1%) ZnO NPs were synthesised by simple, easy and low temperature co-precipitation method. The XRD results confirm decrease in crystal size with addition of dopant as well as concentration level of dopant. There is red shift in absorption spectra which gives variable band gap energy of as synthesised ZnO NPs. Tauc plot evaluation for band gap energy showed that with doping the band gap energy was decreased and this change in band gap energy can be exploited for solar cell applications. The FESEM analysis confirms the effect of dopant on size and shape of ZnO NPs. The prepared ZnO NPs can be used in optical sensors, photocatalytical applications and solar cells due to variable band gap energy. This work can be extended to examine the light absorption and resistivity properties of undoped and doped zinc oxide nanoparticles.

ACKNOWLEDGEMENT

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DECLARATION

The authors have no conflict of interest.

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Fog Computing: A Taxonomy of Smart City Applications

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Abstract **A tremendous growth of IOT devices connected through internet provides services to various application domains that generates large amount of data. So, there is a requirement of huge storage and processing power. Cloud provides a supporting technology. Cloud provides processing as well as storage of the big data being generated by the connected devices. The IOT environment is constrained in terms of bandwidth, processing power, memory and energy. The idea of Fog Computing is to extend the Cloud near to the IOT devices. Fog Computing is a highly virtualized platform that provides computing, storage and networking services between end user and data center of traditional Cloud Computing. Fog Computing has created new opportunities for smart applications. This study represents a scientific and systematic study of various smart city applications of Fog Computing.**

Keywords Fog Computing, Personal Digital Assistant (PDA), Fog Learn, Internet of Things, Security.

I. INTRODUCTION

The Internet of Things is connecting number of smart devices. The International Data Communication (IDC) expected that sensor enabled objects connected to the network will rise to 50 billion by 2022. The number of connected devices will increase from 50 billion to 1 trillion. It is also estimated that there will be 240 million wearable devices by 2022. The number of connected devices per person is going to be 9 on average by 2022. A smart home currently contains on an average more than a dozen of sensors. This is going to generate tremendous amount of data. So, there is a requirement of huge storage and processing power [1]. Cloud Computing provide support via massive storage of data, huge processing power, cost effective solution with security, reliability and 24*7 service time. Therefore 90% of global internet users are now dependent on Cloud based services. The Cloud Computing faces various limitations in terms of delay, bandwidth, traffic congestion and energy consumption [2]. This leads to the requirement of an intermediate layer to extend cloud near to the IOT devices. The term 'Fog' is a Cloud close to the ground. The Fog Computing is to bring Cloud near to the IOT devices.

Fog Computing or Fogging is a term coined by CISCO. It acts as an intermediate layer between IOT and cloud. The main purpose of this technology was to support time sensitive applications such as health care services, augmented reality and IOT applications that generate huge amount of real time data which cannot be send to the cloud for processing due to latency and bandwidth requirements [2]. The Fog Computing provides processing at the edge of the network to support latency sensitive applications.

The paper is organized as follows: Section II presents the Fog Computing. Section III provides the Fog Computing Three-tier Architecture. Section IV details about the Applications of Fog Computing. Section V is the conclusion of the study.

II. FOG COMPUTING

Fog Computing is a computing paradigm for providing computing, storage and networking services between end user and data center of the cloud computing. Fog is basically cloud close to the ground. The term Fog comes From cOre to edGe Computing. Fog Computing is not a substitute of cloud but it is a complement to the cloud. The primary aim was to solve the problem faced by Cloud Computing [3].

In Fog Computing architecture very large number of geo-distributed devices forms a mini-cloud at the edge of the network. Instead of always sending and receiving data from edge devices to the cloud, the edge devices which are in proximity can obtain data from end users through direct link. In addition, Fog network release some of their resources like computing and storage capacity to support the demands of their neighbours. The tasks that are not well handled by the edge devices are sent to the correct cloud for further processing [4].

A. *Features of fog computing*

1. Low latency and location awareness [5].
2. Support geographical distribution [6].
3. End devices mobility [5].
4. Capacity of processing high number of nodes.
5. Wireless access.
6. Real -time applications.
7. Heterogeneity [7].

III. FOG COMPUTING THREE-TIER ARCHITECTURE

1. *Tier-1 End Devices:* This layer contains IOT devices, end users, smart devices (smart phones, tablets, smart cards, smart vehicles and smart watch) also known as terminal nodes.
2. *Tier-2 Fog:* This is Fog Computing layer comprised of network devices such as router, gateway, switches and access points. These Fog nodes have storage and computing facilities.
3. Tier-3 Cloud: Traditional cloud servers and cloud data center residential in the top-notch tier. This tier has sufficient storage and computing resources.

Figure 1 shows the Three-tier architecture of Fog Computing. In the architecture, the Fog Computing acts as an intermediate layer. In the IOT environment we require both cloud and Fog. Edge devices are generating data. This data is to be processed and then stored at the cloud. The Fog layer is used for intermediate processing and transient storage of the sensed data before it is sent to the Cloud [8].

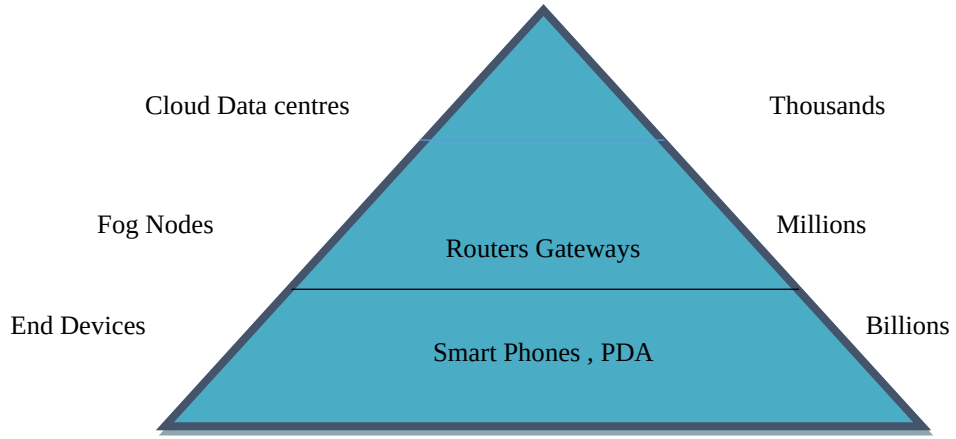

Fig.1: Fog Computing Three-tier Architecture

A. *Characteristics of fog nodes*

1. Storage: Transit
2. Computing facility: To process data before it sends to the cloud. To take quick decisions.
3. Network Connectivity: To connect end devices and fog nodes.
4. Examples of fog devices: Servers, routers, switches and access points.

Table I

DIFFERENCE BETWEEN CLOUD AND FOG COMPUTING

Sr No.	Features	Traditional Cloud Computing	Fog Computing
1.	Computing Model [9]	Centralized	Distributed fog nodes are controlled in both distributed and centralized manner.
2.	Deployment Cost	High, due to sophisticated planning.	Low, fog enables ad-hoc deployment with or without planning.
3.	Resource optimization	Global	Local
4.	Latency [9]	High	Low
5.	Size	Cloud data centers are very large in size	Smaller however a large number of small fog nodes form a large fog system.
6.	Mobility management	Easy	Hard
7.	Operation	Operated by large companies.	Often operated by small companies, however large companies can operate depending on size.
8.	Reliability	High	Low
9.	Maintenance	Operated and maintained by technical experts	Generally, requires no or little human involvement.

Table I gives the difference between the traditional Cloud Computing and Fog Computing infrastructure.

IV APPLICATIONS OF FOG COMPUTING

Fog Computing provides versatile applications in wide areas. The applications are growing due to distributed processing solutions near the generation of data. This makes real-time decisions possible with almost minimum delay as well as reduces the burden of traffic on the network. Figure 2 provides a broader view of the Fog Computing applications in various areas.

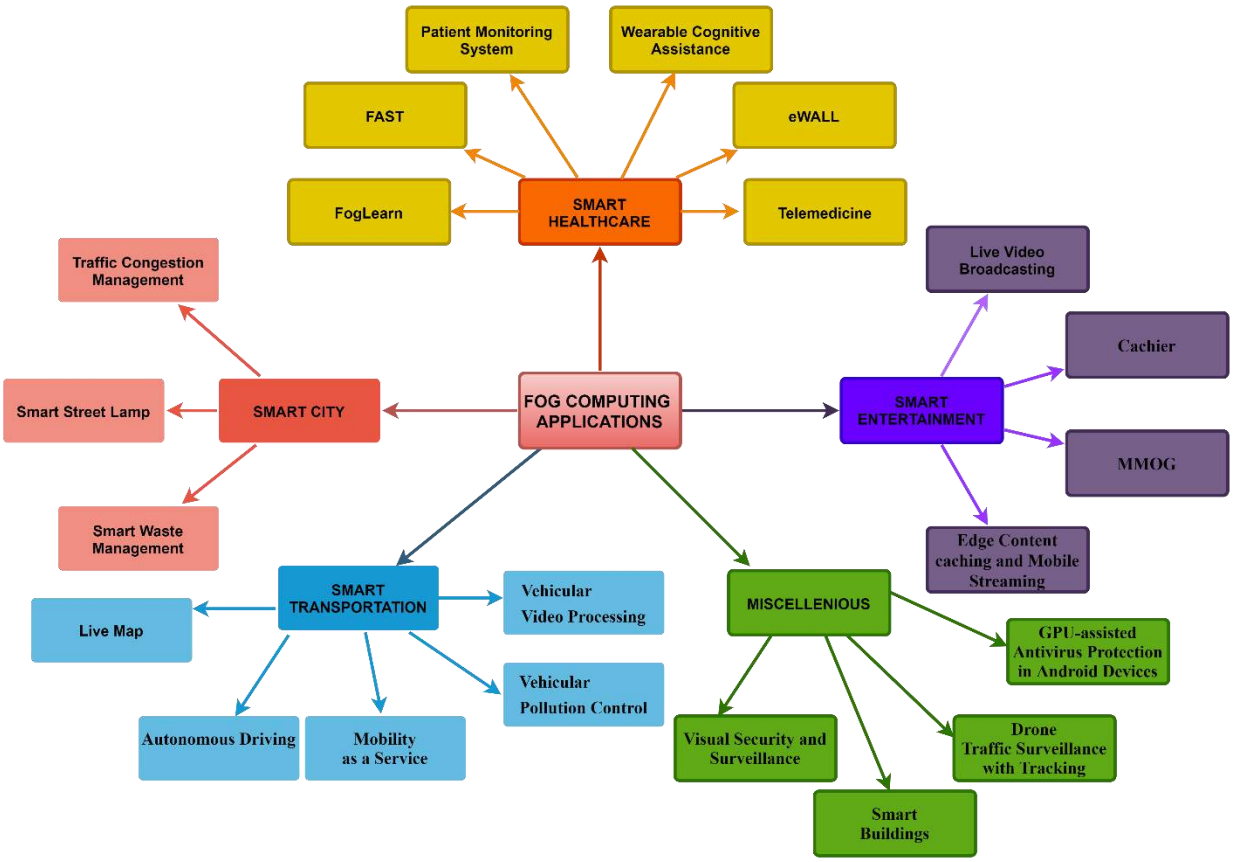

Fig.2: Fog Computing Applications

A. Smart Healthcare

The health monitoring is of great concern in today's scenario. The data collected from thousands of wearable body sensors is need to be analyzed. The analyzed and processed results are to be communicated. This requires an infrastructure to provide real time decisions with minimum latency as well as bandwidth requirements. The Fog provides a platform for processing at the edge of the network. The Fog provides a highly virtualized distributed environment for analysis, processing and communication about the data. The distributed Fog nodes provides scalability that is helpful for communication of decisions for the streamlining and integration of healthcare system [10]. The application of Fog computing in healthcare are studied. Few of them are discussed here:

1-Patient Monitoring System: The sensors can sense patients' data and these thousands of sensors should be able to communicate data to the health system so that a real-time care can be provided to patients in a scalable environment from health experts. The healthcare professional with the help of Fog nodes distributed in the network can analyze and process the data so that real time care can be provided [11].
2-Wearable Cognitive Assistance: There are millions of people who have certain form of illness due to their age. There should be some form of wearable device that can sense, process and communicate about their health conditions. Some software can be built up on wearable devices to help gather their health records [12].
3-FAST: There are certain illness such as COPD and MuDementia which are due to age. The environment in the home should be such as to cater the personal details and the processing of the real time data should be done with no delay so as to provide safe and secure environment [13].
4-eWALL: System to monitor the stroke, is a distributed analysis that has fall detection algorithms incorporated into Fog node that distribute information in the network through smart phones to cloud servers [14].

5-Foglearn: It is a three-layer infrastructure for Ganga River Basin management for detecting patients suffering from diabetes. The latency of processing and analysis of the data can be reduced by pre-analysis and processing at fog nodes and even fog layer can facilitate the larger workload by processing at the edge of the network [15].
6-Telemedicine: To the health professional, the electronic medical record of the patient is very much necessary. This may contain data regarding CT scans and MRI reports. The main emphasis is to secure this private health data by initial processing at fog nodes and storing at cloud servers [16].
Table II gives the summary of the Smart Healthcare Applications of the Fog Computing.

Table II

SMART HEALTHCARE APPLICATIONS

ID	Name	Category	Source
1	Patient Monitoring System [11]	Health	Open Fog Consortium
2	Wearable Cognitive Assistance [12]	Health	Peer Reviewed
3	FAST [13]	Health	Peer Reviewed
4	eWALL [14]	Health	Peer Reviewed
5	FogLearn [15]	Health	Peer Reviewed
6	Telemedicine [16]	Health	Peer Reviewed

B. Smart City

The cities are now becoming more advanced due to a greater number of smart and connected devices. These are facilitating the lifestyle of the people with more ease and comfort. The more the generation of the data from connected devices the more is the requirement of processing and storage. Fog computing is a scalable and distributed computing paradigm that helps processing at the edge and reduces delay and bandwidth consumption.

7-Traffic Congestion Management: The traffic in the cities is becoming a major concern, as with the increase in population the number of local vehicles is also increasing. Their movement specially in the peak hours is a matter of concern for local municipal management. To decide the route load and giving the real-time data to the end user with the help of fog nodes will be relaxing the authorities and local people from congestion. The distributed fog nodes will sense and process the traffic load data to the near gateway that will further transmit to other neighboring gateway and relief the traffic congestion [17].
8-Smart Street lamp: It is a good option for saving energy. These applications have sensors deployed in each lamp to collect real time surrounding data about intensity of light, presence of human being and also about voltage and current levels. These lamps can also communicate to the server about their working conditions. This makes a smart conservation of energy.[18]
9-Smart Waste Management: The waste management is a bigger task is larger cities. The sensors attached to the waste collection corners can communicate the garbage level of a particular unit to the waste collection vehicle. This will help the garbage collection vehicle to decide the route so that they save fuel and time and make the waste collection more managed.[19]
The smart city applications provide a view of emerging technology trends to make smart environment. Table III enlists the Smart City Applications of Fog Computing.

Table III

SMART CITY APPLICATIONS

ID	Name	Category	Source
7	Traffic congestion Management [17]	Smart City	Open Fog Consortium
8	Smart Street lamp [18]	Smart City	Peer Reviewed
9	Smart Waste Management [19]	Smart City	Peer Reviewed

C. Smart Entertainment

10-Live Video Broadcasting: The entertainment industry is now becoming a real-time industry. The sports fans are now demanding real time broadcast for their favorite sport from the play field. This is done by placing hierarchical Fog nodes that collect real-time data and decrease latency and bandwidth consumption and help cloud in management of large video streaming.[20]

11-Cachier: The caching model minimizes the latency with an adaptive load balance between the edge and the cloud. The latency sensitive applications such as recognition and perception based mobile applications are very much popular in mobile phones. Cachier are the Fog computing applications which provides real time response by processing near the generation of data.[21]

12-MMOG: The increase in online gaming has led to more promises from the conventional gaming models as this has given users as ease of hardware and software requirement for playing games. Fog provides support of streaming and processing games with less latency and more speed.[22]

13-Edge Content Caching: Mobile video streaming has led to the conventional content caching to edge network content caching. The edge provides more refined performance. This leads authors propose edge content caching.[23]

Table IV provides a glance at the Smart Entertainment applications of Fog Computing.

Table IV
SMART ENTERTAINMENT APPLICATIONS

ID	Name	Category	Source
10	Live Video Broadcasting [20]	Entertainment	Open Fog Consortium
11	Cachier[21]	Entertainment	Peer Reviewed
12	MMOG [22]	Entertainment	Peer Reviewed
13	Edge Content Caching for Mobile Streaming [23]	Entertainment	Peer Reviewed

D. Smart Transportation

Fog Computing provides smart traffic services to the people as traffic management is an important concern. The heavy load of vehicles on road, jams in a particular area and in the stipulated times is very common. It also includes the parking facilities available in a particular area, traffic loads and alternate path to reach from source to destination, if the main path is facing congestion. The Fog Computing help is monitoring traffic load in particular area with the help of fog nodes that collect basic information and after analysis and processing provides decisions to the edge devices about the traffic conditions and the path to be followed from source to destination.

14-LiveMap: The transportation system now days becoming smart by using the live mapping system which provides real-time vehicular data. It provides more refined data about road conditions as well as road maps. These systems are becoming popular due to larger traffic as well as it saves time and fuel also.[24]

15-Autonomous Driving: This involves number of simultaneous processes that have data which need to be communicated between devices. The data is collected from low-level sensors and is to be processed and communicated in real-time. This is provided by distributed and scalable processing at the edge paradigm of Fog Computing. PODs are the examples of autonomous driving which are used to travel from one destination to other. They are also called ULTra PRT. Here ULT stands for Urban Light Transport and PRT means Personal Rapid Transit [25].

16-Mobility as a Service: MaaS provides services and allow people moving. The objective is to provide need oriented transport ecosystem where the network enables mobility operators to detect and understand real-time customer need. Fog Computing is a distributed system that supports processing and scalability both hand-in hand [26].

17-Vehicular Video Processing: The large volume of high-quality videos from vehicles is need to be processed. This data is sent to the cloud for processing and storage via WAN. The Fog Computing off loads the burden of cloud by processing the real-time data near the generation of data and also saves the bandwidth of the channel by reducing the load of the data to be sent to the cloud for processing and storage [27].

18-Vehicular Pollution Control: This system takes the real-time data from gas sensors and sends it to fog servers. The fog nodes are deployed on the traffic post for processing the gas sensor data from the vehicles. The k-means cluster algorithm is used for grouping the data and identifying the pollution level in real-time. The pollution level found to be more than a prescribed limit; it is notified to the pollution control centre [28].

The smart transportation gives helping hand to the management of vehicular traffic. Table V gives the list of smart Transportation Applications of Fog Computing.

Table V
SMART TRANSPORTATION APPLICATIONS

ID	Name	Category	Source
14	LiveMap [24]	Transportation	Peer Reviewed
15	Autonomous Driving [25]	Transportation	OpenFog Consortium
16	Mobility as a Service [26]	Transportation	CISCO white paper
17	Vehicular Video Processing [27]	Transportation	Peer Reviewed
18	Vehicular Pollution Control [28]	Transportation	Peer Reviewed

E. Miscellaneous Applications

There are many application areas where the Fog computing provides a potential of computing as well as real-time, latency sensitive distributed infrastructure.

19-Visual Security and Surveillance: The security and safety of our surroundings is becoming more important with the increase in population and the migration of people from one place to other for various reasons. The parents are working, kids and old age people are at home. There is a need of security and safety. The sensors deployed in the home environment can sense the environment. The data collected from sensors about any abnormal heat, pressure or gas condition is sent via fog nodes to Fog gateway. The Fog provides a cost-effective distributed surveillance also by taking information from the local cameras in residential areas and their surroundings if something suspicious is found.[29]
20-Smart Buildings: The buildings are now a days making use of IOT for improved lifestyle in terms of energy efficiency, water usage and air quality etc. There are thousands of sensors deployed to measure the building parameters such as temperature, humidity, occupancy, energy usage. The fog nodes are placed in such a way that building conditions at room level, floor level and building level are maintained in a hierarchal order.[30]
21-Drone Traffic Surveillance with Tracking: The traffic monitoring system in cities is speeding up with the help of tracking drones. These are connected to fog nodes to process the image data collected from vehicles. They use divide and conquer strategy and find the vehicles of interest so that the information can be send to fog server gateway for further processing.[31]
22-GPU-assisted Antivirus Protection in Android Devices: These algorithms are meant for the protection of android systems in the area.[32]

Table VI summarizes the Miscellaneous Applications of Fog Computing in various areas such as security, IT security, Smart space and smart cities.

Table VI
MISCELLANEOUS APPLICATIONS

ID	Name	Category	Source
19	Visual Security and Surveillance [29]	Smart Cities	OpenFog Consortium
20	Smart Buildings [30]	Smart Spaces	OpenFog Consortium
21	Drone Traffic Surveillance with Tracking [31]	Security	Peer Reviewed
22	GPU-assisted Antivirus Protection in Android Devices [32]	IT Security	Peer Reviewed

V CONCLUSION

The Fog Computing paradigm is a communication infrastructure that provides processing at the edge of the network. The Fog acts as an intermediate layer between the device generating data and the cloud processing and storing the data. The Fog relieves the burden on the cloud by processing the real time and latency sensitive data on the edge of the network. The Fog provides a virtualized distributed processing environment that gives advantage in terms of bandwidth, latency and processing. The Fog Computing is one of the important pillars of the IOT super-infrastructure. This provides supporting paradigm to the big data management. The Fog Computing provides support to many application areas. The Fog Computing applications are very much diversified in nature. They have requirements of real time processing of the data as well as optimization of resources. The above study provides a glance on the versatile application area of Fog Computing.

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Survey on Millimeter wave Antenna for 5G Technology: Design Considerations and Applications

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Abstract—**The millimeter wave technology has made its way to the 5G technology as the system of 5G requires larger bandwidth, higher frequency and system capacity. In order to achieve these parameters, the millimeter wave antenna research becomes necessary. The current wireless technologies require huge bandwidth which makes the spectrum of millimeter wave a potential candidate. Microstrip antennas have always been in an increasing demand due to their exceptional performance in the applications of wireless communication. The advantages of microstrip patch antenna led to its popularity among the researchers. The technologies such as MIMO, CMOS and beam forming are used with millimeter wave antenna for improving the mobile phone performance. There are various designs of microstrip patch antenna related to 5G technology and applications in the millimeter wave band which are discussed in the paper.**

Keywords—**Microstrip Patch Antenna, 5G technology, Millimetre Wave, Wireless Applications, Bandwidth.**

I. INTRODUCTION

5G stands for fifth generation in telecommunication. In cellular networks, 5G technology is a standard which has been deployed by various companies of cellular phone in 2019 worldwide. 5G technology is a successor to the networks of 4G through which the connectivity to most of the current cell phones is provided. There is division of the service area in 5G cellular networks into small cells. These cells are the geographical areas inside the cellular network. A single cell contains large number of 5G wireless devices which are connected to the cellular network and internet by radio waves via antenna present in the cell. This new network has various advantages such as larger bandwidth and higher data rates [1-2]. Because of the larger bandwidth, the new networks can be used as internet service providers to desktop computers and laptops. The new applications in M2M (Machine to Machine) and IoT (Internet of Things) areas would also be possible. The NR (New Radio) air interface for 5G is divided into frequency bands. First one is FR1 (Frequency Range 1) which has the frequency range below 6 GHz and other is FR2 (Frequency Range 2) for millimeter wave frequency. Each frequency band has different capabilities. The maximum bandwidth of the channel for FR1 is 100 MHz because the frequency range is highly crowded which further lacks the continuous spectrum [3]. The channel bandwidth for FR2 is 50 MHz- 400 MHz high speed data transfer is supported by higher frequency. Various applications of 5G technology include automobiles, public safety, fixed wireless and broadcast applications as the wireless video transmission would be possible. The services of the wireless communication are increasing in demand day by day due and have possessed a great challenge to the current wireless communication system due to lack of bandwidth requirement [4-5]. The millimeter wave technology has made its way to the 5G technology as the system of 5G requires larger bandwidth, higher frequency and system capacity. In order to achieve these parameters, the millimeter wave antenna research becomes necessary. The large transmission gain and high bandwidth are the two main utmost important factors of millimeter wave antenna [6]. The frequency of 28 GHz and 72 GHz are introduced in the MMB (millimeter-wave mobile broadband) system. In comparison to the microwave, the propagation loss and the penetration loss of millimeter wave is much less which relatively leads to long links and higher antenna gain. The capacity and the spectrum requirements are the prominent factors owing to increased data traffic the current wireless communication system [7]. The 5G mobile network can use the millimeter wave band of high bandwidth to provide various communication services such as HDTV (high-definition television) and UHDV (ultra-high-definition video). The electronic products used in the millimeter wave band such as CMOS (Complementary metal-oxide Semiconductor) and RF (Radio Frequency) integrated circuits have been in rapid progress. There are many factors on which the applications dependent on the 5G operations are enabled [8-9]. These factors include spectrum selection, antenna technology, digital signal processing, and transceiver integration along with propagation characteristics. The current wireless technologies require huge bandwidth which makes the spectrum of millimeter wave a potential candidate of such technologies. Therefore, a significant amount of work is dine in collecting the substantial knowledge about the millimeter wave spectrum as the 5G technology is evolving at a fast pace in industrial and commercial applications. In wireless systems, antenna is the most important component as it affects the sensitivity of the receiver, transceiver designs, link budget and the schemes made in the choice of digital modulation [10]. There are improved characteristics in the design of millimeter wave antenna such as size of the antenna, bandwidth, high data rate, traffic demand and the antenna gain. The basic ground for the 5G technology is provided by the radio frequency at millimeter wave. The spectrum of the millimeter wave is 30GHz-300GHz as shown in figure 1. The spectrum required for the 5G application is 20GHz-90GHz. The antenna for the 5G technology is designed at various frequencies of 28 GHz, 38 GHz and 72 GHz. They have the bandwidths

of 500MHz, 1 GHz and 2 GHz. These bandwidths are suitable for low latency system and high data rates. Such type of antenna design can be used in the 5G cellular applications because of their high directivity and sensitivity to the obstacles having narrow width.

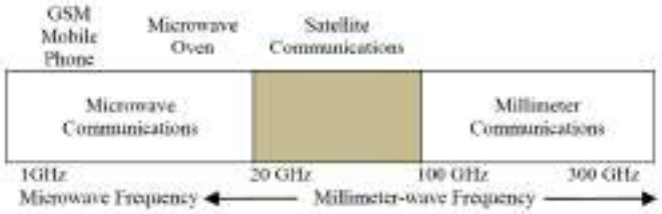

Fig. 1. Millimeter wave spectrum

II. MILLIMETER WAVE ANTENNA FOR 5G TECHNOLOGY

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. As the demand of the mobile traffic is increasing significantly, there is prominent shortage of the spectrum and capacity requirements. 5G wireless networks require large bandwidth. Therefore, the millimeter wave band having huge bandwidth of 30 GHz – 300 GHz prove to be an integral part of the 5G wireless system. The current research is mostly focused on 28 GHz, 38 GHz and 60 GHz frequency. Due to the rapid and fast progress in CMOS (Complementary Metal Oxide Semiconductor) and RF (Radio Frequency) integrated circuits, the electronic components and devices can easily compliment the millimeter wave communication [11-12]. There are various standards defined for WLAN and WPAN such as IEEE 802.1, ECMA-387 which helps in extending the millimeter wave band network in cellular system. There are various challenges faced by the millimeter wave communication in the physical layer and the routing layer because it varies significantly with the current microwave band communication. This leads to the great impact on 5G wireless communication system [13]. New insights and thoughts in the protocols and architecture of the millimeter wave communication is required in terms of directivity, propagation loss and sensitivity caused by the mobility of the communication.

A. 5G Related Millimeter Wave (mmW) Microstrip Patch Antenna

To develop a mobile network in 5G, the designing of a suitable antenna become very critical. The proper measurement of various antenna parameters is required to check on the suitability in 5G network and technology. The technologies such as MIMO, CMOS and beam forming are used with millimeter wave antenna for improving the mobile phone performance. There are various designs of microstrip patch antenna related to 5G technology. An antenna for 5G technology with circular polarization was designed which focused on the miniaturization of patch and enhancing the beam width. Consideration of various parameters is necessary to design an antenna for 5G cellular network which include bandwidth, antenna size, operating frequency, manufacturing cost and polarization. The size of the antenna is reduced by introducing folded type antenna of circular shape. The antenna beam width is enhanced by surrounding the patch antenna with dielectric substrate and adding the metallic block at the rear side of the antenna [14]. 5G directional antenna was designed using the technology of millimeter wave spectrum to face the challenges of rapid increase in the growth of mobile users. This required large bandwidth for efficient communication [15]. 5G wideband rectangular shaped antenna is used at 6 GHz frequency which satisfied the requirements of 5G technology. The design technology of far field radiation pattern is used in the antenna which significantly analyzed the environmental parameters of atmospheric absorption [16]. 5G directional antenna is designed at the operating frequency of 28GHz and 38 GHz in the mobile communication of millimeter wave spectrum. This design followed some effective approaches such as impedance matching optimization, multiple resonance and increasing the substrate thickness which results in the reduced substrate permittivity. The substrate of high dielectric constant is used which reduced the radiation losses [17]. A CPW fed design microstrip patch antenna is designed for 5G technology with operating frequency of 8.4 GHz WSN, WLAN, Hyper LAN and Wi-Fi technology. These designs use fractal technology for multiple band spectrum operation and better impedance matching [18]. 5G array patch antenna is designed at the operating frequency of 18GHz-28GHz. The wide area is covered using the modified antenna array design. The radiation pattern of Omni direction is used with this design to avoid the traffic rate. High gain is achieved by placing the identical sub arrays with coaxial probe feed [19]. 5G wideband patch antenna is designed at the operating frequency of 6 GHz using MIMO (Multiple input Multiple output) technology which increases the gain and quality of service [20]. Table 1 shows the complete comparison of antenna designs used at 5G cellular network and communication technology.

TABLE 1. COMPARISON OF ANTENNAS FOR 5G

S.No.	Type of Antenna	Technology	Features/ Advantages
1	Circular Polarized Antenna	Technique of miniaturization	Beam width enhancement
2	Directional Antenna	Millimmeter wave spectrum	Bandwidth improvement
3	5G Wideband Antenna	Design of far field radiation pattern	Analysis of environmental parameters
4	5G Directional Antenna	Millimeter wave spectrum	Multiple resonance and impedance matching
5	Microstrip Patch antenna with CPW feed design	Fractal Technology	Multiple band spectrum and good impedance matching
6	5G Array Patch Antenna	MIMO Technology	Improved space coverage
7	5G wideband patch Antenna	MIMO Technology	Gain improvement

III. MILLIMEMETER WAVE (MMW) ANTENNA DESIGN CONSIDERATIONS

The design of the communication system in 5G need to support high data rates and high speed with maximum frequency band coverage. The spectrum allocation and coverage depend on various applications such as smart buildings and sensor networks. High gain of the antenna is one of the most essential and desirable requirements to balance the path loss created at millimeter wave frequency and system cost reduction. The other desirable properties of designing such an antenna include high efficiency, compact size and technology of multi-antenna. The radiation patterns should be stable over the entire frequency band. The antenna should be low profile and can be easily integrated with various electronic devices. Higher levels of received signals are desirable which can be achieved by increased antenna efficiency and gain [21]. The technology of multi-antenna increases the quality of received signal by maintaining the link through the production of high gain beams. The high frequency antenna design is achieved by miniaturizing the front end of RF and on-chip system integration without comprising on bandwidth, radiation efficiency and gain. The capacity of the system design can be increased by using the techniques of multiplexing that relies on baseband signal processing. The feeding structure is also one of the significant design considerations in the antenna array design at millimeter wave frequency band. Radiation and conduction losses are experienced by traditional feeding techniques such as coplanar waveguides and microstrip lines at millimeter wave frequencies. This restricts the gain reduces the efficiency of antenna arrays [22]. To design the millimeter wave antenna at high gain, waveguide structure is preferred over the microstrip line because of lower losses. This kind of design is not suitable for production at large scale due to bulky volume and huge production costs. SIW (Substrate Integrated Waveguide) is an alternate option for applications in millimeter wave communication as it has the characteristic of low fabrication cost, low loss and planer structure [23].

IV. APPLICATIONS OF MILLIMETER WAVE BAND IN WIRELESS COMMUNICATION

The investigations on millimeter wave technology has been explored intensively in 1965 on radio communication, atmospheric sensing, radars and satellite imagery [24]. The low-cost transceiver design is made possible with the millimeter wave technology. These transceivers have components of small size and which are specially for wireless communication having high speed and short range with applications of high resolution and accuracy. There are three frequency bands in the millimeter wave spectrum which are V-band, E-band and W-band. The applications used in all the three bands are discussed.

B. V-Band: Wireless Communications with High-Speed and Short-Range

V-band is the 60 GHz band that is unlicensed allocated by FCC (Federal Communication Commission) in which the spectral band of 5 GHz is utilized by the researchers. The advantages include interference immunity, frequency reuse and high security [25-27]. The losses in the atmospheric oxygen is very high in the V-band millimeter wave spectrum due to which the attractive resources in the wireless industry are exploited which include radar sensors of high resolution with short distance and indoor communications of high speed. Therefore, short range communication is suitable for atmospheric losses of 10-15 dB/km. Some of the V-band applications include video transmission at high definition, wireless ethernet, high speed file transfer and short-range communications.

C. E-Band: Radar Detectors

The sensors and radars are required for traffic detail monitoring very precisely around the vehicle. The system of driver assistance is one of the major applications which uses the most important technology of millimeter wave radar. The vehicle radar detectors have two frequency bands of 24 GHz and 77 GHz. A critical role is played by the size of the sensor related to the antenna as all the sensors are integrated in the vehicle. The antenna size is smaller for larger frequencies which in return require large apertures. The absolute bandwidth of 4 GHz is required by the radars of short range to attain high resolution [28-29]. The high distance and long-range abilities and operations are ensured by combining high bandwidth and high transmit power. 77 GHz frequency band allows this combination.

D. W-band: Radiometric Imaging Systems in Millimeter Wave

The recent and challenging technology in the domain of wireless communication is imagery. The W-band has the frequency band of 85GHz – 94GHz [30-31]. The most important application of W-band is indoor and outdoor imaging. The active imaging radars have high resolution and are low range and therefore more suitable than infrared and optical sensors. A fixed atmospheric attenuation is allocated in the wavelength of 3 mm and 9 mm. so, the movement through fog, dust, rain and smoke is easily allowed while avoiding the obstacles. The useful information of aircraft landing can be provided by the imaging radars so that the dependence on the instrument present at the ground plane is reduced. The transparent dielectrics are present in the W-band spectrum of millimeter wave. So, a millimeter wave sensor can be used to detect the weapons while scanning a group of people. Surveillance and security confirm their needs of millimeter wave imaging. The early cancer detection in the diagnostic medicine field can also be done by millimeter wave imagery [32-33]. As compared to X-Ray imagery, the interaction of the target with the microwave radiation is based on the dielectric rather than on the density.

V. CONCLUSIONS

The millimeter wave technology has made its way to the 5G technology as the system of 5G requires larger bandwidth, higher frequency and system capacity. In order to achieve these parameters, the millimeter wave antenna research becomes necessary. The current wireless technologies require huge bandwidth which makes the spectrum of millimeter wave a potential candidate. The millimeter wave technology has made its way to the 5G technology as the system of 5G requires larger bandwidth, higher frequency and system capacity. In order to achieve these parameters, the millimeter wave antenna research becomes necessary. There are improved characteristics in the design of millimeter wave antenna such as size of the antenna, bandwidth, high data rate, traffic demand and the antenna gain. The basic ground for the 5G technology is provided by the radio frequency at millimeter wave. To develop a mobile network in 5G, the designing of a suitable antenna become very critical. The proper measurement of various antenna parameters is required to check on the suitability in 5G network and technology. The complete comparison of antenna designs used at 5G cellular network and communication technology is discussed. The design considerations of the millimeter wave band antenna and the applications used in all the three bands of millimeter wave band in wireless communication is discussed in detail.

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An Approach Towards Indian Road Sign Detection System Using Deep Learning

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Abstract— **The various authors have presented extensive research to develop the assistive system. These systems help the human being by providing information about the unfamiliar environment. Thus, people can dynamically plan their path to reach safely and efficiently to other locations. Computer vision techniques have been using for locating and identification of objects similar to our human vision. This research paper has discussed the various convolution neural network architectures (R-CNN, Fast R-CNN, Faster R-CNN, and YOLO) proposed to deal with object detection. Several objects are present in our environment, and road signs are one of them. Road signs provide valuable information that helps us to keep safe. We have developed a road sign detection system using a deep convolution neural network. The main contribution of our research work is the generation of the dataset for Indian road signs, the proposed deep convolution neural network method, and the evaluation of the results with experiments. The Road sign detection models trained over 2728 images for ten classes with six different epochs (30, 50, 75, 100, 150, and 200). This research work presents how custom datasets are trained from scratch with the proposed method. Experiments show that our proposed system has achieved 92% maximum accuracy with real data inputs.**

Keywords— Object detection technique, Indian road sign, Computer vision, Deep learning.

I. INTRODUCTION

Road sign detection is becoming an interesting research area in object detection and benefits society [1]. According to a WHO survey, 1.25 million people die every year because of road accidents [2]. Road signs provide valuable information regarding road direction, conditions, and warnings. So that driver can perform specific actions according to the sign presented on the road [3]. With the advancement of technology, modern automobiles are also embedded with complex subsystems to perform particular functions [4]. The automatic systems provide essential information and help to reduce human errors that cause accidents. Object detection (OD) systems have received enormous interest in the image processing field [5]. The OD system is interlinked with other terms such as object classification, instance segmentation, semantic segmentation, etc.[6] [7] [8]. OD has been used in many application areas such as pedestrian detection, crowd accounting, face detection and recognition, licence plate detection etc. [10]–[13], [9]. OD also assists the visually impaired person by providing valuable information about the nearby environment to independently walk and go anywhere without any obstacle [15], [14].

With the advancements of technology, many devices have been developed to assist human beings in providing valuable information it. Such systems should be beneficial to save lives and costs that motivate us to develop road sign detection systems. Therefore, the development of an automatic Indian road signs detection system using deep learning techniques is the main objective and novelty of our research work. Our proposed system requires an image as input and processes it using a trained model. For this system, we created a dataset named "Indian Road signs" by collecting images from real-world environments. The created dataset consists of 10 classes (stop, speed 50, speed 60, speed 40, speed 70, speed 80, car prohibited, left side curve, right-hand curve, horn prohibited) of road signs images from various places. It is a regression-based framework (one-stage detector) that detects and classifies the objects in one run. Our primary contribution is presented in two folds.

The first one is to develop a new dataset named Indian Road Sign.

The second is to design a system that automatically accepts an image and identifies the road sign from the image. For automatic systems, the one-stage architecture is proposed for training the model. As the experimental outcome, we performed a test of epochs to determine the effect of the model on the testing dataset and new data.

This research paper is structured as follows: Section 2 introduces road signs, discusses the outline of recent research work related to object detection systems and existing datasets of traffic/road sign detection. Section 3 will discuss the general overview of the proposed system structure and the proposed method based on deep learning. Section 4 elaborates the experimental process and results of our proposed approach. In the last sections, the discussion and conclusion sections briefly discuss the findings and show some future insights to object detection research.

II. INTRODUCTION TO THE ROAD SIGN

Road signs provide essential information or message to the drivers to save our lives on the roads. These are rigid objects so that humans can easily noticeable and distinguish the road signs [16]. They provide us information about the road conditions, instructions, and warnings or guidance that are helpful for drivers to reach their destinations. These pictorial signs were developed by the European country and then have adopted by the other countries with changes in design [17]. Road signs are different according to the nations. Figure 9 shows the stop sign is further according to the countries.

Figure 1 Different stop signs according to the countries [18]

Sometimes road signs have the same meaning, but symbols of the road signs are different according to the other countries. Therefore, the Indian sign dataset is created by collecting images from various places on Indian roads. Signs painted with colors which is helpful for the detection of signs [19]. Some authors developed systems that detect and recognize the road sign based on shape, i.e., triangular or circular shape [20]. For developing autonomous vehicles, there is a need to understand the road environments, i.e.; It consists of understanding the natural and artificial objects present on the road [21]. Most road signs have red, blue, and green colors, and shapes are circular, triangular, and rectangular. Some exceptional road signs, such as Stop sign and Give way signs, do not follow the basic shape, i.e., the stop sign is present in octagonal shape, and Give way signs have inverted shapes. The shapes and color information are helpful for the detection of road signs. Table 1 shows some information about Indian road signs according to color and shape.

TABLE 4
INDIAN ROAD SIGN INFORMATION BASED ON COLOR AND SHAPE

Border color	**Shape**	**Background color**	**Icon color**	**Road sign category**	**Example**	
					Sign shape	**Meaning**
Red	Circle	White	Black	Mandatory		Right turn Prohibted
Blue	Circle	Blue	White	Mandatory		Compulsory right side turn
Red	Triangle	White	Black	Cautionary		Right-hand curve
Blue	Rectangle	White	Red/ White/ Black	Informatory		First: Eating place Second: First aid post
Green	Rectangle	Green	White/ green	Informatory		Advance direction sign
white	Octagon	Red	White(Text)	Stop		Stop sign
Red	Inverted triangle	White	Black (Text)	Give way		Give way

As shown in table 1, In India, road signs are broadly categorized into three classes: (i) Regulatory signs, (ii) Mandatory signs, (iii) and information signs. *Mandatory signs:* These signs are used for informing the users about certain laws and regulations, prohibitions, and restrictions to ensure safety and to make sure the free movement of the road. If these signs, rules, and laws are violated by any person, then that person pays offense according to the law. *Cautionary Sign:* These signs are used to make the road users conscious about the coming hazardous conditions on the way or besides on the road, so that road users take necessary actions to tackle the situation. *Informatory signs:* These signs guide the user by providing information like distance, destinations, alternative routes, historical places, etc. these signs are sky blue borders and contain the information in black color. The shape, color, text, and printed icons are some of the basic features of road signs that are briefly described below [22]:

- **Shape**: In India, road signs are present in different shapes such as circular, triangular and informative. Each type represents its meaning like circular shape for order, triangle shape for warn, and rectangle shape for information.

For example, in India, stop signs have octagon shapes, no-entry signs have circles, etc. Different shapes are prints on the physical plate, such as arrows, diagonal lines.

- **Color: Similar** to shape, different colors have been associates with road signs such as foreground color, border color, and background color.
- **Icon**: These are particular types of shapes that are printed on the road signs to depict various objects such as vehicles, animals, and people, etc.
- **Text**: Road signs also include printed text such as stop signs represented with the STOP, speed limit signs have a number, and yield signs print the word YIELD. Different text categories such as number, weight, speed, height, and name appear in road signs. For example, in the name category text of a sign saying entrance to the town and for speed category, speed-limit signs provide the enforceable vehicle limit according to the road conditions at that time.

E. Related Research

This section presents the related research that focuses on three major components to perform computer vision tasks in this field. We include a total of 59 research articles in our study. Approximately 40% of the research articles have been reviewed from the last three years (2019-21) and around 77% of research articles are from 2015-2021. In our literature survey, 15 papers explain the various traditional and deep learning object detection techniques. Then 19 articles are identified that are directly related to the road or traffic sign detection system. We also highlight the various traffic sign detection datasets that the authors have proposed in their studies.

- **Object** detection techniques: Object detection is fundamental and the longstanding computer vision problem and major active research area from a few decades [23]. Over the years, authors have been proposed various techniques for object detection that are discussed in this section. **Traditional detectors:** Traditional detectors have been used to identify the object with the use of approaches like Vj (Viola-Jones) detector, HOG (Histogram of Oriented Gradients), SIFT (Scale-Invariant Feature Transform), etc. Pixel matching technique has been applied in the traditional detector. VJ Detector is the first object detection technique used to detect the human face that performs face detection without any constraints [24] [10]. In 2008, DPM (Deformable Part-based Model) was proposed by P. Felzenszwalb, which was the apex of traditional object detection methods [25]. DPM is the extended version of the HOG Detectors and follows the divide and conquers strategy for the detection process. Due to the advancement of deep learning, object detection approaches have been developed with deep learning. Therefore, deep learning-based two types of object detection architecture such as one stage detector and two-stage detector [26]. **CNN (Convolutional Neural Network) based two-stage detectors:** R. Girshick, J. Donahue and T. Darrell, et al. have proposed the RCNN (Region-based Convolutional Neural Network) technique that has used the three steps for object detection, i.e., first regions are extracted, compute CNN features of extracted regions, and finally we classify the region based on features [27]. In this process, many overlapping regions generate that increase the system computation. To overcome this limitation of RCNN, K. He et al. have introduced a new network structure SPP-Net in 2014 [28]. In RCNN, CNN is applied to a fixed size input image which is removed in SPP Net for accuracy improvement. The newer network structure generates the image in a fixed size, which is accepted by the fully connected convolutional layer. It also has some drawbacks, so that this method is further improved by Girshick and has introduced a new architecture, Fast RCNN. Fast RCNN is used for producing the features maps from the whole input image [29]. It removes the multi-level pooling layer and uses only one single layer grid. The "Region of Interest (ROI)" pooling layer is used to a fixed-length feature vector. The speed of SPP-Net is a little bit slow because of proposal detection.
  In 2015, S. Ren, K. He, and R. Girshick et al. introduced a new method using RPN (Region Proposal Network) that is Faster RCNN [30]. **CNN-based one-stage detector:** No intermediate task is performed for taking the final output in one stage detector. Therefore, it leads the faster and simpler architecture. In 2015, the first stage detector YOLO (You Only Look Once) was introduced by the author J. Redmon, S. Divvala, and R. Girshick et al. [31] [32]. YOLO follows the different methods for detection and verification. In this technique, a single neural network has been applied for the detection of objects. The whole image is divided into regions. From each region, the probability and bounding box of the object is calculated. There are different versions of YOLO present: YOLOv2, YOLOv2 tiny network (ear detection), tiny-YOLO-voc1 (forest fire detection), YOLOv3 [33] [34]. Further, W. Liu, D. Anguelov, and D. Erhan et al. have introduced a new deep learning technique SSD (Single Shot MultiBox Detector), in 2015 [35]. The only difference between the SSD and former object detection techniques is that SSD runs only on the top layers. With time, a tiny SSD has been proposed providing reliable performance compared to tiny YOLO [36]. RetinaNet was developed by T. Y Lin, P. Goyal, R. Girshick et al. [37].
  Literature survey: Numerous researchers have done a considerable amount of work in this research area. In real-time detection, images and videos are captures with the help of the camera, and the input data is analyzed. In a traffic sign detection system, two modules: (i) identification (ii) and recognition, are the essential key components. The detection models identify or locate the road signs area from input data in the form of images or videos. A region with the highest probability is chosen to perform classification only in selected regions. Several machine algorithms such as AdaBoost, Random Forest, and SVM (Software Vector Machine) are used to recognize traffic signs [38]. Matos et al. have developed a method using "Multi-class SVM" and "Hough Transformation" to detect road signs, i.e., speed limit signs. In this method, pre-processing step is used to make the decision simpler. HSL (Hue Saturation and Lightness) values are taken in pre-processing step to increase contrast in the image dataset. The shape of the speed sign is a circle because of the "Hough

Circle" features required in the detection process. Therefore, Hough Transformation is used to find out the circle from the image. Edges are detected with HOG descriptors, and an SVM classifier is further used to classify the sign. This proposed method has achieved performance up to 95% with two datasets, GTSRB and MASTIF, that contain noisy images [39]. Image size also affects the system's accuracy as larger size images contain more information and provide high accuracy [40]. J. Miura et al. proposed a system that has been used to recognize real-time traffic signs based on color [19]. M. Madani et al. have introduced low profile hardware and an enhanced color segmentation technique for real-time detection of the objects [41]. Z. Zhu et al. have implemented a system using the "Tsinghua-Tencent 100K" benchmark that supports high-resolution images [42]. A robust CNN has been designed to detect the traffic signs that occupy only a small fraction of the image. X. Ning, W. Zhu, and S. Chen have proposed a method that deals with white background images [43]. Vennelakant, S.Shreya, and R. Rajendran et al. [44] have introduced the Traffic Sign Detection and Recognition (TSDR) method, and the recognition has been done with the help of the CNN ensemble. S. Harshavardhan, V. Madhavi, and S. Tejaswi [3] have proposed an algorithm to detect road signs. According to the authors, the threshold method is the best for detecting road signs in terms of speed and efficiency. Y. Yuan, Z. Xiong, and Q. Wang et al. have proposed an end-to-end deep learning technique [45] for the detection of a traffic sign in a complex environment. MobileNet has been used as backbone architecture for object detection in this proposed technique because it has high time efficiency. J. Zhang, Z. Xie, and J. Sun et al. have implemented a cascaded R-CNN algorithm to detect traffic signs [40]. The proposed method used the dot-product and softmax for obtaining the weighted multi-scale features. These features have been added together to highlight the features of the traffic light in images with complex backgrounds. Some researcher develop human-computer interface that detect the eye-blinks and result is interpreted to control commands [46].

- **Existing** Datasets: After deciding or developing the model architecture for identifying or detecting road signs, the next crucial step in road sign detection is the acquisition of data relevant to the research problem. Few structured annotated datasets have been created in the past studies. This section identifies and highlights those datasets and their features shown in Table 1.

TABLE 5
EXISTED DATA SETS FOR TRAFFIC SIGN AND LIGHT DETECTION

Name	signs	Type	Country	Annotations	images	Year
TLR[47]	traffic lights	Video	France, China, and U.S.A.	---	11179	2009
LISA[48]	49	Video, Image	United states	7855	6610	2012
GTSDB[49]	43	Image	Germany	50000+	50000	2013
BelgianTSD[50]	108	Video	Belgium	11K	7300	2014
TT100K[42]	221	--	china	20K	41907	2016
BSTL[51]	15	Video	United states	24K	5000	2017
DTLD[52]	344	Image	11 cities of Germany	230K		2018
Urban Object detection[53]	45	Video	Spain	600K	200K	2018
MTSD[54]	313	Image	Multiple Countries	52K(full) 48K(partial)	1,00,000	2019

Apart from the road sign dataset, there are different benchmarks broadly used for object detection, i.e., Pascal VOC, MS COCO, KITTI, ImageNet, CALTEC, etc. Pascal VOC and COCO dataset detect the 20 and 80 categories of object, respectively. Most of the techniques has been evaluated their result on these datasets[55]. In order to aid in the comprehension of this field, the table has been arranged in ascending order according to the year of publication, starting from 2009, taking into account the progress of research.

This section conducts a comprehensive literature survey on three subsections: object detection and road sign detection. The first section discusses the various research techniques and works proposed by various authors with changing technology and time. Despite these, analysis has been done on how the succeeding techniques improve the preceding technique. Object detectors are two types based on CNN, i.e., two-stage detectors and one-stage detectors. Sometimes combinations of techniques such as Faster RCNN and OHEM(Online Hard Examples Mining) are used to detect the small objects from images[56]. These models give high accuracy but slow speed. On the other hand, the one-stage detectors (YOLO, SSD) perform the object recognition task with high speed by learning class probabilities and bounding box coordinates. These models are faster models than two-stage detectors, but their accuracy rates are lower. In the second section, a literature survey regarding traffic sign detection has been done, and various authors implement various approaches on different traffic sign or traffic lights datasets. In this study, we present a one-stage technique for detecting and classifying road signs from images. In the third section, we identify the various datasets that various authors have released in the world. Nine datasets have been used in the various research articles to evaluate the proposed techniques. According to our literature survey, most of the studies GTSDB dataset widely opts to evaluate the proposed methods.

III. THE PROPOSED SYSTEM

The main objective of our research work was to propose a reliable system that detects Indian road signs from images. The working flow of our proposed system is shown in Figure 2. The figures show the flow of the complete system from data preparation to testing. The proposed system has three steps used in this study: data preparation, training process (pre-processing, trained a model on training images), and testing is performed on the test dataset. The trained model is used for the identification or detection of 10 categories of the Indian road sign.

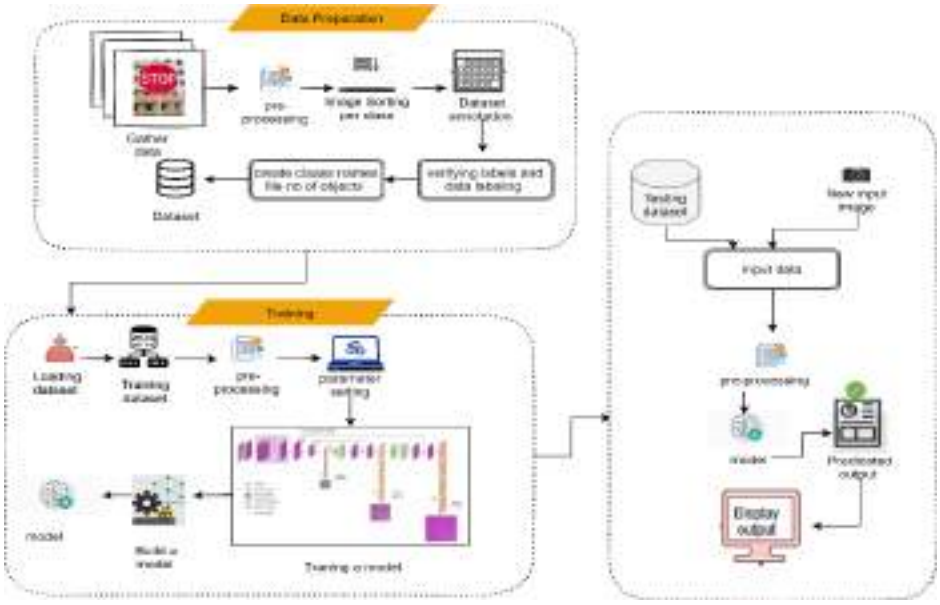

Figure. 2 Our proposed system architecture for Indian road sign detection

F. Data Preparation

Data is collected from online (image search engines) and offline resources (directly captured real-world images using the mobile camera). Our dataset consists of ten unique road signs categories such as Stop, speed 50, speed 60, speed 40, speed 70, speed 80, car prohibited, left side curve, right-hand curve, horn prohibited that contain 2728 samples to train a new road sign detection model. Further, all the interesting objects from the photos are annotated manually by drawing a bounding box around them and class names. In this work, LabelImg tools are used to label objects, which saves the annotations in text format [57], according to the sign presented in the image. This rectangle mark coordinates the location of the sign and result stored into a text file. All text (.txt) files generated by the annotation process have the same image name and are stored in the same directory. In each text file, information such as object class coordinates, height, and width of the bounding box is stored. The structure of the file having the following parameters as $< object_{class} >< x_{center} >< y_{center} >< width >< height >$. Verifying labels and data cleaning steps is used to make sure that there is no error in labeled data so that incorrect data is not used for learning. All the interested categories of object names are stored in one separate file and processed during model training. When the dataset is created, then we move to the training process. In the training process dataset is categorized into two parts: training set (80%) 2183 images and testing set (20%) 545 images.

G. Training process

After the creation of the dataset, dataset is used to train the models. The quality of image data effects the accuracy and performance of the model. To take a perfect image from the environment is not practically possible. Therefore, the images captured through an imaging sensor or camera are not directly fed into the system because various illumination and lighting conditions occur. The first step of the training process is pre-processing of the image. For the training and testing, some pre-processing techniques are required on raw images, such as blur correction, focus correction, noise reduction, and contrast enhancement. For example, the color information of the road signs is highly affected in varying illumination; hence pre-processing is required for making the color information more robust. The basic purpose of this step is to increase the detection rate. Despite this, image resizing is also performed on input images because the convolution neural network architecture accepts the fixed-size input image. Different size of images is collected from the environment for training purpose. After the pre-processing, the training images are fed into the proposed method for training.

Overview the network architecture: The object detector is basically designed for generating features from the input images and further these features are feed into predication system to draw a bounding box around the object and classes of detected object is also predicted. The proposed model is end to end network architecture that predict the bounding box and class labels in one run. The network consists of three process such as backbone, neck, and predication part.

Backbone: Most of the deep learning models have used the backbone architecture to extract the important features from input data. This module consists of 'Focus structure', 'Bottleneck layer' and BottleneckCSP. Here CSP is Cross Stage partial network

which is backbone architecture to extract the rich and important features from an input image. CSP networks help to improve the processing time in a deeper network. Because of bottleneck, this module expands as well as reduce the number of channels. In this, first 1×1 convolution is used to reduce half number of channels and secondly 3×3 convolution is used extract features with increasing double the number of channels

Neck part: it is basically used for the generation of feature pyramids which helps for the identification of the same objects in different scales or sizes. With the help of features pyramids, the models also perform on unseen data. Various types of image feature pyramids techniques existed, but Path Aggregation Network (PANet) is selected for this module. This module also adopts the Feature Pyramid Network (FPN) for extracting the low-level features by enhancing the bottom-up path.

Predication part: In the final detection part, the predication module is applied in which anchors boxes are applied on feature maps, and the final output is generated with bounding boxes. It is end-to-end model that detect the target object as well as predict location and class of the multiple target bounding box at a time.

After these three steps, some tasks are also performed on intermediate output, i.e., Activation function, optimization function, and loss function. Activation Function: Any neural network output is determined with the use of different activation functions. The proposed method used Leaky Relu and Sigmoid activation functions. In the middle/hidden layer of the model, leaky Relu is applied, and Sigmoid is applied on the final detection layer, respectively. In leaky ReLU, a non-zero slope is used instead of dropping the negative part, which is a limitation of ReLU. The negative part of the different neural networks is used to improve results. The equation of Leaky ReLU and Sigmoid is as:

$$f(x) = \begin{cases} -x_i, & if\ x_i \geq 0 \\ \frac{x_i}{a_i}, & if\ x_i < 0 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\sigma(y) = {}^{1}\Big/\big(1 + exp(-y)\big) \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Optimization Function: SGD (Stochastic Gradient Descent) is the optimization function that is used to select random samples from the whole data set. This optimization function uses a two-parameter say $x(i)$ and $y(i)$. The SGD equation is:

$$\theta_j = \theta_j - \eta.\nabla_\theta\big(\theta; x(i)y(i)\big)\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Training platform and network initialization parameters:

In this, we discuss the environment setup where actual experiments have been performed. The implementation of this system is done using PyTorch and CUDA library of Python programming environment. Additional parameters are set for the proposed architecture, such as momentum being 0.937, batch size 16, weight delay 0.0005, and GIOU being 0.05. With the use of batch size 16, the better training effect attained according to GPU performance test and image feature of the Indian Road sign dataset. Six different epochs (30, 50, 75, 100, 150, and 200) are used to train the different models with 165 layers.

Various evaluation indexes. This paper used the training and testing dataset for training and testing the model. Compound loss is calculated in this proposed method and uses the class probability score, objectness score, and bounding box score in their computation. In this, GIOU(Generalized Intersection over Union) is used to calculate the loss function [58]; the equation of GIOU is:

$$GIOU = IOU - |C/((A \cup B))|.|C| \ldots\ldots\ldots (4)$$

In this study, Mean average precision(mAP), precision, and recall metrics are used to evaluate the road sign detection. Precision and recall concepts have been mostly used for assessment of object detection methods. Precision is a percentage of retrieved predictions that are relevant or correct. Precision P is calculated by using the TP (True Positive) and FP (False Positive). The recall is a fraction of relevant instances that are successfully retrieved. It is calculated by using TP (True Positive) and FN (False Negative). The mAP (mean Average Precision) is a metric that used to measure the accuracy of the detector on all the classes and this is the actual metric to check the accuracy of detection

H. Testing process

On the training dataset, the proposed method is implemented to generate a model that is used to identify road signs from images. After that model is trained on the proposed architecture, and the trained model is saved. This trained model is tested on the testing dataset and newly captured images from the environment. The predicted sign is presented with the bounding box of the object ($\boldsymbol{b_x}, \boldsymbol{b_y}, \boldsymbol{b_h}, \boldsymbol{b_w}$) in the output image.

IV. Result and Discussions

The proposed Indian road sign dataset is divided into two parts training and testing. The previous section discusses how the model is trained on the training dataset by using the proposed method. The section presents the results achieved with the use of the proposed method on the created Indian Road Sign dataset. This section is divided into two section sections: (1) provide detailed info on how the training process is performed, and (2) Experimental results and discussion. Our experiment is carried out on a "Collaboratory," an online research platform provided by Google. The trained model is used for the evaluation results on the test dataset and some new images. Experiments are performed with different model parameters of the same datasets to validate results.

Six Different models were trained with small variations in epoch levels (30, 50, 75, 100, 150, and 200), and Table 2 shows results for all the trained models.

TABLE 6
MODEL EVALUATION RESULTS WITH DIFFERENT EPOCH LEVELS

Epoch	Accuracy (0-100 %)	Precision (0 - 1)	Recall (0 - 1)	mAP (0 - 1)
30	82	0.17	0.64	0.39
50	88	0.39	0.80	0.75
75	91	0.59	0.87	0.84
100	91	0.59	0.90	0.87
150	92	0.68	0.91	0.90
200	92	0.71	0.92	0.91

The value of precision is high means that the bounding box of the sign matches with the actual ground truth of the sign. Figure 2 shows the difference of mAP, precision, and recall curves for the 30 and 200 epochs. The value of precision is 0.8 means that 80% of detectors correctly detect the object. Recall values also lie between 0 and 1, when the most grounded truth of road signs was detected, means recall value is high. Another add-on to find real-time accuracy was using variable-sized images rather than the fixed size images used during training time. All the experiments were performed manually on all the trained models. The experimental results show the accuracy of different models directly affected by the number of epochs. In other words, increase the epoch's size; the model's accuracy is improved, but over-fitting will not always increase accuracy. The experiment is started with 30 epochs; we got 82% accuracy on that trained model. After that, epochs were increased to 50, 75, 100, and 200 according to that each model achieved the maximum of 92% accuracy. Despite the test dataset, testing is also performed on other real time. Thus, we capture some road signs images of different scenarios for testing. Figure 3 shows the test results on test dataset in which orange line shows the 30 epochs and blue shows the 200 epochs. The mAP, precision and recall of 30 epochs is greater than 0.45, 0.18, 0.64 respectively and for 200 epochs values are is greater than 0.91,0.74 and 0.64 respectively. There are different kinds of variations presented in the real-world environment while capturing the road sign image, but our trained model detects the road signs images correctly without any error. The proposed system predicts the road sign, draws them on images and predicts the label in text.

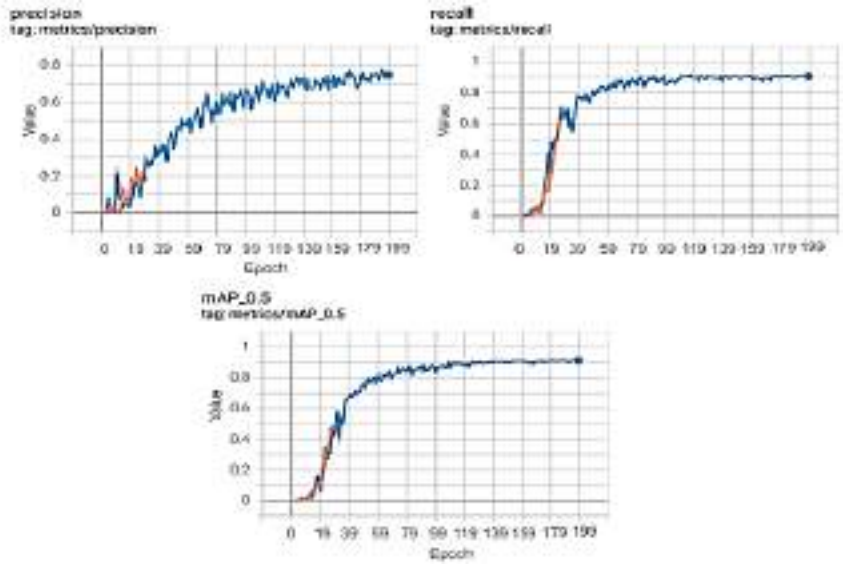

Figure 3 mAP, precision, and recall value for comparison of 30 and 200 epochs

Figure 4 Examples of some road sign detection by the proposed algorithm on the Indian road signs

The five different types of road signs images with detected regions and corresponding labels are shown in figure 4. Our trained models detect the speed limit sign 50 in the .017s, stop sign in 0.014s, give way in 0.018s, the left-hand curve in 0.20s, and right-hand curve in 0.19s. From the figure, our trained model can classify the road signs accurately from images. Several researchers work towards many directions to take better detection accuracy, such as the huge amount of data is required, and fine-tune the layers and blocks of the network for better accuracy and faster performance.

Technically, road signs are digitally processed in images, and different object detection techniques have been proposed to handle or understand the challenging tasks. Sometimes interacting with the system is not sufficient; users require some method that helps them by providing information or instructions[59]. In the current trend of technology, deep learning is amazingly working in various fields of artificial intelligence. Due to tremendous advancements of deep learning-based object detection, various types of object detection techniques have been proposed by various researchers according to their specialization areas or research problem. In this paper, we have created a road sign detection model with extremely low-cost resources and the PyTorch toolkit of python. Generalized Intersection over Union a loss function has been implemented to decrease the loss of the bounding box. An Increased Number of epochs does not mean that the detection model will provide high accuracy, so our experiments show: increased epochs from 30 to 50 have been provided 6% improvement, whereas 75 to 200 epochs provided only 1% improvement. In this sense, increased epochs are just overfitting the model because the training function is too closely fit on the limited dataset. The presented research work is not limited to the specific group, area, or country. Further, this system would also assist the specially disabled people by providing output in multi-lingual and audio format [60].

V. CONCLUSION

Locating and identifying objects from an image or video is the utmost research area of artificial intelligence. Deep learning-based architectures are one of the computer vision problems solving frameworks that predict objects with the bounding box technique. Our proposed system has been implemented on the proposed method, and six Indian road sign models are trained with different epoch levels. The basic system architecture of the object detection model for a custom dataset has been discussed here. Road sign corpus of 2728 images for ten categories has been created. A deep learning framework allows researchers to focus on the object detection techniques and assist them in developing models for low resources devices. Currently, our proposed system has achieved 92% accuracy on fresh real-time data. The road sign detection system's accuracy can be improved with the increase of the training dataset. Furthermore, the researchers can be implemented this framework for the detection of objects in video. In future work, we collect the other road sign categories images and expand our dataset.

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Distinct Modulation Techniques for Millimeter Wave Over Fiber for 5G Fronthaul Network

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***Abstract*— 5G fronthaul network demands affordable infrastructure with the sufficient bandwidth, bit rate and short jitter time to deal with the rising explosion of the network traffic. To reduce the starvation of bandwidth, cellular broadband network needs extremely high unused frequency spectrum that can help to accommodate the large volume of cellular population the fronthaul network. In this article, the different millimeter wave generation approaches have been proposed and investigated for the dissimilar frequency spectrums at the dynamic coverage area to increase the bandwidth and to control the collision at the remote head for 5G fronthaul network enhancement. The proposed techniques demonstrate the millimeter wave modulation schemes over the same fiber to overcome the problems pathloss, data loss and blockage during millimeter wave in wireless communication. The simulation results have been analyzed at the 25 km in terms of Q-factor (>9) and error rate (<1x10^{-20}) and comparison shows the accuracy of the modulation techniques.**

***Keywords*— 5G, Fronthaul, Millimeter Wave over Fiber, External Modulation, Direct Modulation.**

I. INTRODUCTION

Today's rising explosion in demand of smart devices and cellular subscribers have triggered the necessity of the 5G fronthaul network that presents the segmentation of network from optical line terminal (OLT) to optical network unit (ONU) through the distributed unit (DU) which shows the baseband unit and remote radio head respectively[1]. The CISCO has stated that the network traffic and transmission rate is increasing 291.8 exabytes in annual forecasting report. While Korean brand Samsung has predicted 10,000x more collision can be seen in future[2]. 5G fronthaul network is introduced which offers the great applications that are high bit rate with large bandwidth, small latency time, enhanced coverage, network infrastructure with reduced power consumption and collision etc. to meet the mobile user's requirements[3]. For fronthaul network, many technologies and key enables have been introduced like small cell densification in urban areas, massive multi-input and multi-output, ultra-dense networks, intelligent inter-cell interference coordinated, heterogenous network and millimeter wave. These all-key technologies help the 5G to be existed to accommodate the enormous mobile subscribers at fronthaul network that helps to decrease the load of OLT at central station[4]. The fronthaul network supports 1000x speedier network that demands the capacity of spectrum efficiency and large bandwidth to match the requirements of wireless communication network. For the ubiquitous connectivity, the telecommunication industry is working to upgrade the mobile infrastructure and installing the fiber to make connected world with the contemporary advancements. The small cell densification is increasing the coverage area and fiber deployment to make the robust fronthaul network[5]. The deployment of small cells in urban zone offers the high throughput gain to enhance the utilization of frequency spectrum efficiently[6]. Whereas for the huge amount of transmission bandwidth and rate, the high frequency band is needed.

At present, many wireless communication networks use the unused extremely high spectrum band for the 5G cellular network is called millimeter wave. The range of this band lies between 3 GHz to 300 GHz with the wavelength from 1 mm to 10 mm as shown in figure 1 and radars are the first way of communication system that accessed the millimeter wave in the history to tackle the traffic[7]. In[6], proposed spectrum band provides the high-speed transmission rate and hundreds of megahertz for the wireless communication that is used for 5G fronthaul cellular network.

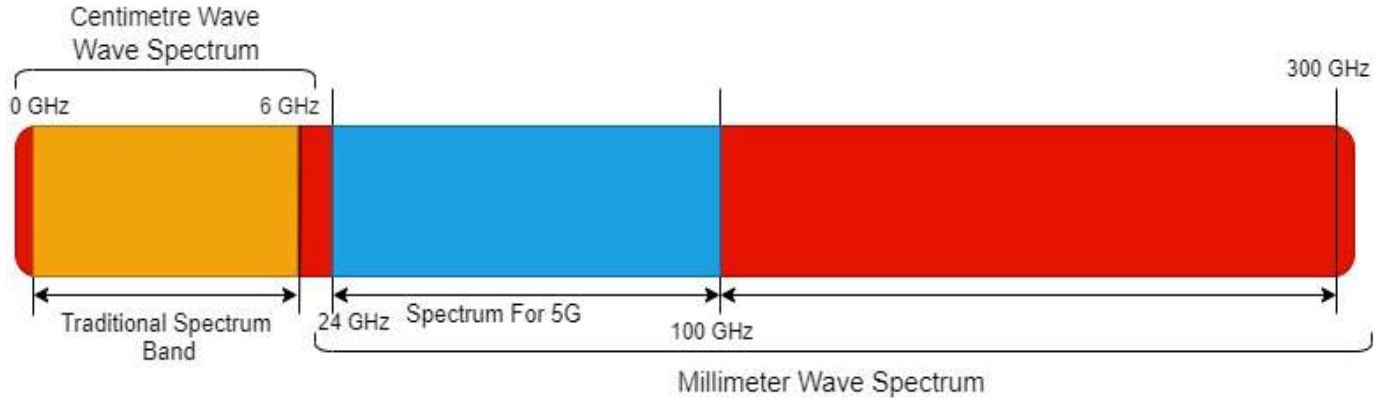

Fig. 1 Millimeter wave spectrum band

Despite these features, the wireless millimeter wave transmission was challenging that rise the problem of signal blockage due to wall or tree, pathloss and data loss due weather conditions[8]. The convergence of millimeter wave and fiber optic makes the fronthaul network one of the better solutions for high velocity network that reduce the wireless transmission constraints as above mentioned[9]. So, the millimeter wave over fiber gives the new direction to required bandwidth and bit rate with low jitter for 5G fronthaul network.

There are different existing techniques to modulate the millimeter wave over the fiber that are direct modulation, external modulation, heterodyne and etc.[10]. The proposed optical millimeter wave generation techniques aim to serve the 5G fronthaul mobile network by providing the efficient performance in terms of traffic control, data transmission speed and high response time. The proposed research presents the presents the brief introduction of millimeter wave generation techniques under the Section II with the performance of simulation setups in the Section III. The conclusion is presented in the Section IV.

II. MILLIMETER WAVE GENERATION TECHNIQUES

All techniques come with their own pros and cons. Some of them are discussed briefly as followed below.

A. Direct modulation

In the direct modulation, the laser carrier source is used directly to modulate the millimeter wave by transmitting the electrical signal into optical power and photodetector is used to detect the millimeter wave signal directly at the receiver side[11][12]. It is low-priced generation technique that does not use any external modulator that makes it attractive. The figure 2 is shown the basic process of direct modulation technique.

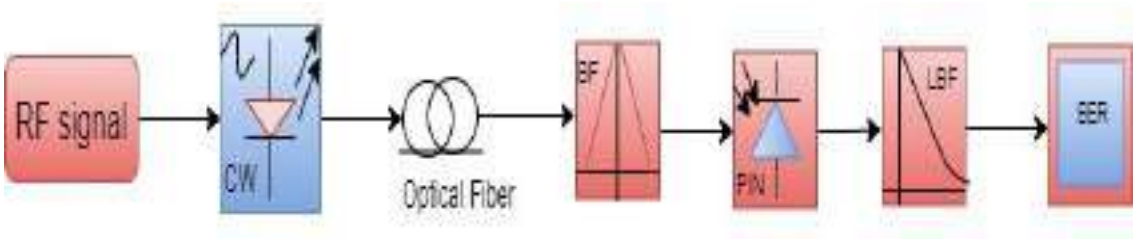

Fig. 2. Block diagram of direct modulation approach

After the signal detection, low pass Bessel filter is used to filter the unwanted noise from electronic signal and received by the user at receiver end. It is also called an intensity modulation technique. In some of the cases, it cannot be better than others like high frequency spectrum, phase modulation and chirp that influence the performance[12][13][14]. To deal with these obstacles, external generation technique is introduced.

B. External modulation

Wave generation using the external modulation techniques provides the long transmission distance of fiber link and carrier suppression that comes under the different high velocity modulator like intensity modulation and phase modulation[12]. The intensity modulation is used for the direct modulation for short coverage area and low frequency where the phase modulation is better to performs the phase changing technique to change the phase of signal for long distance It's feasible, to use the direct intensity modulated laser too as an external scheme to overcome the obstacle of coverage area[15]. It provides the interface among the laser and the modulator to modulate the signal in light form over the fiber link. In this technique, basically the continuous wave (CW) is used in external modulation and connected to the external modulator like Mach-Zehnder modulator (MZM) or phase modulator (PM) or amplitude modulator (AM) or electro-absorption modulator (EAM) or etc. to generate the millimeter wave[11]. The block diagram of this scheme is shown in figure 3. It can use the multiple external modulators together to reduce the problem of insufficient bandwidth that helps to boost the millimeter wave to travel the large fiber link[12][16]. External modulators provide the multiplication of low radio frequency to generate the high frequency spectrum band and helps to utilize the finite optical sources in efficient manner.

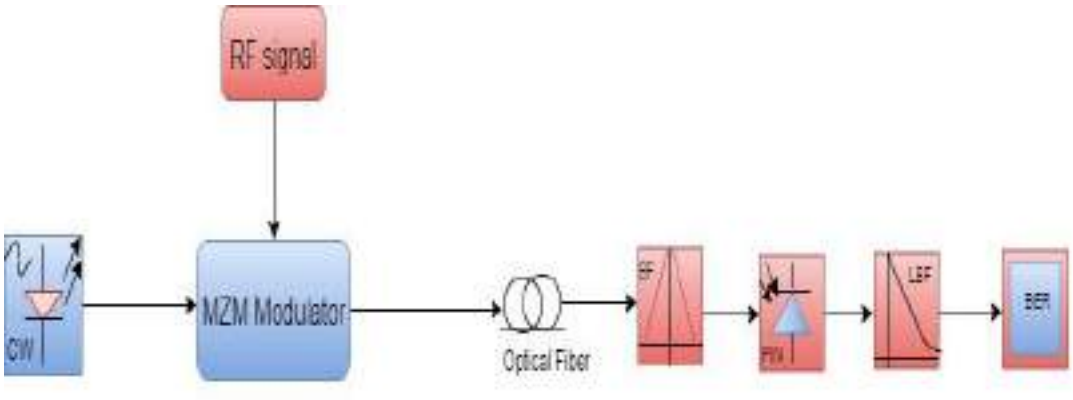

Fig. 3. Block diagram of external modulation approach

The input signal is transmitted to the external modulator to modulate into optical power by using the source laser carrier. The amplifier amplifies the signal before go through the single mode fiber and at the receiver side photodiode receives the filtered signal to convert it into electronic form. This form is received by the user at user end via antenna. It also suffers with an insertion loss, influence of fiber dispersion and necessity of the filters under the optical domain.

C. Heterodyne modulation

It is used to generate the high frequencies and for spectral purity that uses the two tunable lasers at the different frequency. Two optical signals with the separate source are transmitted and received by the user after detection at photodetector[17]. It is blessed schematic millimeter wave generation technique that is simple in configuration for the chromatic dispersion and shown in figure 4.

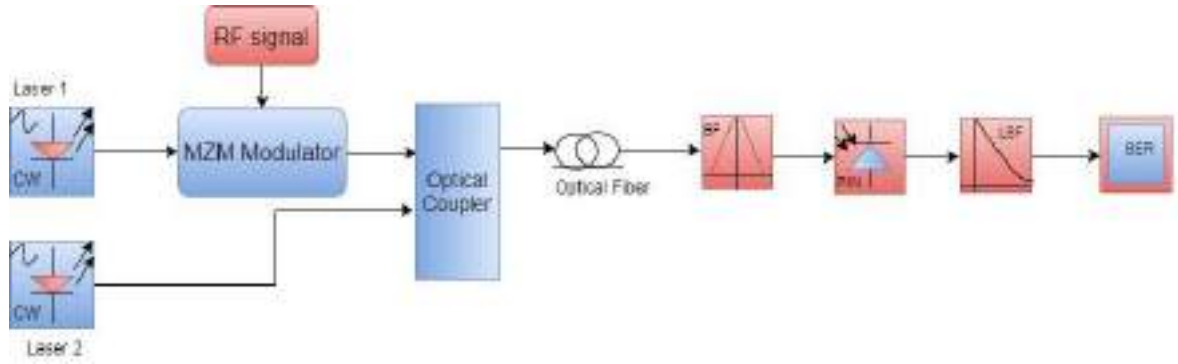

Fig. 4. Block diagram of heterodyne modulation approach

The two different laser source carrier are transmitted the signal separately to modulate the intensity of optical and amplified by the amplifier. The photodetector sends the electronic signal to the user via remote head after getting filtered signal. It is flexible and less expensive modulation technique. The foremost drawback is the phase noise of lasers that are not connected directly in this technique[11].

All millimeter wave generation techniques have the different ways to modulate the high frequencies. For the better understanding, the simulation is done for above mentioned techniques and presented in next section.

III. PERFORMANCE OF SIMULATION SYSTEM

The block diagram of simulation transceiver is shown in figure 5. As per the specifications of separate modulation techniques, in the OLT at the transmitter, it contains the direct modulated laser and CW laser at the 193.1 THz, data signal at the 10Gbps using pseudo random pulse generator is modulated over the fiber at the distinct frequency spectrum millimeter wave. On other hand in the ONU at receiver side, transmitted optical signal is filtered by the Basel pass filter at the cutoff frequency 0.75 Hz to separate the noise and send it to the PIN detector to convert the signal into electrical form that serve the user directly through antenna. The EDFA amplifier amplifies the signal that travels the transmission distance of 25 km from the OLT to ONU.

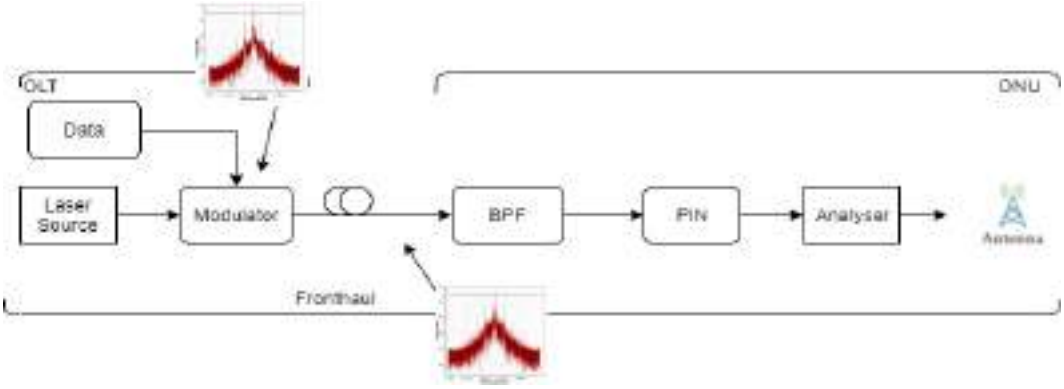

Fig. 5. Block diagram for simulation setup

The simulation is performed for the proposed research that aims to investigate the different modulation techniques to generate the millimeter wave at the distinct coverage distance at the different frequencies to compare the results. By using the Optisystem software, the simulation is done to study the different millimeter wave generation techniques for the separate frequencies at the distinct coverage area as per the fronthaul convenience. The table 1 shows the parametric requirements for the modulations.

TABLE 1
PARAMETERS FOR MODULATION TECHNIQUES

Parameters	Description
Transmitter	
Bit rate	10 Gbps
Frequency	60 GHz, 80 GHz, 100 GHz, 120 GHz
DML	193.1 THz
CW	193.1 THz
Power	10 dBm
Single-mode optical fiber	25 km
Attenuation	0.2 dB/km
Fiber Dispersion	16.75 ps/nm/km
Dispersion slop	0.075 ps/nm^2/km
EDFA	5 m
Gain	5 dB
Noise figure	6 dB
Optical coupler	Pump coupler
Receiver	
OBF	Filter
Photodetector PD	PIN PD
LPBF	Cut off frequency 0.75 Hz
LPBF Insertion Loss	0 dB

The Q-factor, bit error rate and eye diagram are measured to investigate the performance of the proposed modulation approaches that is presented the successful outcome. The table 2 displays the variations in the error rate and Q-factor at the different spectrum that shows the better results of external and heterodyne modulation scheme than the direct generation technique at the same wavelength.

TABLE 1
COMPARISON OF MODULATION TECHNIQUES FOR MILLIMETER WAVE

Wavelengths (nm)	Q-factor
Modulation techniques at 60 GHz mmWave	
Direct modulation = 1552.52	10.09
External modulation = 1552.52	10.12
Heterodyne modulation= 1552.52	10.9
Modulation techniques at 80 GHz mmWave	
Direct modulation = 1552.52	10.05
External modulation = 1552.52	10.09
Heterodyne modulation= 1552.52	10.7
Modulation techniques at 100 GHz mmWave	
Direct modulation = 1552.52	10
External modulation = 1552.52	10.06
Heterodyne modulation= 1552.52	10.7
Modulation techniques at 120 GHz mmWave	
Direct modulation = 1552.52	10.02
External modulation = 1552.52	10.07
Heterodyne modulation= 1552.52	10.3

To clarify the variations corresponding the distinct coverage area, the figure 6 is shown the proposed millimeter wave generation techniques. The Q-Factor presents the signal variations at the spectrum band 120 GHz for all simulation setups as per the distinct modulation techniques. As the distance is increasing, the Q-Factor is impacted and gone through ups and downs. The variations in external modulation and heterodyne modulation are better and smoothly during rising distance.

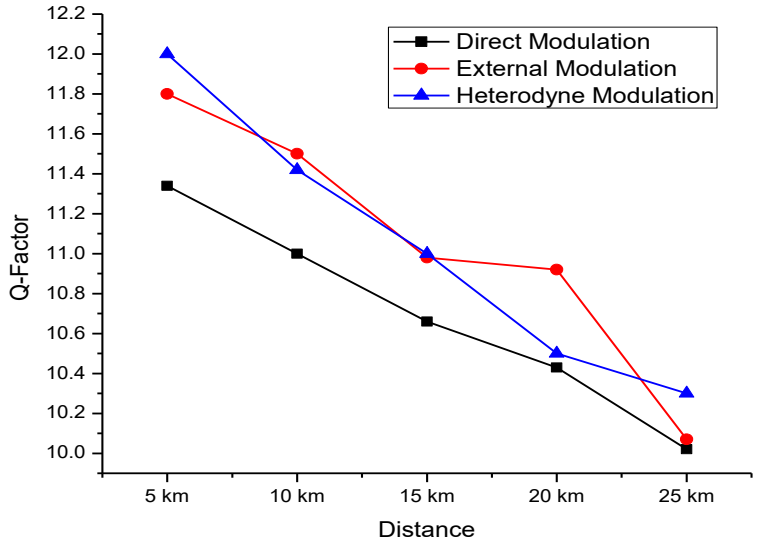

Fig. 6. Q-Factor variation during distinct coverage area

The variations in the performance can be seen in this as the spectrum band is increasing and presenting the associated Q-factor. At the same wavelength, the widely opened eye is shown the accuracy of the transmitted signal. Enrichment of schematic approaches of modulation has been observed from the eye diagram as well as Q-Factor using same wavelength as above mentioned. To analyse the all techniques, opened eye corresponding the investigated techniques are shown in figure 7 (a), (b) and (c).

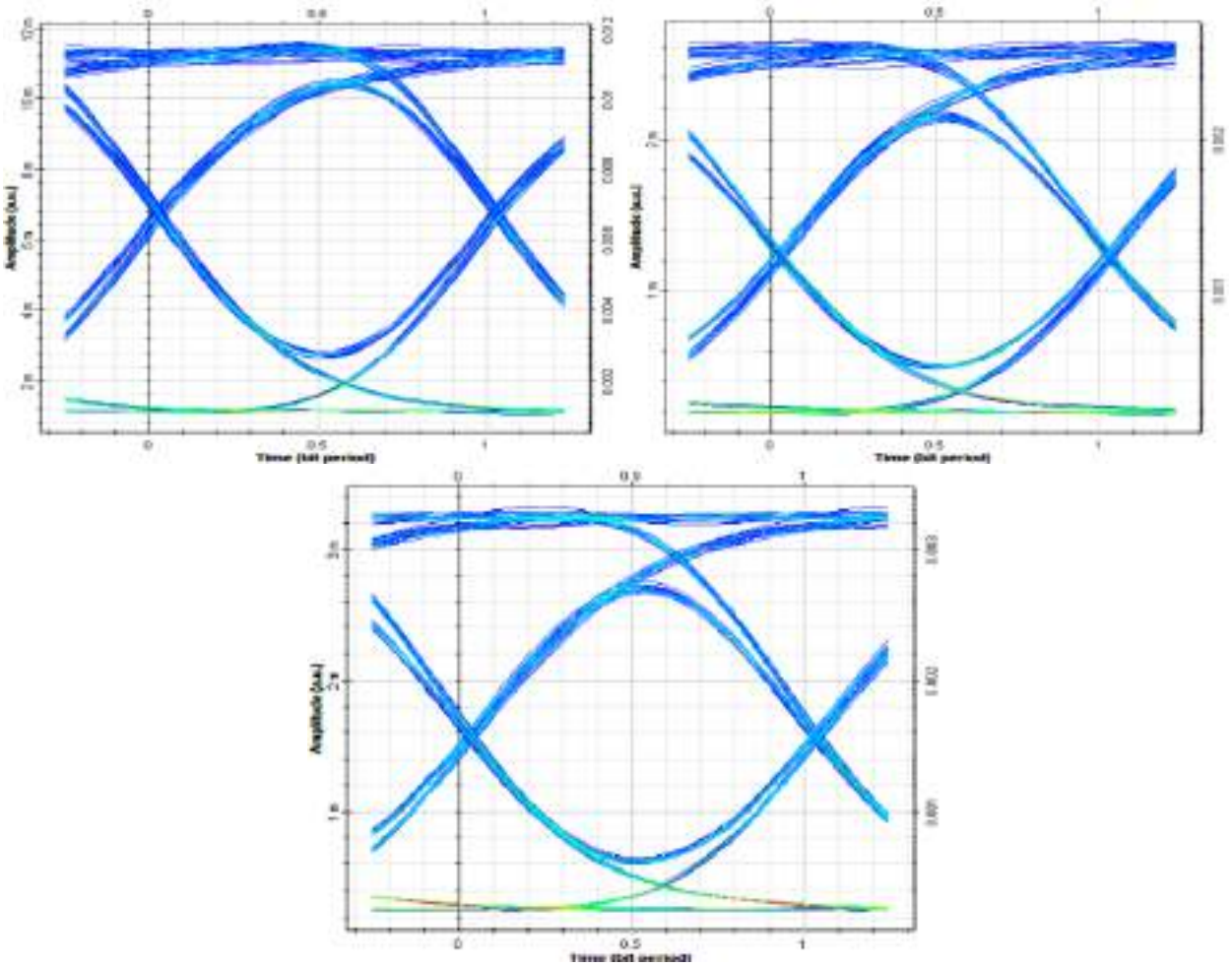

Fig. 7. Eye diagram (a) direct modulation (b) external modulation (c) heterodyne modulation

IV. CONCLUSION

The 5G fronthaul network is needed the highly efficient spectrum band that is millimeter wave provides the unused range 3 GHz to 300 GHz to reduce the collision by utilizing the enough bandwidth. In this proposed research, the millimeter wave modulation methods have analyzed that presents the positive results with the help of Q-factor that is >9 as well as eye diagram. The comparison table and graph figures show the efficiency of enhanced external and heterodyne generation technique whereas direct modulation is not applicable for high spectrum and long distance.

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Survivability Schemes in Generalized Multiprotocol Label Switching Networks

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***Abstract*—GMPLS (Generalized Multiprotocol Label Switching) is the emerging field in optical networks. Survivability domain has major impact in high-end networks to protect or restore the node or path failure. The failure of link, path or segment makes the situation worst to handle high traffic data in GMPLS networks. In a GMPLS network, blocking of path may cause loss of large data even it happens for short time. In this paper, survivability schemes in GMPLS networks is discussed. It is concluded that the path must be recovered in case of failures or the data should be shifted through the alternate path by using restoration or protection techniques. The network should be intelligent enough so that there is provision of alternate paths or implementation of some restoration method so that the failure paths restored quickly for smooth data transfer.**

***Keywords*— GMPLS, Protection, Restoration, Survivability**

I. INTRODUCTION

High transmission network elements get faulty sometime. Transmission lines get problem, and nodes, amplifiers, network devices, add – drop multiplexer, and controllers work out of service surprisingly. Since the vast amounts of data taken over GMPLS networks, down network, even for a glitch can results in a lot of loss to users of services. Generally, Clients cannot bear such a loss even for short time. In such situations, it is a very severe condition to recover from such disruption. The solution to face such situations is either to divert the path to any other optional path or to recover the original path for information transfer in short time slot. The network should be smart enough to handle this situation and detect the failure timely.

II. LITERATURE

In designing optical communication networks, various parameters and network characteristics are necessary taken into consideration, including signal transmission length, traffic protection provision, interconnections between optical network components, a control, a technology [1,2]. The conventional Passive Optical Network (PON) is a bidirectional point-to-multipoint system that contains passive optical elements in a distribution part and active optical components at the end points of the access network. With increasing demand of data rates, it has become necessary to upgrade current optical networks through multichannel approaches. As for the optical metropolitan and access network, a greater capacity can be obtained by using wavelength division multiplexing techniques. The idea to use various transmission channels in metropolitan and access networks is well known [3]. The realizable design of the Wavelength Division Multiplexing—Passive Optical Networks (WDM-PON) from a viewpoint of interconnecting schemes. In certain basic variants of WDM-PON architectures [4,5,6]. a provision of traffic protection must be realized as early as possible [7]. APS is the best solution, while SHR offers the most benefits in a ring topology [8]. [9] discuss link, node, and channel failures in WDM. Hiroaki Harai, et. al. [10], discussed the performance optimization of all optical networks. Chuan-Ching Sue [11], presented a wavelength routing scheme for all optical networks to reduce the blocking probability. S. Subramaniam et. al. [12], used wavelength converters on a path to minimize the call blocking probability. Gagan L. Choudhury, et. al. [13], proposed an algorithm based on normalization constant function generation. Saini et al. [14] proposed the optical networks blocking probability. Wason et al. [15–17] discussed the blocking probability in WDM networks. Kumar et al. [18] discussed the algorithm to optimize the QOS of PON networks.

III. SURVIVABILITY

Survivability can be:

- The network element availability is the possibility that it can deliver some specified Quality of Service (QoS) at certain time [19].
- If at some point, the network stops to work up to some Quality of service seems that network fails.
- If the network starts working after failure is the moment that the said element recovered to deliver QOS
- The time period taken to repair the network is called as outage.

The Non-availability of network is defined as the ratio of mean time to repair to the failure. Therefore Network Availability can be defined as below:

$$NA = 1 - \frac{elemments\ Mean\ Time\ to\ repair}{elemments\ Mean\ Time\ between\ failures}$$

Where, NA is the network availability. NA is close to 1 because elements mean time to repair << elements mean time between failures

A. Cycle for Recovery of services

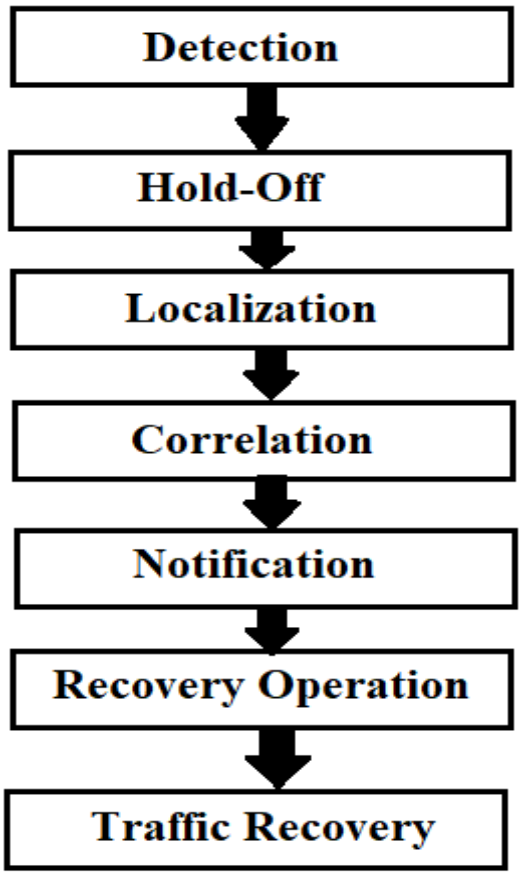

Fig.1 Recovery Cycle

There are seven stages comprises recover cycle as shown in figure 1. The first five stages combined to form fault management. The stage Fault detection cannot be carried out without the data plane. Fault detection process take some time [20]. The state Fault hold-off is required to analyze that the lower layer may have some restoration scheme, so that different layers do not start their own processes in parallel. The stage fault localization identifies the scope of fault recovery. There can be multiple failures due to single link down, fault correlation stage correlate to resolve this issue. The fault notification process notified the arrivals at the deciding entity from a fault-reporting node. As soon as the fault notification message received the node starts the recovery operation. Traffic recovery stage started after recovery operation [21].

The total time of recovery cycle can be found by summing the time slots during detection (T_d), hold-off (T_h), localization (T_l), correlation (T_c), notification (T_n), recovering operation (T_r) and traffic recovery (T_t) as shown in below equation (1):

$$T = Td + Th + Tl + Tc + Tn + Tr + Tt \quad (1)$$

B. Span Recovery

Span protection is the service shown in Figure 2. Here the path ABDEF is the path having two pair links and provide protection in case of one failure. Some are given below:

1) Dedicated unidirectional 1+1
2) Dedicated bidirectional 1+1
3) Dedicated 1:1 with extra traffic
4) Shared M:N
5) Enhanced

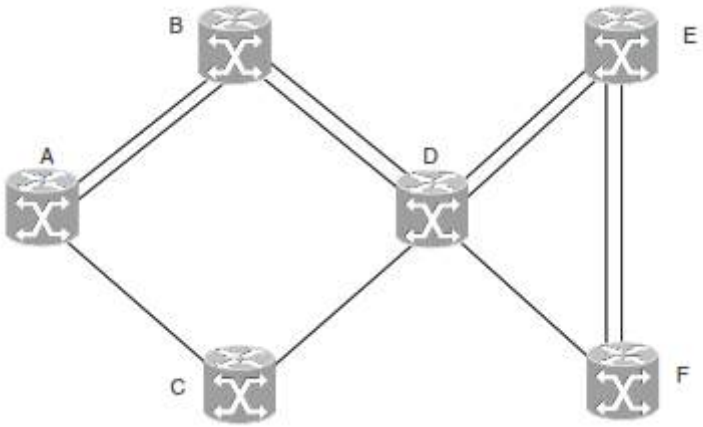

Fig. 2 Span Recovery

C. Path Recovery

Figure 3 shows a path recovery which provides recovery from some fault that may occur on the LSP (Label Switch Path) ABCDE. The recovery LSP is through the nodes AGFE.

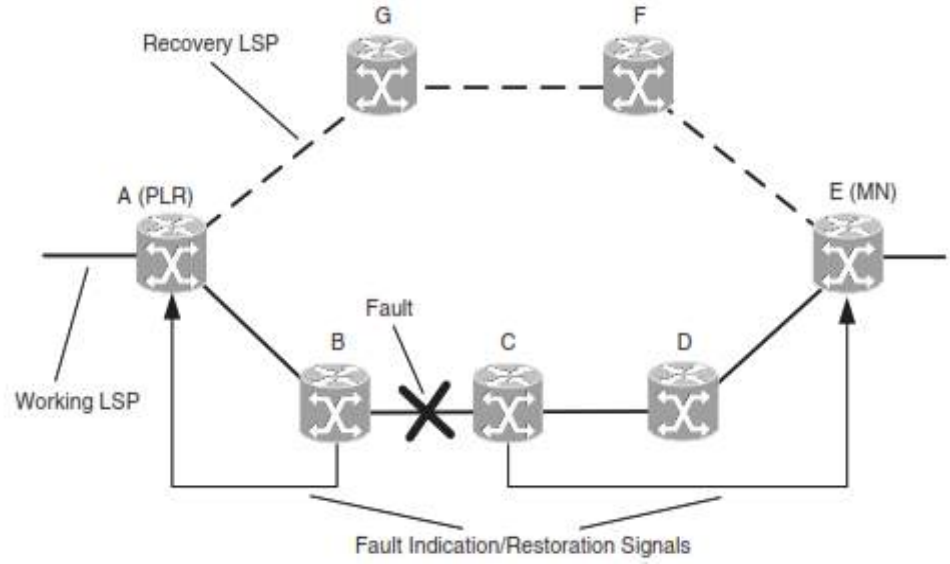

Fig. 3 Path Recovery

Figure 4 shows the End–to–End 1+1 Protection scheme in which the protection path ABCDE is shown for the LSP AGFE. On fault occurrence, the alternate path is followed.

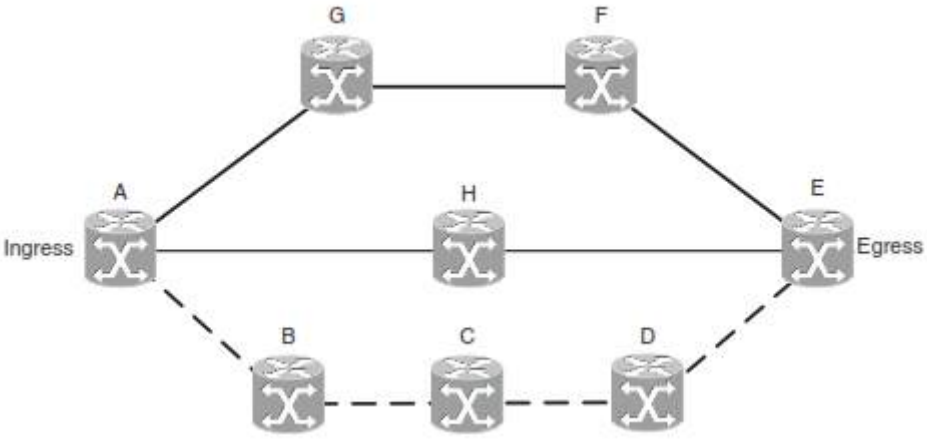

Fig. 4 End–to–End 1+1 Protection

Figure 5 shows the End–to–End 1:N Protection scheme. The figure shows that traffic is carried over paths ABCDE and AGFE. The LSP AHE protects both of them.

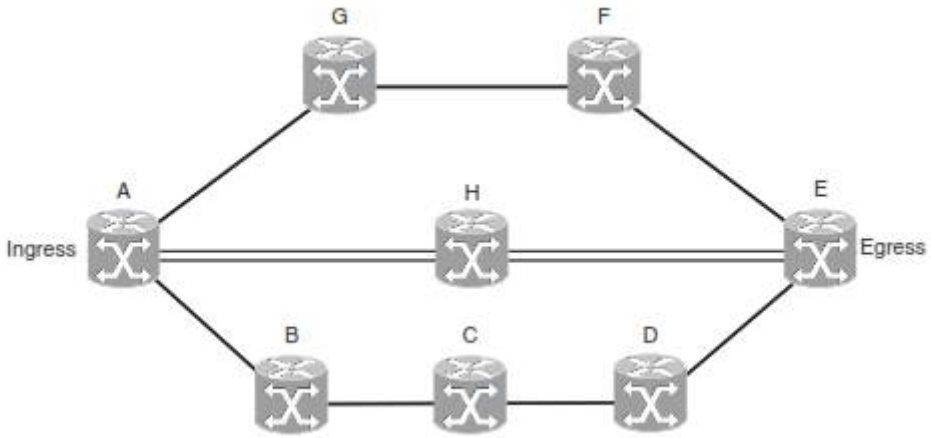

Fig. 5 End–to–End 1:N Protection

IV. CONCLUSION

The secure and sure information transfer is the prime constraint for data network companies. The transport network failure may cause a lot of loss to service users. GMPLS enables such intelligence to handle the path failures like cable cut, node failure or these types of interruption which can cause large data loss. The network should be enough intelligent that can divert the data to alternate routes and recover the paths simultaneously. This can be achieved by several restoration and protection schemes like dedicated or shared 1:1, 1:N, M:N.

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A Brief Review on Sentiment Analysis

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***Abstract*—Sentiment analysis is a subfield of machine learning that deals with the statistical handling of subjectivity, sentiment, and opinion in text. This article outlines the necessity for sentiment analysis, as well as numerous sentiment analysis methodologies and sentiment analysis tools. The purpose of this study is to offer a brief review of sentiment analysis so that researchers may get useful information from it. The data is examined to discover which social media network has the most active users, allowing potential researchers to focus their efforts on that platform.**

***Keywords*— Opinion Mining, Feature Selection, Tools for Sentiment Analysis, Approaches for Sentiment Analysis, Sentiment Analysis**

I. INTRODUCTION

Sentiment Analysis (SA) or Opinion Mining (OA) uses data extraction and computer linguistics to analyze people's opinions, perceptions, habits, emotions, and sentiments in a number of sectors, including marketing, commerce, and industry. Sentiment analysis and opinion mining are disciplines of study that use written language to analyze people's ideas, sentiments, judgments, behaviors, and emotions (Mäntylä et al., 2018). Opinions matter and have a major influence on human behavior (Woldemariam, 2016). Social media platforms such as Facebook and Twitter have become popular for doing analysis on shared views. Emotion Analysis identifies a person's sentiment or sentiments in a domain (Gupta et al., 2019). Sentiment Analysis is used to assess a person's level of pleasure or dissatisfaction (Javier et al, 2018), whereas Opinion Mining extracts and analyses people's opinions about an entity (Medhat et al., 2014). As a result, the ultimate aim of SA is to collect views about the product, identify the various attitudes that individuals express, and then categorize their polarity. With the growing number of texts generated by Web users, it would be tremendous to investigate the method of automatically extracting and extracting perspectives from those texts that are useful to individuals, information from business and government, and decision-making (Woldemariam, 2016).

Sentiment Analysis divided into three major parts, namely:

A. Sentence level:

Every text has been analyzed and assessed in sentence level sentiment analysis to measure polarity. It is closely connected to the subjectivity classification, which distinguishes words termed impartial phrases representing true facts from phrases called subjective phrases expressing subjective thoughts and ideas (Du and colleagues, 2019).

B. Document level:

In the document level sentiment analysis, the complete document has been assessed and the polarity of the entire document has been determined. At the document level, just one view about a particular individual is given. It does not include different organizations for product review (Shirsat, 2017).

C. Aspect level:

Most of the time, a brief remark we make might include words about various sentiments, people, or advice. ABSA, in contrast to the study of document and sentence level sentiment, focuses on more subdivided sentiment expressions connected to a specific individual mentioned in a sentence or appearing in a sentence.(Yang, 2020).

As the quantity of social media postings and tweets continues to rise, it has become increasingly difficult to accomplish the process of assessing all evaluations and opinions about a product within appropriate time frames. Different organizations require various sorts of data to be analyzed. To address these difficulties, this article provides several techniques for analyzing various sentiments of text available on social media.

II. RESEARCH MOTIVATION

Due to the ever-changing dynamics of the Web in terms of the volume, velocity, and variety of opinion-rich information available online, research in the domain of Sentiment Analysis(SA) has become a trend for many practical applications that help domain analysts make better decisions and deliver targeted information(Kumar, 2019).

- delivering a summary of the chosen papers and highlighting their essential aspects.

- giving significant and valuable information regarding sentiment analysis.
- delivering idea about different techniques of sentiment analysis and highlighting some of the tools used in this field.
- outlining the major future problems in this field and making some useful research recommendations.

III. SYSTEM MODEL

In this section we learn about the architecture of sentiment analysis, which describes how sentiment analysis operates with various techniques and methods using different algorithm. The approach followed by the study of sentiment architecture ,techniques used either Machine Learning approach or lexicon based approaches , deep learning and then multiple methods of feature selection are explained which explained how features can extract .

A. Architecture:

The main approaches for sentiment analysis are: machine learning, which uses well-known ML algorithms to solve the SA as a regular text classification problem that makes use of syntactic and/or linguistic features (Mäntylä et al., 2018); and text mining, which uses text mining techniques to solve the SA as a regular text classification problem. figure1. Classification is performed via supervised machine learning, and the characteristics in the underlying record are linked to one of the class labels.

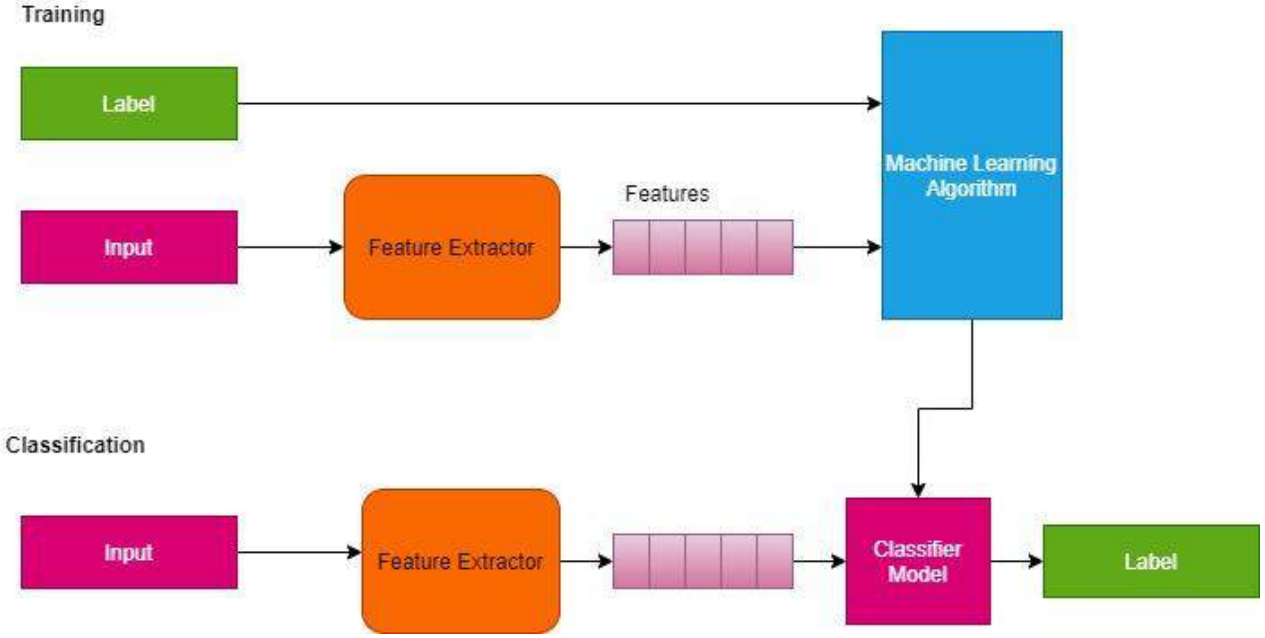


Fig. 5 Training and classification process of sentimental analysis

The machine learning technique views the procedure as text classification and uses several methods such as help vector machine SVM, maximum entropy, k-nearest neighbor, and Naive Bayes. One of the primary activities of Sentiment analysis (SA) is subjective and objective characterization (Mehta & Pandya, 2020). On the basis of the subjectivity of the word, we may split lexicons into positive, negative, and neutral lexicons. The classifier identifies the defining characteristics of texts using a training set, and a test set is used to validate the automated classifier's output (Surnar & Sonawane, 2017).

B. Feature selection:

SA is a sentiment classification task that employs text-based data (Mäntylä et al., 2018)&(Ighazran et al., 2019). In sentiment classification, we first extract the problem and the choose text characteristics that are closely linked to the problem. We utilise the Bag-of-words (BOW) paradigm to describe text documents used in sentiment categorization using machine learning.The words in the text (such as a phrase or a document) are represented as a bag (multiset) of its words. The redundant and associated characteristics further raise the classification's time and memory requirements, making it computationally inefficient (Bruzzone, 2017).

1)chi-square method: In this technique, we compute the chi-square metric between the target, i.e. the number of documents in the collection, and the numerical variable containing the conditional probability of class for documents, and we only choose the variable with the highest chi-squared values. Contextual advertising use the Chi square technique.

2)point-wise mutual information(PMI): The amount of co-occurrence between class I and word w determines the point-wise mutual information (PMI) between the word and the class. Mutual information is a phrase from the field of information theory.

The point-wise mutual information is a quantifiable metric that allows us to determine whether a feature is informative or not and then choose features based on that.

3)Latent semantic Indexing(LSI): Latent Semantic Indexing (LSI) is a powerful technique for extracting characteristics that reflect the underlying latent semantic structure in word use across documents (Shima et al., 2004). It is used to examine the word's semantic similarity. LSI is utilised in the search process to investigate latent semantics by extracting definitions from the source word in space.

IV. TECHNIQUES AND THEIR APPROACHES

There are several techniques available for sentiment analysis, but two main categories are employed. First, the difficulties of SA will be solved using the machine learning approach. The second group employs a lexicon-based approach that is linguistically motivated.

A. Machine Learning Approach:

After numerous pre-processing processes, it converts textual input to numeric data and utilizes classification methods to categorize the data. This is an automatic categorization approach (Da et al., 2016). Text characteristics are used to do categorization. The Machine Learning method is used to train an algorithm using a predetermined dataset before applying it to actual datasets (Kathuria & Upadhyay, 2017).

1)Supervised Learning : Supervised ML approaches anticipate events by utilising what it has learned from previous and current data with the help of marks (Saravanan & Sujatha,2018). This technique begins with the dataset training phase, during which ML creates inferred features to predict output values. The system is taught using labelled programming samples. Each class represents and is represented by a mark that is linked with certain qualities. When a word comes, its characteristics are matched and categorised with the best class possible.

2) Unsupervised learning: Visual identification and grouping tasks are resolved using labelled data. Unsupervised learning approaches, on the other hand, are useful for situations where manually generating labels for huge datasets is time-consuming and costly. Unsupervised techniques have been applied to solve problems in a variety of fields, including object classification, speech recognition, and audio processing (Hussein et al., 2019). It is based on the search and identification of the underlying pattern and structures in data to categorise things autonomously (Roohi et al., 2020).

B. Lexicon based Approach:

In the 1990s, M. Lewis proposed the lexical approach as a way of teaching foreign languages. Researchers have recently started experimenting with lexicon-based methods to sentiment analysis. Without a question, the most essential indication of sentiments is the use of sentiment words. These are phrases that are frequently used to express either good or negative feelings (Taj et al., 2019).

1)Dictionary Based: In these approaches, a lexical dictionary is utilised to identify positive and negative opinion words. A dictionary is a set of concepts, and matching dictionary items exactly against text is simple and precise (Gong, 2015).

2)Corpus Based: Corpus is simply a phrase that refers to a type of writing that is akin to a cluster of writing on a single subject. (Mehta & Pandya, 2020).

- Statistical approach This technique is used to find recurring words in a corpus. According to the hypothesis, if a word appears mostly in positive literature, it has a positive polarity. It has a negative polarity if it appears mostly in negative literature.
- Semantic approach**:** The notion of word similarity is used to compute sentiment values in this approach. Wordnet might be beneficial in this case. This may be used to identify synonyms and antonyms for a given term as well as to quantify sentiment meaning.

Table 1 shows the different sentiment Analysis method over the years and all different method have variant results by which we can analyze efficiency.

C. Deep Learning:

The use of multiple-layer artificial neural networks (ANNs; neural networks for short) to address learning issues is known as deep learning. It can make far more use of the learning (representation) power of neural networks, which was previously considered to be confined to one or two layers and a small amount of data(Zhang et al., 2018). Deep Learning is a collection of approaches that have shown amazing results in a number of disciplines, including natural language processing (NLP), computer vision, pattern identification, and speech recognition(Alshammari & Almansour, 2019)&(Onan, 2021). We predict deep learning to achieve the same level of accuracy and performance in the field of sentiment analysis, which is a key component of language comprehension, as it did on tasks like language comprehension and image analysis.

1)Recurrent Neural Network : RNN is a type of neural network that employs hidden layers to allow information to flow from one layer to the next. RNN is a kind of neural network that handles consecutive input. RNNs may be developed to far longer successions than unprotected networks(Saha & Senapati, 2020).

2)Convolutional Neural Network: CNNs are deep neural network-based architectures that evaluate input using a grid-based structure[2020 deep learning 2]. CNN is differentiated by a particular mathematical technique called as convolution. To control

the convolution operation, one or more convolutional layers were employed. Convolutional neural network architecture includes input, output, and hidden layers.

3)Long Short -Term Memory Network: LSTM is one of the most commonly used RNN variants, capable of dealing with the vanishing gradient problem that affects ordinary RNNs and detecting long-term associations. As a consequence of this (Yadav & Vishwakarma, 2020), they become more powerful and flexible. LSTMs are a type of network with a memory that remembers previous input data and makes choices based on it. As a result, LSTMs are better suited to text inputs since each word in a sentence has meaning based on the words around it(Gao et al., 2019).

• Traditional methods such as lexicon-based approaches employ handcrafted features, which is time-consuming and complex. In addition, they are not generalized to other areas or sectors well. Even with conventional machine teaching methods, functional engineering and function extraction are the most time demanding procedures. Deep learning reduces the effort of constructing functions by generating the necessary functions for the classification process automatically as the network learns.

• One of the major reasons for Deep Learning's usefulness is that it eliminates the need for human feature engineering on unstructured data, which is extremely difficult and is relied on by virtually all conventional machine learning methods.

• A massive amount of data is currently being generated. According to Twitter, around 6000 tweets are sent per second, for a total of over 200 billion tweets sent every year. As a result, traditional machine learning-based approaches fail with such a vast volume of data.

TABLE I
COMPARISION OF METHODOLOGY

Study	**Title**	**Dataset**	**Sentiment analysis method**	**Results**
(Nakov et al., 2016)	SemEval-2016 Task 4: Sentiment Analysis in Twitter	Twitter Dataset	SVM	84.5%
(Li & Qiu, 2017)	A Sentiment Analysis Method of Short Texts in Microblog	COAE2014(BBC Dataset)	Language Technology Platform (LTP) for dependency syntax analysis	86.5%
(Zirpe, 2017)	Polarity Shift Detection Approaches in Sentiment Analysis: A survey	Product Review	Lexicon-based and Supervised Machine Learning-based	84.6%
(Shirsat, 2017)	Document Level Sentiment Analysis from News	BBC News Dataset	Machine Learning Approaches	57.7%
(Vanaja & Belwal, 2018)	Aspect-Level Sentiment Analysis on E-Commerce Data	Amazon Customer Review Data	Naïve Bayes , SVM	90.423% 83.43%
(Park & Seo, 2018)	Sentiment Analysis of Twitter Corpus Related to Artificial Intelligence Assistants	Reviews of Electronic product	Valence Aware Dictionary and Sentiment Reasoner (VADER)	87.4%
(Dhar, 2018)	Sentiment Analysis using Neural Networks: A New Approach	Product Data Review Twitter Data	Convolutional Neural Network	74.15%
(Chandra & Jana, 2020)	Sentiment Analysis using Machine learning and Deep Learning	Twitter data	Machine learning and deep learning	81 % to 90%
(Mandloi, 2020)	Twitter Sentiments Analysis Using Machine Learning Methods	Twitter Dataset	Naïve Bayes classifier, SVM, Maximum Entropy method	86% 74.6% 82.6%

From TABLE 1 we can say that naïve bayes algorithm gives us the better results than SVM for large chunks of data. (Vanaja & Belwal, 2018) uses the naïve bayes uses Amazon customer review data to detect aspect phrases from each review, the parts of the speech, the use of classification algorithms to determine the positive, negative and neutral score for each assessment. and find out the accuracy of 90.423%,whereas accuracy for SVM is 83.43%.For small chunks of data generalize the best result. (Dhar, 2018) uses Convolutional Neural Network with two models one is with MSP and other is without MSP . The accuracy obtained once the neural network was trained without the use of MSP model is 64.69 % on an average. Once the MSP model is applied and the system is trained, the accuracy obtained is 74.66%.the overall average accuracy given by the system is 74.15%.

V. TOOLS USED FOR SENTIMENT ANALYSIS OF TEXT ON SOCIAL MEDIA

Social media nowadays provides a place for individuals to express their feelings, emotions, objects around them, sharing geographical locations, etc. The major aim is to extract data since social media data is used in diverse formats such as unstructured data, emoji data, hidden feelings, words with numerous significances and odd abbreviations(Joshi & Simon, 2018). (We have many kinds of technologies for extracting social media data to address these difficulties. The technologies used for extracting data as data are quite voluminous and varied. The review evaluates whether it's favourable, negative or neutral instead of passing through every tweet, one by one comments, processing feedback.

TABLE II
TOOLS USED FOR SENTIMENT ANALYSIS

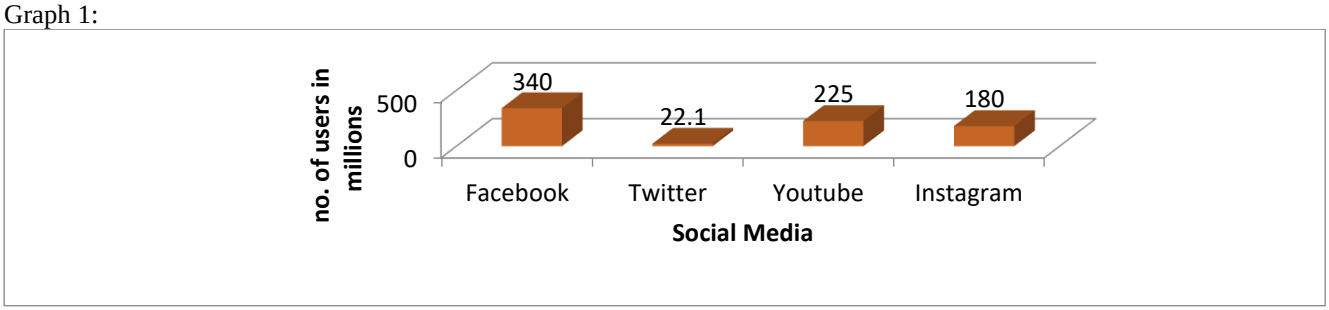
Tools	Country	Year	Cost	Deployment	Features
HUBSpot service hub	America	2006	Free	Window	Email scheduling, Email Templates, Meeting scheduling.
Awario	Belarus	2015	$29/per month	Web-Based, cloud, SaaS	Reputation management, Influencer Tracking.
Brandwatch	Brighton, UK	2007	$1,000/per month for 1000 mentions	SaaS	Search Operators, Unlimited Users, Twitter Insights , ,Email Alerts .
Mention	Paris, France	2012	Free up to 500 mentions	Mobile based, Web-Based	Export mentions or data ,Drag and drop interface.
Rapid Miner	Dortmund, Germany	2013	Free	Mac, Windows, Web-Based ,cloud ,SaaS	Unified platform, visual workflow, broad connectivity.
Clarabridge	Reston, Virginia	2006	Free	SaaS	Connect to social media networks, Analyze customer sentiment.
Monkey Learn	San Francisco	2014	$299.00	Cloud based	Graphical Data , Text Analysis, Summarization, Topic Clustering
Critical mention	United states	2002	Free	Cloud –based	tracking of TV, radio, online news, print sources and social media.
Aylien	Dublin	2012	$49/per month	Web-Based	Image tagging, automatic hash tag suggestion etc.

From TABLE 2 these are the tools used for sentiment analysis of text on social media and their explanation on the basis of their born place, year of born , cost of the tool, their deployment and their features.

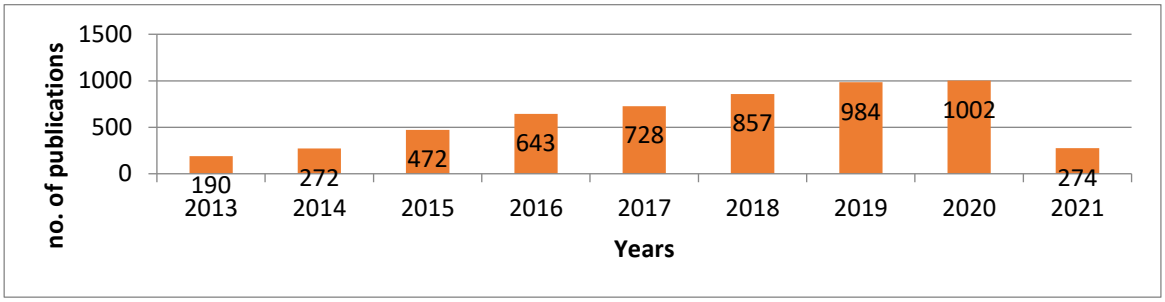
VI. INTERPRETATION

To deal with large amount of data we use different tools to extract data from social media. In this section we interpret some results related to our topics in the form of graphs. As social media is a platform where user express his/her feeling openly and all social media applications provides its user with very interactive interface and because of this active users on different social media is increasing day by day(graph1). Researchers do number of publications related to sentiment Analysis from texts (graph2). The result show from the search showed year wise publication related to sentiment analysis in IEEE Xplore(graph 2) and in Science direct(graph 3).

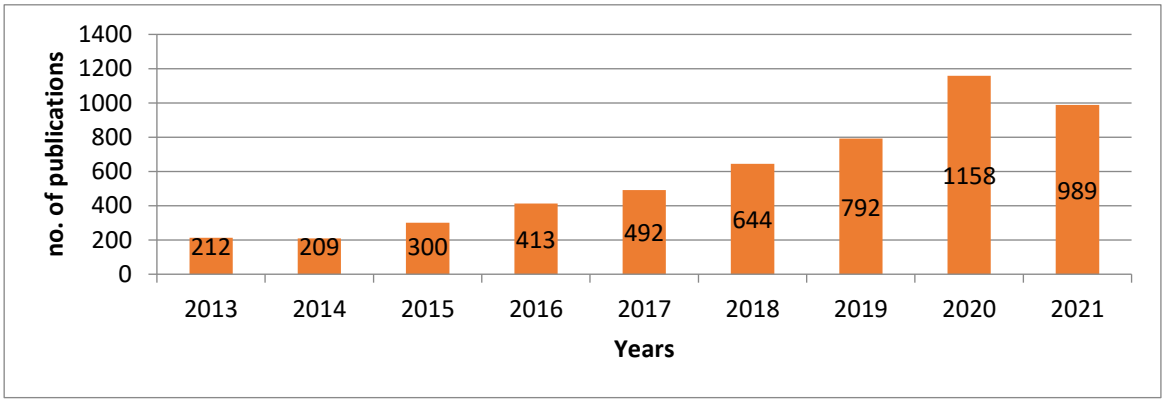
Graph 1:



Graph 2: IEEE XPLORE DATABASE



Graph 3: SCIENCE DIRECT DATABASE



VII. CONCLUSION AND FUTURE

This work begins with a study of sentiment analysis and then goes on to discuss several mathematical models, including i) sentiment analysis architecture and ii) feature selection techniques in detail. iii)Recent themes in sentiment analysis, which plays a critical role in the entertainment industry. In the entertainment industry, particularly in gaming, current technologies such as augmented reality and virtual reality play an essential role in making interfaces more dynamic and appealing. v)tools for extracting and analyzing data from social media using sentiment analysis. The tools mentioned in this work have a variety of uses. The majority of technologies are used to extract data from social media, summarize data, and identify emotions behind various remarks and emojis.

A major problem in using sentiment analysis techniques to collect and evaluate data from social media is that new tools are needed to prevent ambiguity and to identify emotions underlying sarcasms, which are particularly difficult to identify. The technologies mentioned in this article are all connected to social media data. We'll aim to add additional tools in the future that can extract data from a variety of e-commerce websites.

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Comparative study of various All-Optical logic gates Implementation Techniques: A Review

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***Abstract*: SOA MZI structure to form all optical logic gates has become prominent because it has better speed, compact in size, integrable, have regenerative properties, simpler in circuitry,liberated from polarization and wavelength changes, low energy requirements for operation and switching, almost all gates have been formed by this configuration. Most of its operation is limited to 80Gb/s but with the use of different new techniques, attempts have been made to increase the speed of the SOA MZI structure (eg. TS SOA-MZI, Quantum-Dot SOA,). Quantum -dot SOA has brought the speed of the system to 1Tb/s by shorten the carrier recovery time of the SOA, and which is a big work in terms of speed achievement but it is complex to fabricate. Large drive current andHolding beam also decreases the gain recovery time to some extent. QD-SOA MZI structure using TPA has better results than QD-SOA MZI without TPA. QF is higher (>6dB) at the data rate of ~2.5 Tb/s with TPA.**

***Keywords:* SOA, Logic gates, Sagnac Interferometer, Cross Phase Modulation, Polarization Maintaining Loop, Continuous Wave, Two Photon Absorption**

I. INTRODUCTION

A photon is a very suitable information carrier compared to electron in many aspects. Therefore, light may provide a way out of the limitations of computational speed and complexity ingrained in computing in electronics. Information processing with photon as information carrying signalbut it is clear that conventional techniques of electronics cannot be applied in optical data processing.So, there is huge need of optical signal processing approach to transmit the signal in the form of light. All optical logic gates are the key element of all optical signal processing systems. They can be used to make devices like Adder, multiplexers, counters flipflops etc. Nonlinear effects in optical fibers that arises due to third order susceptibility in optical materials are used to make gates. Gates can be designed by using SOA or without using it.Fibersare used for making gates havingultra-high speed but experiences high dispersion at high frequencies. On the other hand,many schemes of all optical logic gates are described, using semiconductor devices, optical fibres or waveguidesand other new structures.

II. SEMICONDUCTOR OPTICAL AMPLIFIERS

Semiconductor optical amplifiers (SOAs) has been innovative and an excellent choice for performing different optical functions, as they are used as wavelength converters, optoelectronic devices, optical logic gates, bit comparators, add-drop multiplexing, packet synchronization, clock recovery, address recognition, and signal processing among many otherapplications of all-optical digital signal processing. It is an optoelectronic device which amplify the input light signal. however due to better performance of EDFA and another amplifier like RAMAN amplifier, SOA was replaced.

The nonlinear behaviour of SOA being a drawback as a linear amplifier makes it a good choice for an optically controlled optical gate because the nonlinear coefficient of SOA is much higher than other optical components.Non-linearity properties in SOA is due to changes incarrier density as power of the input signal varies. It exhibits strong change in refractive index together with high gain. In-fact high nonlinearity and ease of integration act as advantages to the SOA based devices such as MZI in all-optical gate operations.Electrons from external current source are injected in the active region of SOA. The phase modulation produced by the wave during propagation in the SOA is given by

$$\Delta\varphi = 2\pi no\frac{L}{\lambda}\alpha[\log G - \log Go] \text{ [14]}$$

where G is the saturated gain, Go is the linear device gain, L is the length of the active region of the SOA, λ is the wavelength of the input data signal, α is the SOA line width enhancement factor, no is the refractive index when no optical power is given [14].All SOA-based optical gates are primarilybased on non-linear phenomena such as cross-gain modulation (XGM), four-wave mixing (FWM), cross-phase modulation (XPM) and Cross Polarization Modulation that omit the need for optoelectronic conversions.

Table1: Nonlinearities used in Optical Logic Gates [23]

S No.	Nonlinearities	Characteristics
1.	**Cross Gain Modulation**	High Power Consumption, significant Cross talk, Small ER (Extinction Ratio), Insufficient transparency, Appreciable ASE noise
2.	**Cross Phase Modulation**	Sensitive to Input Light Polarization, High ER, Practical Integrability, Better Results with Interferometric Structures.
3.	**Four Wave Mixing**	Good Transparency, Low efficiency when path length difference is high, Medium ER, Sensitive to Input Light Polarization
4.	**Cross Polarization Modulation**	Higher Transparency, Highly Sensitive to Polarization, High ER, Less Power Consumption in comparison to Cross Phase Modulation, Dependency on Bit Pattern

To enhance efficiency and large conversion range the XPM is increased by changing the SOA active region length and bias current. the control signals from the two SOAs can interfere either constructively or destructively at the output of the interferometer. SOA based gates are ultra nonlinear configuration, Sagnac Interferometer gates, Michelson Interferometer gates, Mach-Zehnder interferometer configuration, Delay Interferometric gates. Semiconductor based device, SOA has wide gain spectrum, lower power consumption, monolithic integration with other devices and low cost.

SOA-MZI structure is used to perform the logic gates XOR, NOR, OR and XNOR. Basic operation depends on nonlinearities of SOA that brings intense changes in refractive index of SOA. Effect of change in number of bits(4, 6, 8, and 16 bit) and low input power on the minimum bit error rate, received power and maximum Q-factor at 10 Gbps is studied. Input data signal wavelength is 1556nm[1].Co-propagating MZI configuration along with SOA is picked out to design the universal gates using XPM and XGM as non-linearities and execution of various Boolean expression are carried out with the support of proposed NAND, NOR and NOT gates. Extinction ratio, clear eye-opening diagram and bit error rate (BER) measurements helps us to know the correct logic functions and their high output power[2]. An all-optical AND logic gate system based on SOA-MI with symmetrically identical FBGs at output of each arm with different bit numbers using cross-gain modulation (XGM) technique at 10 Gb/s bit rate and filter bandwidth taken is 10, 20 and 40 GHz. Different amounts of bits in their inputs, being 4, 8, 16 and 32-bits and different bandwidth of the receiver filter are used to obtain optimum output and comparison. The analysis of the results was performed through the optical spectrum and the eye diagram along with the maximum quality factor. In addition to that the effect of bandwidth and no of bits on received power, minimum bit error rate and maximum quality factor, and optical signal to noise ratio is also measured [3]. Work has been done on data access problem when the bit error rate and quality factor are high and low respectively. SOA's nonlinear properties are effectively used to accomplish AND, NAND and OR gates to support Boolean functions and these Boolean functions are utilized to perform optical signal processing. R. Model that is achieved with AND, OR, and NAND gates is suitable for wavelength converter, parity checking, and data encryption with high pace and high-quality factor. The obtained optimum Q-factor is equal to 26.7766 using the first proposed model[4].Based on four wave mixing that arise due to three input data signals that includes two data signal at wavelength λ_1 and λ_2 and one pump signal λ_3, a scheme has been demonstrated to process OOK modulated signal with any duty-cycle, including NRZ/RZ-OOK, as well as CSRZ-OOK, and this compatibility could be achieved by merely turning ON or OFF a sinusoidal driven electrical signal. Such a multi-function logic unit is utmost architecture-compact and cost-effective for future optical network nodes[5].

All optical signal processing is done both on basic level and on system level. SOA has been used with DI or MZI to make the best use of it. Dual pump probe configuration was used in SOA-MZI. Speed of stimulation was 80Gb/s [6]. XOR gate has been implemented using SOA-MZI. Both OR function and Invert function operates on the nonlinearity induced by gain saturation in the SOA. the experimental results of SOA-Delayed Interferometer (DI) based OR function at 20 and 40 Gb/s. The simulation shows the data rate limitation is set by the carrier recovery time of the SOA. A polarization maintaining loop mirror is used as delay interferometer. The high-speed operation of OR gate is limited by the gain recovery time in SOA [7]. SOA-MZI with PML (Polarization Maintain Loop)-DI is used at 80 Gb/s to improve the quality of XOR result. XOR operation is performed applying numerical stimulations [8]. Error free operation based on XGM and XPM of XOR gate and its numerical stimulation is achieved at data rate of 160 Gb/s when Delay Interferometer is used with SOA-MZI where SOA is placed at each arm of MZI and DI is places next to it after Optical band pass filter. It also shown that SOA recovery time does not limit the data rate of the scheme. Quality factor of 16.5 dB is achieved at output power of -17dBm and delay of 2.25ps. With consideration of residual ISI and the error floor due to ASE noise, Power Penalty of approximately 6 dB is achieved [9]. Different types of Digital Pulse Generators like Non-Return to Zero, Return to Zero and Carrier Suppressed Return to Zero are used with ON-OFF keying modulation scheme to check the f easibility of using single SOA circuit while using these methods. OR and AND logic gates are formed based on Four Wave Mixing Nonlinearity in SOA has attracted considerable interest due to their low-power consumption, compactness, and ease of integration [10]

III. TRENDING INTERFEROMETERS AND THEIR COMPARISON

A. Sagnac interferometer

A beam of light is split into two and the beams are made to follow a path but in opposite directions i.e. one in clockwise and another in anti-clock wise direction. On return to the point of entry the two light beams are allowed to exit the ring and undergo interference. The relative phases of the two exiting beams depends on the different distance travelled by them, and thus the position of the interference fringes, are shifted according to the angular velocity of the apparatus. Semiconductor Laser Amplifier

in a Loop Mirror (SLALOM) was the first proposed sagnac interferometer where nonlinear element was used in one of the loops of interferometer which causes phase changes in the loop and results in constructive or destructive interference between the two beams. It is compact in size and low energy is required to drive the circuit but it has low operation speed. Nonlinear Optical Loop Mirror(NOLM) uses Kerr Nonlinearities also known as third order Nonlinearities like Cross Phase Modulation and Self Phase Modulation for actuating the shift in phase of the signal moving through it. Generally High Non-linear Fiber(HNLF) or Dispersion Shifted Fiber(DSF) is laid down for introducing the phase shift and using high optical power and long fibers compensate the weak kerr coefficient in optical fibers. It has high bit rate of operation and easily configurable but is difficult to integrate and have undesired interaction effects. Terahertz Optical Asymmetric Demultiplexer (TOAD) is most popular nowadays due to its ease of integration, high speed, thermal stability and most importantly reasonable noise power etc. but it has low Contrast ratio and Power Penalty. Mostly unaccompanied SOA is used in the fiber loop. Recently a Dual Control TOAD has been used where two identical SOA are introduced in loop to produce the output. If no control signal is applied on the SOA's, gain is unsaturated and there will be no phase difference between the two counter propagating components constructive Interference will be at Port 2. if any of the control is given to SOA into the DC-TOAD, its gain becomes saturated, clockwise and anti-clockwise components experience different gains and a phase shifts, adjusted to give a phase difference π. When they interfere at the coupler, data signal comes out of the port 1 as constructive interference happens there. When both the control enters into the Dual Control-TOAD both of these component experience same unsaturated gains and phase shift resulting zero phase difference between them and data will exit from port 2 again [19].

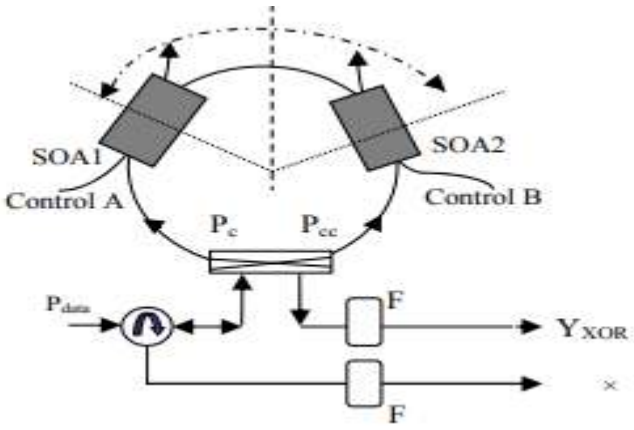

Figure: Dual control Terahertz Optical Asymmetric Demultiplexer[19]
A,B: Control Signal

B. MachZehnder Interferometer

SOA alone used to make logic gates are better than other approaches due to SOA properties like compact size, ease of integration and low power requirement. Using SOA-MZI structure makes it even more stable, compaction and an important feature of Regeneration capabilities.

An MZI consists of one beam splitter, one beam combiner, and two symmetric/asymmetric waveguides through which beam passes. Balanced MZI have symmetric waveguides attached to it. On the other hand, Asymmetric waveguides are used for Unbalanced MZI. Optical path length difference between waveguides is ΔL and can be written as,

$$\Delta L = m\lambda/\eta$$

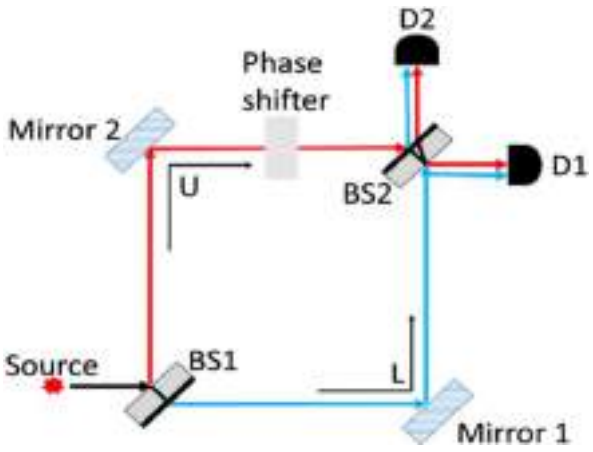

Figure: Basic MZI Structure

When MZI configuration is generally used to make logic gates[16]. It has two arms in which SOA are placed. [4]These SOA can be combined using 2x2 coupler or by using phase shifter in both the arms.Two optical control beams are sent into ports A and B of the gate. The wavelengths of the two input signals can be the same or different. Input signals from A and B enter first coupler and combine with CW in second coupler. Then these waves enter the SOA. Existence or non-existence of data stream A and B cause different chirping for CW. Optical filter eliminates undesirable part of SOA's output wave and pass others to obtain logic operation. The speed of the SOA is limited to ~ 100 Gb/s due to its slow carrier recovery time response. It is foremost to address this problem by speeding up its carrier recovery time to meet the need for the high-speed communication systems. The Turbo switch introduced to the system relies on nonlinear optical filtering to boost the high-speed response of the SOA, leading to up to four times enhancement in switching speed as compared to the use of a single SOA. XOR gate has been implemented using SOA based TS-MZI to check its feasibility over SOA MZI and demonstrated that it is beneficial to further implement the all-optical operations with an acceptable performance when using SOAs-based TS-MZI than standard SOAs-based MZI.Amplified Spontaneous Emission(ASE) effect is also examined. Ultrafast all-optical NOR gate using a single QD-SOA assisted by an OF for 160Gb/s has been examined. the effects of clock wavelength, peak power of data and clock signals, other critical parameters of QD-SOA and OF, the arrival time difference (ATD) between data signals and clock signal, and amplified spontaneous emission (ASE) on the extinction ratio (ER) and Q2 -factor[12] [13].

Quantum dot structure of SOA can increase the carrier recovery 100 times faster having same width as Bulk SOA. The usefulness of the configuration consisting of a single QD-SOA and an OF is enhanced by moderation. This enables us to set out the margins of clock wavelength, peak power of data and clock signals, current density, electron relaxation time from the excited state (ES) to the ground state (GS), linewidth enhancement factor, small signal gain of QD-SOA, OF bandwidth and order, the admissible extent of arrival time difference(ATD) between the data signals and clock, and the effect of Amplified spontaneous emission(ASE), for both logical faultlessness and high quality. Multiple Input NOR gate can be implemented with this device after measuring its scalability Configuration of Implementation is Two wavelength selective optical couplers (OC1, OC2), QD-SOA, and OF are connected in series. XPM and XGM occurs and induce the spectral broadening and gain suppression of the signal when both the inputs are either (0,1),(1,0) or (1,1). In case of (0,0) XPM and XGM do not occur and also there is no spectral broadening and gain suppression of the signal[20].

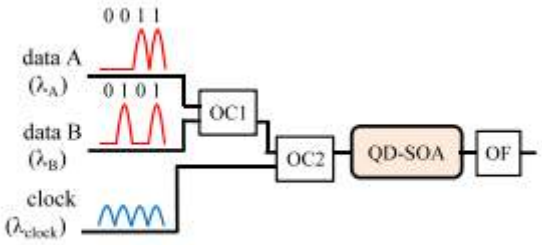

Figure: Shows NOR gate Configuration [20]

Large drive current upto 50mA increases the values of ASE in SOA, gain saturates and reduces gain recovery time[21].Holding beam or Continuous wave laser also decreases the gain recovery time to some extent as it generates new carriers and does not allow depletion of carriers due to gain saturation caused by intensity dependent data stream. Wavelength diversity technique facilitates uniform gain in SOA which makes SOA to be useful for high speed applications[22][23]. Using Quantum-dot SOA MZI structure used Two Photon Absorption has put forward the optical technology one step ahead by increasing the speed of operation up to 2Tb/s. NOR gate was formed using the technology and comparison is done the basis of TPA and without TPA and find out that it has better Quality factor with high speed of response[22][25].

C. Ultra Nonlinear Interferometer

Most Important Feature of UNI is its single arm architecture and cascade ability. The operations are based on Cross Phase Modulation(XPM) nonlinear effect. The UNI model was substantiated using a birefringent fiber of long length(m) and an SOA. It consists of two fragments of Birefringent Fiber (BiF) that are in orthogonal position. Time delay between two signal pulses is controlled by Birefringence(B) and length of Birefringent Fiber(L).

$$\Delta t = \frac{BL}{c}$$

A control signal is induced in SOA, which shifts the trailing signal by π. After passing through the SOA, signal leading and trailing components are re-timed to turn over. A tunable optical filter is alsoused at output to discard the control pulse. It is a demultiplexer to carry out OTDD operations. It is used forAND, OR, NOR and NOT operations[4].Limitations of UNI are its polarization sensitivity of data signal, difficulty in integration and limited bit rate of operation. The control signal is insensitive to polarization in UNI.So, the operation is basically based on the optimum adjustment of the polarization of the incoming data signal. There is a need of filter in the architecture to remove the control signal at output which may be a advantage of many other architectures which avoid the use of filter[15].

S No.	Practical Approach Used	Gates Formed	Nonlinear Effect	Data Rate	Results	Ref.
1.	SOAand DI based on Polarization Maintaining Loop Mirror	OR	Gain Saturation Property of SOA	80Gb/s	QF greater than 6 is needed for BER less than 10-9. α factor is 7	Wang. 2006
2.	Reconfigurable architecture using single SOA-MZI	XOR, AND, OR, NOT	Cross Phase Modulation (XPM)	10Gb/s	High Extinction Ratio(>10dB) for data peaks at -2dBm	Martinez. 2007[11]
3.	SOA and MZI used for Reversible gates. EDFA acts as Control signal	ALL GATES	Toffoli and Feynmann scheme. Cross Phase Modulation.	1.53μm	Variation of contrast ratio (C.R.) and BER with control pulse energy	Tarafdar. 2010
4.	Bulk SOA	NOR	Phase Modulation	Max 1Tbps	Output is Exactly NOR	Sahafi. 2012[3]
5.	NRZ format, SOA-MZI Structure	AND, XOR	Complementary Data is used in Input of SOA-MZI	40Gb/s	Reduces Transition time. QF>6	G Wang. 2012
6.	SOA-MZI Structure	NOR, OR, XOR and XNOR	Cross phase Modulation (XPM)	10Gbps	I/P bits (4,6,8,16) QF dec. and PE inc.withinc. in no. of bits	Saeed. 2016 [1]
7.	Single wavelength SOA-MZI with RZ format and OOK	OR, AND, NOR, NOT, and XOR	Phase Modulation(PM)	160 Gb/s	Based on Constructive and Destructive Interference, QF is greater than 15dB	Lovkesh, 2016[14]
8.	SOA based TS-MZI	XOR	Extra pair of SOA cascaded and Separated by Broadband Optical Filter	160Gb/s	Higher QF than SOA-MZI structure	Kotb. 2018 [12]
7.	Dual Pump probe SOA with MZI	OR	Cross gain Modulation (XGM) and Cross phase Modulation (XPM)	80Gb/s	SOA-MZI performs better than SOA-DI	Kotb. 2018 [6]
9.	NRZ, RZ and CSRZ scheme with ON-OFF Keying is used with SOA	AND, OR	Four Wave Mixing (FWM), Cross Gain Modulation (XGM), Transient Cross Phase Modulation(T-XPM)	10Gb/s	Processing of NRZ, RZ and CSRZ signals is feasible with SOA used in system	Bingbing. 2010[24]
10.	Hybrid encoding Technique, SOA as frequency converter	NAND	four-wave mixing (FWM) and nonlinear cross-polarization rotation effect		QF is 3, BER is $1.4\times10^{-3.}$ More is QF less is BER.	Mukhrjee. 2019
11.	DCTOAD (Sagnac) based Switch uses SOA	XOR	Soliton Pulse as Control signal	1550nm	ER is 13.76dB, CR is 16.77dB and QF is 16.68dB	Maji. 2019[10]
12.	PC-SOA	NOR, XNOR	Gain and Phase Modulation	160 Gb/s	PCSOA operates better at higher speed with high QF	Kotb. 2020 [18]
13.	SOA-MZI followed by DI	AND, NOR, XNOR	Comparison based on operating data rate, equivalent PRBS length, ASE power, and operating temperature	160Gb/s	Effect of ASE and operating temp examined, Qfactor in	Alquliah 2021 [26]
14.	Single compact scheme-based SOA-MZI and Delayed Interferometer	AND, NOT, NOR, XOR, XNOR, NAND	Cross Phase Modulation (XPM)	100Gb/s	Quality factor, extinction ratio, and contrast ratio considered 22 dB signal gain, 10 mW saturation power, and 25 ps carrier lifetime	Kotb 2021[27]
15.	SOA	NOT, XOR, XNOR, AB, AB, OR and NOR	Cross Gain Modulation (XGM) for high gain and low saturation power	340Gb/s	High-power pump signal and a high injection current	Sharma 2021 [28]

IV. CONCLUSION

SOA being the nonlinear element with high third order nonlinearities, is used in all the interferometric techniques to form all optical logic gates as It is compact, stable, integrable, and has regeneration capabilities and low power requirements.Its

shortcoming is speed of the system. Many advancements are working on to shorten the carrier recovery time which in-turn increases the speed of the system. Quantum dot with same length of bulk SOA decreases the carrier recovery time tremendously. Large drive current and Continuous wave also helps dec. in carrier recovery time but they have their own shortcomings. Wavelength diversity is another better method for achieving better recovery time to increase speed of the system. The analysis makes it clear that Quantum-dot SOA MZI structure is better for all optical logic gates with TPA. It has high speed of ~2.5tb/s with Quality factor greater than 6.

V. ACKNOWLEDGEMENT

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Issues and Challenges in 6G Communication

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Abstract—**the limitations of 5G technology have been discovered as more 5G networks are deployed, encouraging more research about 6G networks. The researchers have started solving the challenges of 6G mobile communication such as THz frequency, minimum end-to-end delay, reliability, capacity, global coverage, security, and many more. This paper aims to identify various issues and challenges for deploying 6G technology in the industry, customer network, data centers, and ISPs. It has been found that critical issues are Terahertz technology and other alternative techniques, Artificial Intelligence, Blockchain, and Distributed Ledger Technology, Big Data, and Edge technology. In contrast, challenges faced by 6G technologies are Underwater Communication, Capacity, Global coverage, Energy, Cost, Heterogeneity, Security, and privacy. 6G technology also promises to empower the Internet of Everything by 2030.**

Keywords— **Wireless Communication, 6G, Issues, future Challenges, Internet of Everything (IoE), Internet of Things (IoT)**

I. INTRODUCTION

The wireless communication system is the fastest-growing part of the communication industry. In today's life, wireless communication covers all aspects of daily life, from voice communication to vital communication. Organizations all over the globe have been going through what we are calling a "digital transformation." Artificial Intelligence (AI), Blockchain technologies, Data Science, and Machine Learning have become essential in these digital transformations. These emerging research areas have many practical applications in predictive modeling, smart healthcare, social media analysis, online customer support, product recommendations, and many more. There is significant research development in the communication context evolving in 6G networks to meet the demand for the applications as mentioned above.

While the 6G wireless technology is still being researched, the vision and significant aspects of the 6G networks come into the discussion. Many nations have already begun their research projects on 6G networks. The researchers have started solving the various challenges of 6G mobile communication such as THz frequency, minimum end to end delay, reliability, capacity, global coverage, security, and many more. 6G networks have no standard functionalities or specifications, just many possibilities which empower various new technologies. The 6G networks will predictably provide a 1tbps data rate with a maximum wavelength of 300 micrometers to achieve the Terahertz frequency band. It also expects that the cost will be a thousand times cheaper in the 6G. 6G will provide not only ground coverage but also underwater and space coverage. 6G networks can accommodate various heterogeneous devices and infrastructure to yield ultra-high data rates, high reliability, low latency, and secure communication processes. The 6G networks also enable the Internet of things (IoT) and the Internet of Everything (IoE). It guarantees to interface every electronic gadget to the Internet. Hence, 6G is a powerful communication technology that will enable a wide range of new technologies, including holographic communication. Achieving the 6G with all of the desired criteria listed in Table 1 is a significant problem.

TABLE VII
COMPARISON BETWEEN 5G AND 6G ISSUES

S.No.	Issues between 5G and 6G		
	Issues	**5G**	**6G**
1	AI	Half Supported	Fully supported
2	Satellite Integration	Partial	Fully
3	Autonomous Vehicle	Partially	Fully
4	Terahertz Communication	Very Limited	Widely
5	Operating Frequency	3-300 MHz	1THz
6	Data Rate	1 Gbps	1Tbps
7	Wavelength	3mm	300µm
8	Core Network	IoT	IoE
9	Architecture	Massive MIMO	Intelligent Surface
10	End to End Latency	10ms	1ms

II. ISSUES OF 6G

The deployment of 5G wireless technology has only recently begun. Furthermore, 5G is yet to be thoroughly investigated. Moreover, no user experience on 5G and beyond 5G (B5G) exists. Furthermore, B5G technology is still in its early stages of

development. As a result, there are numerous issues to consider while considering 6G wireless technology. Various issues and challenges of 6G are depicted in Figure 1.

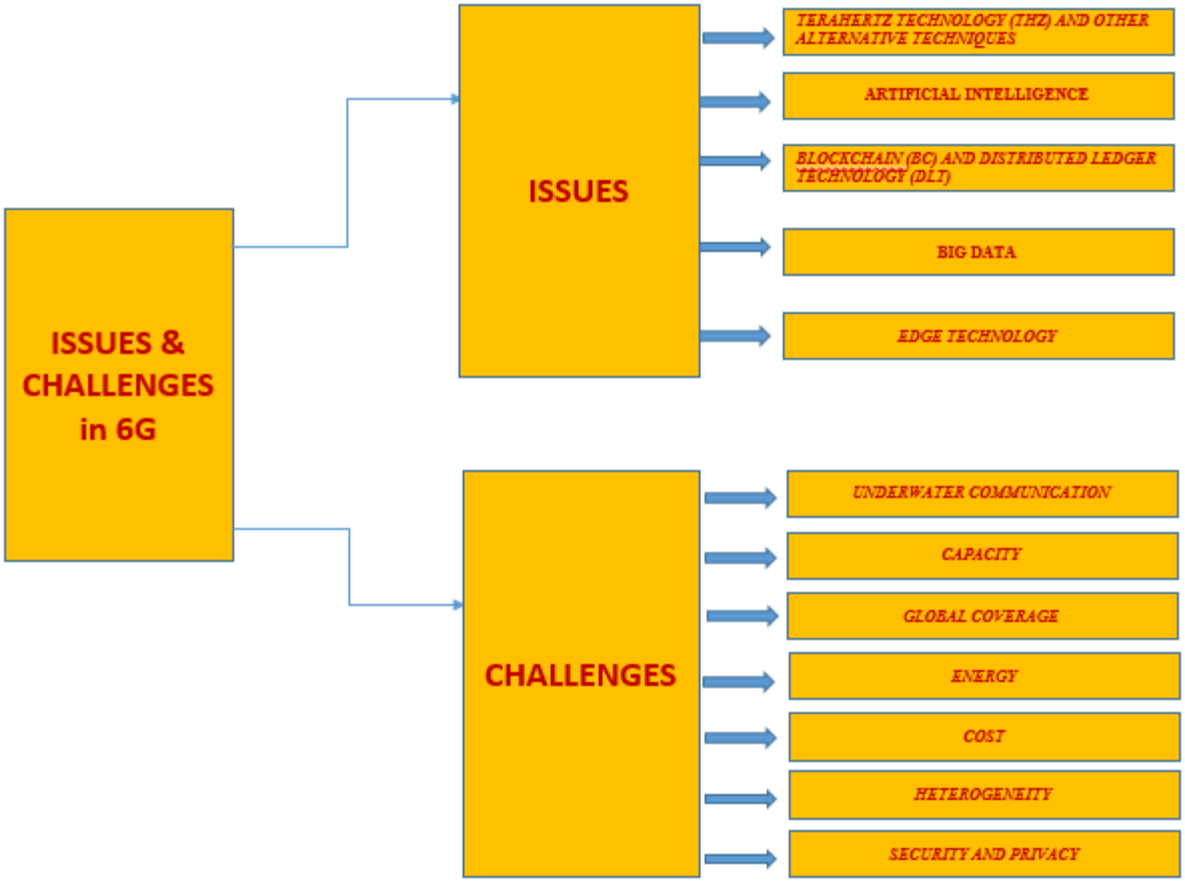

Figure 1: Issues and Challenges in 6G

I. Terahertz Technology (THz) and Other Alternative Techniques

The TeraHertz (THz) frequency band will be used for communication in 6G. However, working in terahertz is a significant issue when the wavelength reaches 300 micrometers. 6G transmission needs a constant terahertz frequency signal. However, generating a continuous terahertz signal is more challenging because it has more complexity in designing the antenna [4], [5]. Furthermore, it is expensive to produce Signal in THz. Another issue with terahertz signals is short-distance communication. The signal energy is lost due to spreading loss, and molecular absorption will be another issue faced by 6G mobile wireless communication. It is not worth amplifying the signal after every one meter. In addition to terahertz signals, new communication alternatives are being investigated. Visible Light Communication (VLC) employs low-cost light-emitting diodes (LEDs) to attain a higher frequency range. The VLC, on the other hand, has challenges with noise interference and coverage. As a result, VLC is employed in a limited arena with no interference from other light sources. Molecular communications (MC) is another alternative. It transmits data through biological signals. Particles ranging in size from a few nanometers to a few micrometers make up biochemical signals. Biocompatibility, low energy consumption for manufacturing and transmission, and high data speeds are advantages of MC signals [6]. However, it poses security and interface issues. Quantum communication (QC) is a third alternative. In a quantum state, photons or quantum particles are used to encode data. It makes data cloning and access by hackers harder. Highly secure transmission, high data rates, and efficient transmission across a long distance are all advantages of QC [7]. However, it is still in the early stages of development and has a long way to substitute for the terahertz signal.

J. Artificial Intelligence (AI)

The latest 6G technology should be fully AI-empowered and AI-driven [2], meaning that the data will be intelligently routed. Furthermore, federated AI will be an aid in exchanging information among smart devices. In addition, the performance of 6G will be enhanced by quantum machine learning by smart data analysis. Many techniques, on the other hand, are still in the early stages of development. All AI algorithms need heavy computation. The serious computation task takes a long time to complete and uses a lot of power. 6G technology, on the other hand, is unable to provide such comfort. The network's dynamic nature is another challenge. Once AI algorithms obtain conclusions, which are then utilized to forecast future incoming data. The inferences, however, will quickly become obsolete due to the changing nature of communication networks. Training the AI module for 6G

will be prohibitively expensive over a short time. In addition, AI will assist the physical layer. However, due to the physical layer's complexity, putting AI in the physical layer is difficult. Many new security and privacy issues have arisen due to increasing attention towards AI [10]. Artificial Intelligence (AI) is being used in the 5G network. However, it is supposedly being run in isolated places with enormous volumes of training set, powerful but private processing centers, whereas the 6G network's AI will become more integrated [11]. In terms of architecture, AI technologies can be separated into two categories: physical (Data lines and network architecture) and computing (such as SDN, NFV, and edge/cloud/fog computing). As a result, incorporating AI into communication will be a significant challenge for 6G.

K. Blockchain (BC) and Distributed Ledger Technology (DLT)

The blockchain and distributed ledger technologies are very safe. They have a lot of potential applications in 6G wireless networks like network decentralization, ensuring integrating of resource sharing, promises to provide minimum processing delay, and improving the security of spectrum sharing. The blockchain used in network decentralization [1] and distributed ledger technologies have the great potential to improve network performance and authentication security, respectively. Spectrum sharing based on blockchain technology could solve the problem of spectrum monopoly and low spectrum utilization. Blockchain has the potential to be one of the Internet of Everything's most revolutionary technologies [12]. As blockchain technology exchanges information with all participants, it can be used for data and spectrum sharing, hence boosting the security of wireless 6G mobile networks. Still, several issues remain mainly unanswered. These investigations comprise some security and privacy issues about 6G networks: authentication, malicious behaviors, Access Control, communication, and Encryption [3], [4].

L. Big Data

The 6G wireless technology will facilitate the Internet of Everything (IoE) to generate vast amounts of small-sized data. Cloud Computing is used to store, process, and manage Big Data. Data on the Internet of Everything will present new issues in terms of data management. There is currently no technology capable of storing, processing, and managing exabytes of tiny data. As a result of these minor data silos, Big Data will be redefined, with the help of Big Data 2.0 will be presented [8]. In contrast, big data 2.0 necessitates the utilization of a supercomputer to process and analyze the dataset.

M. Edge Technology

Edge computing was developed because of the rapid growth of the Internet of Things (IoT) devices that connect to the internet to receive or send data to the cloud. The Edge technology was developed because the cloud is so far away from the devices that generate data. Edge technology, on the other hand, is a new research area with a lot of problems. The memory and power sources for edge nodes are limited. AI is used heavily in edge analytics. The inferences are supplied to Edge nodes using the cloud-based AI algorithm due to the inability to do intensive computation on the Edge nodes. The performance of 6G networks will be reduced due to the Edge dependency on the cloud. Furthermore, AI concerns will harm Edge performance, which would subsequently harm 6G performance. The Edge nodes will store the massive data, so 6G technology is planning to have a high density. However, Edges nodes will be unable to store information due to limited storage and will be forced to communicate data to the cloud in a short period. As a result, data transmission to the cloud will incur communication costs [9].

III. CHALLENGES OF 6G

The challenges are significantly more significant than the 6G services. The majority of 5G issues are projected to be rectified by B5G, with the remaining problems being solved by 6G. However, the demands are increasing at an exponential rate. As a result, the challenges of 6G are far more significant than those of 5G and B5G.

N. Underwater Communication

Underwater communication is one of the goals of 6G. However, compared to ground or space, the aquatic environment is unique in the 6G era. The undersea environment is random and challenging, with high signal attenuation, equipment damage, and complex network implementation. Radio waves lose their power dramatically when submerged in saltwater. So far, auditory communication has been the only option for getting information over to the other party. Due to the difficulty and cost of node deployment, node density should be minimum. Node mobility is problematic due to water flow and density fluctuations. Underwater sensors are expensive, and they are built with special protection for use in the submerged situation.

Also required are high-tech transceivers and massive memory. It's impossible to use solar power; thus, we need a lot of backup power. Fouling and corrosion make underwater sensors more susceptible to failure. Optical fibre is the best option, but it is also the most expensive. Quantum communication is another alternative, but it is still in its early stages of development. 6G must overcome the challenges of underwater conditions to establish effective underwater communication.

O. Capacity

6G is a key enabler of the Internet of Everything (IoE), which connects smart devices. IoE devices will generate a lot of traffic. However, in the case of minimal traffic, the goal of less than 1 ms latency can be achieved. Furthermore, the Quality of service will be degraded due to the overburden of communication networks. As a result, 6G has a significant capacity challenge. There

are four techniques to boost the capacity of 6G networks: Enhance the spectral bandwidth, second improve spectrum efficiency, third is spectrum reuse, or by increasing the node density is another option. All these can be achieved by implementing new modulation techniques or good channel coding.

P. Global Coverage

For global coverage, 6G at the height of 500 to 2000 kilometers will depend on a low earth orbit (LEO) satellite to pursue less path loss, lower transmission delay, and other objectives from the orbit. While as LEO also reflects some issues with Doppler shift, Doppler variation, latency in transmission, and increased path loss. It has been also seen that these LEO satellites travel very quickly as compared to the rotation of the earth and such property of these satellites causes Doppler shift and oscillation in network communication. Moreover, these satellite also causes challenges with random access, synchronization, signal identification, and signal measurements. Another issues are in comparison to terrestrial transmission, LEO has a more latency and path loss.

Q. Energy

Every 6G device, including smartphones and access points, will use sophisticated signal processing algorithms. They also have to deal with Big Data, which necessitates a lot of processing and energy. As a result, energy is a concern in 6G. In addition to high energy, 6G will use developing technology such as Edge and AI in its network nodes. As a result, 6G must address the issues of energy harvesting, charging, and conservation. Another factor is the cooperation of energy among all the nodes of 6G networks.

Furthermore, as described in the transmission mode, data transfer consumes more energy. As a result, new waveforms and modulations with low peak to average power ratios (PAPR) are necessary to reduce power usage. Furthermore, complicated algorithms that guarantee high levels of security cost more energy. Embedding AI with 6G, on the other hand, will cut energy consumption.

R. Cost

One of 6G's objectives is to make services more affordable. Both non-terrestrial, as well as terrestrial network nodes make up the 6G network. The price of Terrestrial nodes is comparatively low, whereas their cost of maintenance will be relatively high. The non-terrestrial nodes, like drones, satellites, and mobile nodes, are pretty expensive. It is a big issue to launch satellites into space. It is costly to deploy satellites into space. Another prevalent issue is the hefty investment needed for their repair and maintenance. Moreover, the infrastructure of underwater communication is also very costly. Furthermore, 6G necessitates maintaining the highest level of Quality of Service (QoS), so high-quality devices are required. High-quality equipment is also expensive. The issue is to cut the price so that everyone can afford it [9].

S. Heterogeneity

The 6G wireless network will be used for the connectivity of a wide range of smart gadgets. Furthermore, the communication network will differ depending on the coverage. It isn't easy to connect the entire world with single worldwide coverage. Sub-networks will be created within the communication network. Furthermore, these subnetworks will be heterogeneous. Moreover, 6G will merge both terrestrial and non-terrestrial communication networks, which are non-homogeneous. As a result, 6G faces a significant integration issue.

T. Security and Privacy

6G key features are security, secrecy, and privacy [1]. 6G is intended to be capable of providing a highly secure transmission. The present study about the 6G networks involves various technologies like Artificial Intelligence, molecular communications, the TeraHertz (THz), blockchain, quantum communications, and VLC technology. All of these technologies prove to be promising in different 6G network applications, including connected robotics and autonomous systems, multi-sensory X Reality (multi-sensory XR) applications, blockchain, and distributed ledger technologies, and wireless brain-computer interaction. However, all of these elements and applications of 6G networks are greatly affected by security and privacy issues.

Moreover, the combination of both 6G and IoT can result in new security challenges. The use of federated AI improves security as well. Another thing to keep in mind is that 6G guarantees the protection of the physical layer. It will be accomplished by combining AI with 6G. Several studies are being conducted to investigate this possibility. The power system of network equipment is another vulnerable target of 6G. Attackers are using sleep deprivation or battery draining in Denial of Service (DoS) attacks. These investigations comprise some security and privacy issues related to 6G networks: authentication, malicious behaviors, access control, communication, and encryption [3].

IV. CONCLUSIONS

6G is a powerful wireless technology that will enable the Internet of Everything and many new technologies, including holographic communication. This paper discusses the comparison between 5G and 6G, various issues and challenges gfaced by 6G networks with their corresponding solutions. The discrepancies, however, are significant. As a result, achieving the appropriate parameters and delivering the 6G promises is a big task. Finally, it is concluded that 6G would revolutionize various fields and be demonstrated to be a game-changing technology in multiple areas.

ACKNOWLEDGMENT

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Harvesting Radio Frequency (RF) Energy for Wireless Sensor Networks: A Review

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Abstract- In the past years, the most important research area has been harvesting the ambient energy sources available for clean and green systems. Wireless sensor networks have made an exceptional progress in the 21st century as it consists of low cost and low power micro sensors which are spread around a particular area, which aims to collect and monitor the information. Radio frequency (RF) energy harvesting is a technique for acquiring energy for wireless devices directly from ambient RF energy sources. This research looks at the key components of RF energy harvesting systems like wireless transmission medium, antenna and impedance matching circuits, rectifier, voltage multiplier, and energy storage devices like batteries and super capacitors. The thorough performance analysis of each block along with loses, conversion efficiency, impedance matching is presented. Thus providing the necessary insights into the design and performance of RF energy harvesting system.

Keywords: WSN, RF energy harvesting, Rectifier, Voltage multiplier, Supercapacitor.

I. INTRODUCTION

Throughout history, technology has played pivotal role in shaping the life of society. It has always contributed to achieve better livable future for mankind. We have come a long way from industrial revolution to the 20th century but we are still facing severe challenges. Lack of appropriate infrastructure, growth in urban population, inefficient transportation, rise in pollution and depleting sources of energy has led the world to witness another technological advancement. In 2019, United Nations submitted the report expecting the world population to increase exponentially to 8.5 billion in 2030, 9.7 billion in 2050 and 10.9 billion in 2100[1]. Ericsson forecasts more than 1billion IOT connections and around 5 billion connections by 2025[2]. Cisco predicts that there will be 14.6 billion connections and 28.5 billion networked devices worldwide by 2022[2]. AT&T predicts, by 2025 IOT devices will generate 79.4 Zettabytes of data and approximately one million sensors every square kilometer[3]. Hence in this hyper connected era wireless technologies including 5G and Wi-Fi 6 will be indispensable part of our lives. According to Deloitte, novel wireless technologies will immerse through every aspect including telemedicine, tele- surgery, precision automation, autonomous vehicles, tele-pharmacy and remote management[4]. Furthermore, Covid 19 pandemic has plunged the world and accelerated the shift towards better connectivity and support remote working and virtual employee and customer interaction highlighting the value of virtualization. India is witnessing one of the highest average data consumption rates of 12.15 GB per user and this surge is expected to continue in future[5]. 5G is going to make the seismic shift and open gateway to the world full of opportunities, but it will take several other technologies to come together to unleash its full potential.5G is set to have configurable and flexible design which will serve IOT use cases, highly reliable and low latency real time applications like biomedical scenarios. Impact of 5G will accelerate more rapidly after 2025, after it reaches its maturity. 5G networks will enhance the network capacity of 2000 fold which will connect trillions of devices. According to ITU-R specification M.2083, 5G will inhibit the key performance capabilities from IMT- ADVANCED (4G), with downlink peak date rate of 20 Gbit/s and uplink peak date rate of 10 Gbit/s along with connection density of 10,00,000 devices per km2[6]. 5G core network is equipped with attributes such as flexibility, agility, scalability and tunability to support Augmented Reality (AR), Extended Reality (XR), Virtual Reality (VR), smart farming, smart health, smart retail, smart cities etc. According to Qualcomm, 5G is expected to ramp up the economic growth enabling faster response time (70%), cost effective data rates (66%) and faster connection speeds (67%). Consumers are expected to stream more online videos (81%) while mobile gaming will get a boost of 74%. One of the key features of 5G will be densification as millimeter waves are not long range. This will impact the cost of infrastructure and energy requirements although energy consumption per bit compared to 4G is only one tenth[7]. Extensively employed base stations (BS), network components and transmission processes will add to the energy crisis. Climate change has already become the roadblock to development hence new digital economy should first and foremost be sustainable and green. Renewable energy integration into the traditional methods will be a viable option in near future. Energy consumption issues has already leads to development of low power electronics and wireless sensor networks (WSNs) making energy harvesting systems as promising field of research. Environmental energy has gained momentous development in making smart system self-powered. The goal of this survey is to conduct a comprehensive review of ongoing research, limitations of already in use power resources, energy harvesting methods and efforts made to make 5G more sustainable[8].

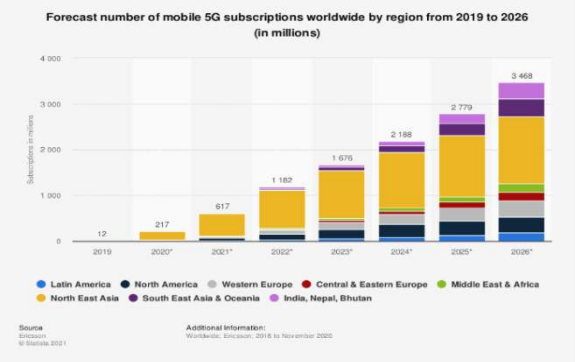


FIG.1 MOBILE 5G SUBSCRIPTIONS FORECAST, 2019-2026[9]

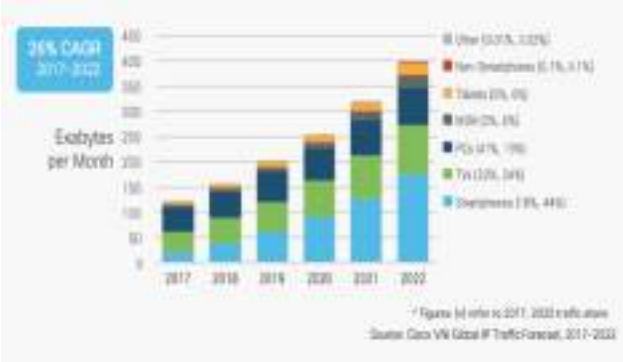


FIG.2. GLOBAL INTERNET TRAFFIC BY DEVICES FORECAST[9]

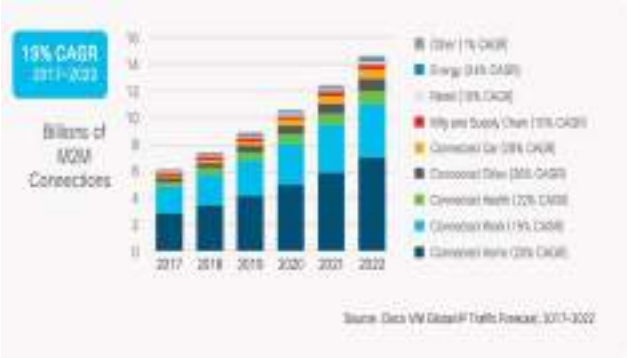


FIG.3. GLOBAL M2M CONNECTION GROWTH BY INDUSTRIES[2]

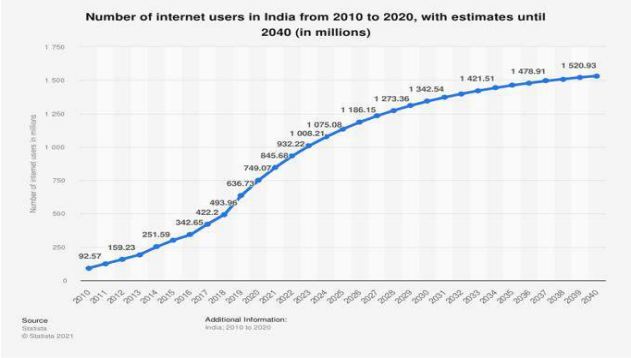


FIG.4. INTERNET USERS IN INDIA ESTIMATE, 2010-2020[2]

II. SOURCES OF ENERGY HARVESTING

IOT and WSN will go hand in hand for smart future and interconnectivity of the wireless devices. Primary source to maintain their operations is an energy source, by now we are mostly dependent on batteries. A non- rechargeable lithium battery has an average power density of 45μW/cm3 for one year and 3.5μW/cm3 for ten years which is a suitable option if one requires less working time but for powering huge network of sensors working for indefinite time period like monitoring health, military purposes and environmental coordination, it cannot serve the purpose[10]. Ambient environment energy is present everywhere around us in different forms and in unlimited supply. It can alleviate the limitation of power supply and will elevate the lifespan of sensor nodes. Although power density and energy density as compared to conventional sources is quite less but efforts are made to increase their outputs along with decreasing the energy consumption of networks. Different types of energy sources surrounding us are in the form of solar energy, mechanical energy, thermal gradient energy, fluid energy, magnetic energy, acoustic energy, hybrid energy and RF energy[11].

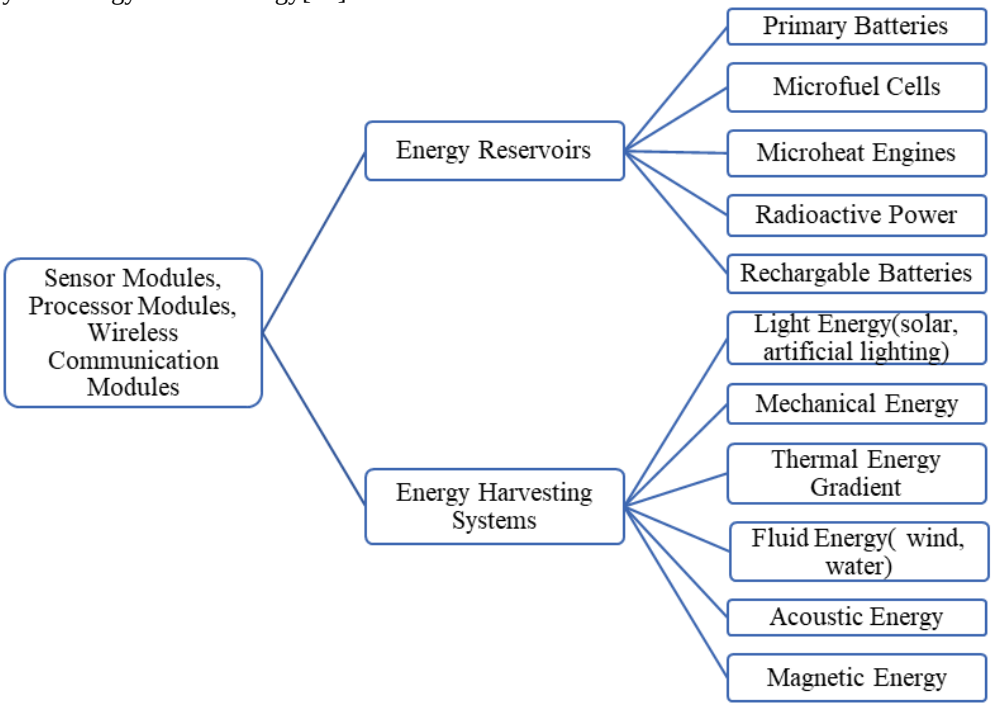
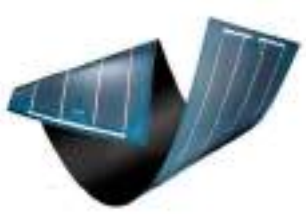


FIG.5. ENERGY HARVESTING SYSTEM OVERVIEW

Hence available energy can be utilized to generate power supply which can be used directly or can be stored in energy storage device. For realizing self- powered sensors, harvested energy needs to be combined with appropriate interface circuit. Further, for energy harvesting, power density of these sources is crucial. Among all the sources, power density of solar energy is the highest with peak value of 100 mW/cm2[12]. But this value varies depending on weather conditions also solar panels occupy large areas. Several types of solar cells are used like silicon solar batteries, multi compound solar cells, polymer batteries and nanocrystalline solar cells. Currently, polycrystalline silicon solar cells own the largest market share followed by monocrystalline solar cells. Solar energy is widely used for WSNs as it is most abundant form of energy. Efficiency of solar cells depends upon shade obstructions, Angle and position of solar panel and Power conditioning features. Recently, micro solar cell called Sphelar is developed which captures sunlight from all directions along with 20% of indirect reflected light. Another type of solar cells are also invented which are thinner than spider web these ultra thin and superlight solar cells will be used in future with the help of electronic charging device. Mechanical energy harvesters generate energy by converting some movement into electrical energy. It includes piezoelectric, electrostatic and electromagnetic harvesting methods. The peak power density for mechanical energy harvesters is 330 mW/cm3[13]. In biomedical science, vibration sensors observe blood pressure and sugar levels by sensing body pulse and blood current. Different type of piezoelectric transducers employed are unimorph, bimorph, rigid bimorph, macrofibre composite, stack type and rainbow type. Thermal gradient energy is generated through temperature difference of two ends of semiconductor p-n junction[14]. The peak power density of this energy harvesting system is 40 mW/cm3. Research of new thermoelectric materials is done to increase the output power. Their usage is limited due to low conversion efficiency and high cost. Fluid energy includes energy derived from wind and flowing water power. The peak power density of this harvesting method is 16.2 mW/cm3. Acoustic energy is derived when the sound wave is incident on the surface causing vibrations of the object. The power contained by this energy is high when huge decibel levels are involved. Peak power density of such harvesting system is 960 nW/cm3. Magnetic energy is produced around the power lines when AC is transmitted through them, with advent of smart grid system this harvesting method seems to be prominent. Peak power density of this system is 200 mW/cm3. Radio Frequency (RF) energy harvesting has lowest power density among others varying between 0.2 nW/cm3 and 1 mW/cm3[15]. Since, RF energy is obtained from electromagnetic waves at different frequency bands, it is available even in remote areas. In this paper, we will evaluate the performance of RF energy harvesting system.

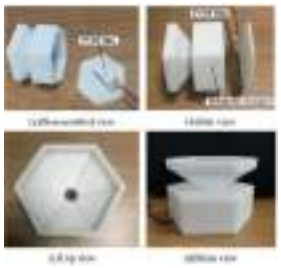
First ever solar panels installed



Flexible folding solar panel

Piezoelectric sensor installed in shoe

PVDF cantilever energy harvester



Acoustic Energy Harvester

Thermo electric generator

Spherical solar panels (spheral)

RF Energy Harvester

TABLE 1. COMPARISON OF VARIOUS ENERGY HARVESTING METHODS

Energy Sources	Voltage Regulation	Power Density	Possible Applications	References
Solar Energy outdoor **Solar Energy indoor**	Maybe	15 mW/cm^3 100 μW/cm^3	Sensors placed in outdoors which are in constant light region like factories, bus stands, shopping centers etc.	[12]
Vibrations (piezoelectric) **Vibrations (electrostatic)** **Vibrations (electromagnetic)**	Yes	330 μW/cm^3 184 μW/cm^3 306 μW/cm^3	Sensors installed on or inside constantly moving body, engines, vehicles, or any other vibration motion.	[13]
Thermoelectric gradient	Maybe	40 μW/cm^3	Sensors placed where there is significant temperature difference like body surfaces and furnaces.	[13]
Wind Flow	Yes	16.2 μW/cm^3	Sensors installed in rotating or moving objects, in water or maybe automated watering.	[13][14]
Acoustic Noise	Yes	960 nW/cm^3	Sensors near level of noises like airports, factories, music halls etc.	[14]
Magnetic Field Energy	Yes	200 μW/cm^3	Sensors where there is strong magnetic field like transmission lines and distribution lines or solenoid.	[15]
RF energy	Yes	1μW/cm^3	Sensors placed where there is large number of Wi-Fi users like urban areas, schools and universities or near base station of transmitting antennas.	[15]

III. RF ENERGY HARVESTING

An RF energy harvesting circuit can be divided into following components including impedance matching circuit , antenna, voltage regulator , rectifier, and load or energy storing device or battery. In a nutshell RF harvesting system starts with a transmitter propagating RF signal through a wireless medium, which is captured by receiving antenna or antenna array. Then to ensure maximum power transfer, impedance matching circuit is used after that rectifier is installed to convert AC power into DC power. If his output power is insufficient, a voltage multiplier is employed to boost the DC voltage. Finally, this harvested energy either can be directly used or can be stored using batteries or super capacitor. Each block of an RF energy harvester has influence on overall efficiency, therefore efficiency of each block should be increased to improve overall efficiency. The block diagram of an RF energy harvesting system is shown in fig below.[16]

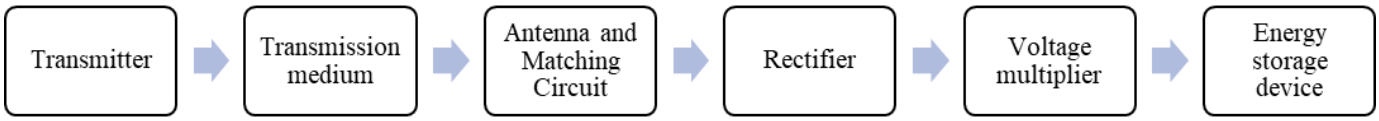


FIG. 6. BLOCK DIAGRAM OF RF ENERGY HARVESTING SYSTEM

IV. TRANSMISSION MEDIUM

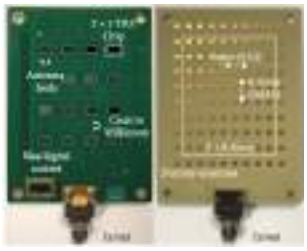
The wireless transmission medium depends upon transmitting frequency band, Near field and Far field regions of transmitting antenna. The frequency band should be selected in such a way that sufficient amount of transmitted power is received at the receiving antenna that can operate the wireless sensor. Higher the frequency, higher will be the attenuation therefore, one should operate at lower frequency. However, maximum output power of transmitter should comply with the regulations recommended by Federal Communications Commission (FCC), Institute of Electrical and Electronics Engineers (IEEE) and International Commission on Non-Ionising Radiation Protection (ICNIRP). In ambient surroundings RF bands like television (TV), Global system for mobile communication (GSM), Long term evolution (LTE) and Wireless Fidelity (Wi-Fi) are available to be used as RF signal sources[17]. As we know, antenna is one of the key elements for radiating electromagnetic wave, transmits in essentially three regions as Reactive near field region, Fresnal region and Fraunhoffer region. The radiation in these regions differ in conversion efficiency and power density values. The power output is inversely proportional to the distance between transmitting and receiving antennas[18].

TABLE 2. FREQUENCY BANDS AND RANGES

Frequency Band	Frequency Range (MHz)
UHF	300-3000
FM	87.5-108
VHF	30-300
TV	470-862
GSM-900	890-960
GSM-1800	1710-1880
UMTS	1920-2170
LTE	791-821, 880-915, 1710-1785, 1920-1980, 2500-2570
Wi-fi	2400-2483.5
ISM	433, 915, 2450, 5800

V. ANTENNA AND MATCHING CIRCUIT

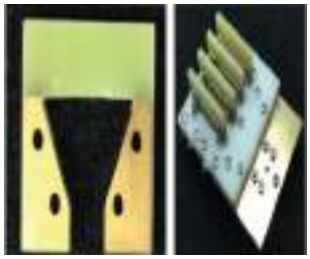
Antenna is classified based upon its operating frequency, gain, physical dimensions, polarization and aperture areas. Mostly the antenna types are as follows array antenna, aperture antenna, microstrip antenna, dipole antenna, loop antenna, horn antenna and Vivaldi antennas. Based on the results, single band antenna harvests less energy as compared to multiband antennas. Its gain decreases due to wide frequency band, also impedance matching becomes very difficult. A multiband RF harvester was discovered to be 15% more efficient than a single band harvester. Other factors which can increase the harvested energy is by the use of polarization match and increasing antenna gain. The amount of energy harvested can be significantly boosted by adding conductive electors to the antenna array[19]. Wearable antennas have also caught an eye in the recent years as promising energy harvesters by the use of smart clothes like electro textile, jeans cotton fabric, glass fibre etc. But these flexible antennas wear out by repeated use of the garment. Various other techniques like Hilbert fractal structure, circular disc antenna, printed elliptical antenna are used to enhance the performance of antenna. Efficiency of antenna depends upon conduction, polarization and dielectric losses hence, these should be minimized. Various impedance matching studies show that impedance mismatch losses can be minimized using shunt and series stub matching[16]. A unique method was used in which the dipole antenna was matched to the rectifier's impedance, eliminating the need for a matching circuit. The antenna's impedance should be matched to the complex conjugate of the rectifier's impedance to allow maximum power transmission between the antenna and the rectifier.



8X8 ANTENNA ARRAY[20]

GDRA GRID ANTENNA[21]

4X4 VIVALDI ANTENNA[22]



HORN ANTENNA ARRAY[20]

VI. RECTIFIER

Rectifier converts received RF power to DC power. It has a huge influence over the overall efficiency of the system. The various parameters to be optimized in rectification are operating frequency, input impedance, output impedance and parasitic effects. Various rectification circuits are used for conversion like half wave, full wave, bridge rectifiers but the most important rectification component of the diode used. The most common diode used is the Schottky diode due to its less voltage drop, lower parasitic effects, low power usage and high switching speed. With the technological advancements, Esaki and Spin diodes perform much better than Schottky diode[23].

DIODE BASED RECTIFIER AND MATHCING CIRCUIT [24]

VII. VOLTAGE MULTIPLIER

A voltage multiplier is used to boost the rectifier's DC level. It is a DC-DC voltage converter. Different types of voltage multiplier topologies are studied but the most common voltage multiplier used is Villard and Dickson. This voltage multiplier consist of capacitors and diodes, hence proper selection of multiplier topology is crucial. Voltage multipliers and rectifiers are manufactured using complementary metal oxide semiconductor (CMOS) technology using NMOS and PMOS transistors. The use of CMOS technology lowers the threshold voltage but increases the leakage current. Hence, cascading of various voltage multiplier stages increases the efficiency[25].

VIII. ENERGY STORAGE DEVICES

If the harvested energy is greater than power consumed by the sensors, the energy harvesting system can feed the load continuously. The highest power conversion efficiency can be obtained only at specified load resistances. As a result, the load resistance of the energy harvesting circuit should be as low as possible. Super capacitors and batteries are one of the feasible options to store the harvested energy. Supercapacitors have high power density than batteries and conventional capacitors, due to which they have short charging times and good discharge performance. The actual life of supercapacitor is around 20 years as its efficiency depends on charging and discharging. Batteries are an alternate energy storage device. They tend to have higher energy

density than super capacitors and conventional capacitors. Some of the types of batteries used are nickel-cadmium (Ni-Cd), nickel metal hydride (Ni-mh), lithium, and lithium-ion batteries. Furthermore, a novel storage device known as super capattery has recently been developed[26].

2X2 RECTENNA CIRCUIT[27]

RF ENERGY HARVESTER CIRCUIT[28]

Numerous energy harvesting circuits have been developed based on their conversion efficiency, physical dimensions, frequency used, antenna gain and load, and other considerations [29]. When the input power was 0 dBm and the load was 1400, the highest efficiency was 83 percent in a wireless energy harvesting circuit built at 2.45 GHz with antenna gain of 8.6 dBi utilising schottky diode HSMS-2852. Another harvesting circuit with the use of linearly polarized patch antenna employed HSMS-2860 schotttky diode achieved the power efficiency of 78% when the load was 550Ω[25].

In reference, rectenna harvesting circuit employing two stage Dickson voltage multiplier with the use of HSMS-2852 diode and Koch fractal patch antenna operating at 2.45 GHz achieves, the power conversion efficiency of 70% when the load was 13 kΩ. [30] The use of a dual band resistance compression network in a dual band rectifier operating at 0.915 and 2.45 enhanced the power conversion efficiency. Schottky SMS-7630 diode is used and a maximum power conversion efficiency of 65% and 55% are achieved when the load was 1 kΩ.

In [31] triple band rectifier operating at 0.5 -1.0 GHz, 1.5 -2.0 GHz and 2.3- 3.6 GHz is presented. Schottky HSMS-282 diode is employed and maximum power conversion efficiency of 55% is obtained when the load was 50Ω. In [32]quad band rectenna operating at GSM 900, GSM 1800, UMTTS and Wi-Fi frequency band, employing Schottky MSS20-141 diode. Achieves maximum conversion efficiency of 84% when load was 11kΩ. In reference broadband rectifier manufactured at frequency range from 470 MHz- 860 MHz, with the help of impedance matching circuit and SMS-7630 schottky diode achieved the power efficiency of 60% when load was 12.2 kΩ. The utilization of a dual polarized cross dipole antenna was used to design and build a novel broadband rectenna. A novel impedance matching circuit improves the efficiency and DSMS-7630 diode used with two stage voltage doubler circuit achieves the power efficiency of 55% when load was 14.7kΩ[33].

IX. CONCLUSION

In this investigation, an RF energy harvesting system was thoroughly examined. Different blocks of an RF energy harvesting circuit based on their efficiencies and losses are studied. Different parameters affecting the efficiency and performance of an energy harvester are explained. Furthermore, different apologies of rectifiers and voltage multipliers are discussed and corresponding literature reviews are presented. As discussed earlier power density of RF energy is relatively lower than other harvesting techniques but it is sufficient to power wireless sensors and devices. In this study, not only the theoretical concepts but the practical application areas are also highlighted. This technology aims to develop sustainable and green energy to the coming 5G and IOT era. The horizons of these energy harvesters knows no bounds and will continue to evolve in future and will seek its true prosperity in the coming years.

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Review on contactless methods and design of SIW based Leaky Wave Antenna for respiration monitoring

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Abstract— **With the change in lifestyles, emerging stress and physical parameters of environment, health related issues have affected many people throughout the world. An important indicator of serious illness is abnormality in respiration rate. This abnormality leads to asthma, obstructive sleep apnea (OSA) and heart related diseases. This leads to have more accurate and robust healthcare monitoring and diagnosis facilities. The detection of respiration rate and vital signs is done through electromagnetic (EM) waves using different types of antennas. In this paper, comprehensive review on current state architectures of contactless methods for detecting respiration rate is presented. For respiration monitoring using EM waves, the frequency 10 GHz is suitable as it is in non-ionizing spectrum and in limit of allowed SAR value. On this frequency, the dielectric constant for muscle and skin is approximately equal to 40 thus incident power reflected from the body is more than half of transmitted making the system work efficiently. Different types of antennas (parabolic, horn, yagi-uda, helical and patch) used for respiration monitoring are studied. The limitations of currently used antennas include bulky size of setup, less directional beam which may interfere with other devices leading to errors. Substrate integrated waveguide based leaky wave antenna is proposed with better results as compared to current antennas available for respiration monitoring. Experimental work is carried out for validation of results simulated. Proposed antenna has gain of 9.72 dBi with angular width or HPBW of approx. 37.5°. The simulated s_{11} of antenna is -16 dB. VSWR shows antenna radiation efficiency is 96%.**

Keywords— **Respiration Monitoring, Contactless Doppler radar Architecture, Antennas, SIW, LWA, 10 GHz.**

I. INTRODUCTION

For the observation of human body activity, cardiorespiratory activity is an important parameter. In the current era, due to stress, environmental conditions, changes in lifestyle and eating habits the world is suffering from many diseases like asthma, apenoa, heart attacks and problems related to respiratory disease which leads to one of these diseases. A respiratory rate of 12-15 breaths/minute is considered to be normal for an adult. Patients suffering from these diseases are more prone to failure of respiratory activity. Also, the failure cannot be predicted in advance so in minutes the condition may take life of patient. In, India for the age group of 25-69 years, about 25% of deaths occur due to cardiovascular disease. [1] Real time and proper monitoring of respiratory activity is done for such type of patients. Automatic and real time monitoring of vital signs/ respiration is done through contact based and contact less methods. Table 1 shows different methods for respiration rate monitoring .

Table 1. Respiration monitoring approaches

Method	Method type	Sensor Placement
Manual Counting	Contact based	Stethoscope on chest
Electromyography	Contact based	Electrodes on skin of patient
plethysmography	Contact based	Around abdomen and chest of patient
Spirometry	Contact based	Inside oral organ of patient
LASER [2]	Contactless	Off body of patient
Ultrasonic [3]	Contactless	Off body of patient
Temperature [4]	Contactless	Off body of patient
Electomagnetic based [5-10]	Contactless	Off body of patient

The disadvantage with contact based respiration monitoring methods like Electromyography, plethysmography and spirometry is that they have limited mobility, bulky, inconvenient and cause distress, irritation, discomforts especially for babies and critically ill or burned patients. In LASER based approach, the design has the limitation of removing clothes of patient for respiration monitoring, also the skin has to be trated with zinc ointment. In Ultrasonic based approach, the waves has to be concentrated on head of patient which limits the continuous monitoring if patients sleeps on side. For temperature based approach, the sensor has to be placed near the nose of patients which makes it inconvenient for patient. The Contactless monitoring of respiration and heart beat rate is more convenient and accurate using electromagnetic (EM) waves. [11] the EM waves also offers other advantages

like covertness, large throughput, coexistence with current radio services and robustness to jamming. The respiration rate for EM based methods is extracted through Doppler Effect generated by respiratory activity which changes the size of chest or abdomen. Figure 1 shows change in chest size due as rib cage expands as rib muscle contracts during inhaling activity and rib cage get smaller as rib muscles relax during exhale activity.

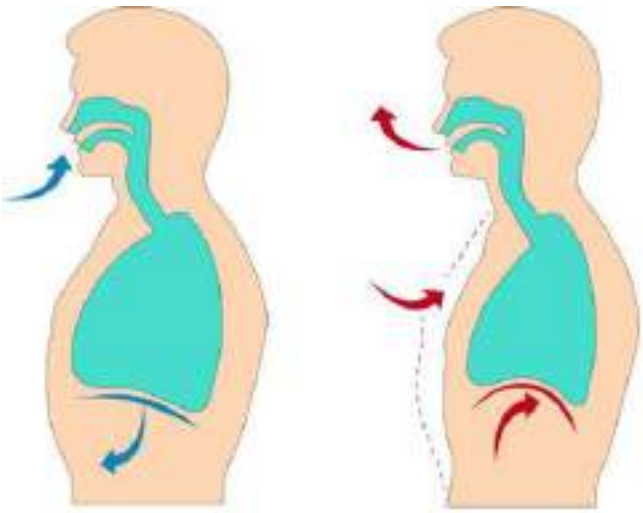

Figure 1. Effect of respiratory activity on chest.

The transmitted frequency of electromagnetic (EM) wave is usually unregulated, unlicensed industrial scientific medical (ISM) band. Genrally 5.8 GHz, 10 GHz or 24 GHz. [12] Many researchers proposed monitoring of respiratory activity at 10 GHz frequency. [13-18] Respiration monitoring at 10 GHz is better because the dielectric constant of muscle and skin is about 40 and at this frequency the reflected signal from the body back to antenna is more than half of its transmitted. Hence the detection of respiration and vital sign like ECG is more convenient. [19] The other advantage of 10 GHz frequency is it comes in non-ionizing spectrum. Another use of 10 GHz frequency is precise ablations as this frequency create shallow penetration of energy and is ideal for surface based treatments too. 10 GHz frequency can also be used to coagulate bleeding in organs such as the spleen and liver.

II. CONTACTLESS RESPIRATION MONITORING DOPPLER RADAR ARCHITECTURES

Doppler principle is used for retrieving respiration rate. The signal is sent towards the target. The information for respiratory rate or cardiac activity can be extracted from phase modulated signal received from periodic movement of chest or abdomen. The modulation in phase of received signal is measured to estimate respiration rate. When target has time varying position, the received signal is phase modulated in proportion to variation in target. The architecture and configurations for Doppler radar is explained as

U. Heterodyne and homodyne Architecture

Heterodyning is mixing or combining of two radio frequencies to create a new frequency called heterodynes. Two separate local oscillators (LO) are used for transmission (Tx) and reception (Rx). At receiver section, the received signal (signals received back from body) is first filtered by band pass filter (BPF) followed by mixing the signal with local oscillator with different frequency. The mixed signal is again filtered by second band pass filter and then provided to low noise amplifier and then demodulated using baseband demodulator [20, 21]. Figure 2 shows heterodyne transceiver architecture.

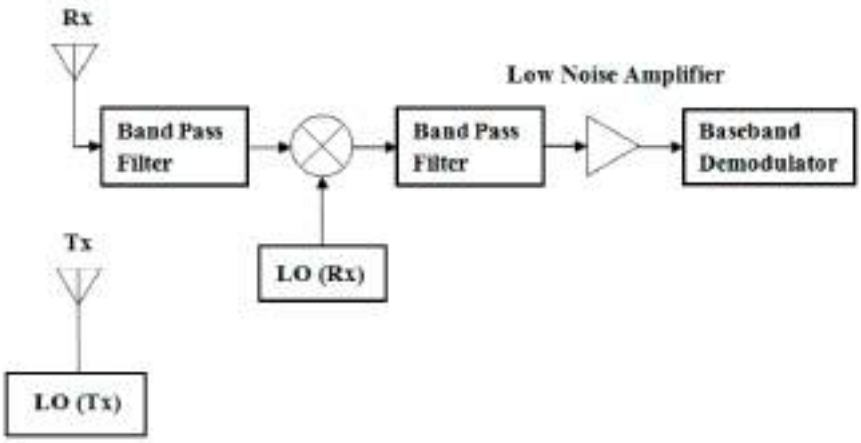

Figure 2. Heterodyne Architecture

Homodyne is also known as synchrodyne, direct conversion receiver (DCR) or zero-IF receiver. One local oscillator is used in the system and received signal is mixed with same frequency as carrier. The signal is then provided to baseband band pass filter followed by low noise amplification. Then it is demodulated using baseband demodulator [22, 23]. Figure 3 shows homodyne architecture. Table 2 shows the comparison of both approaches

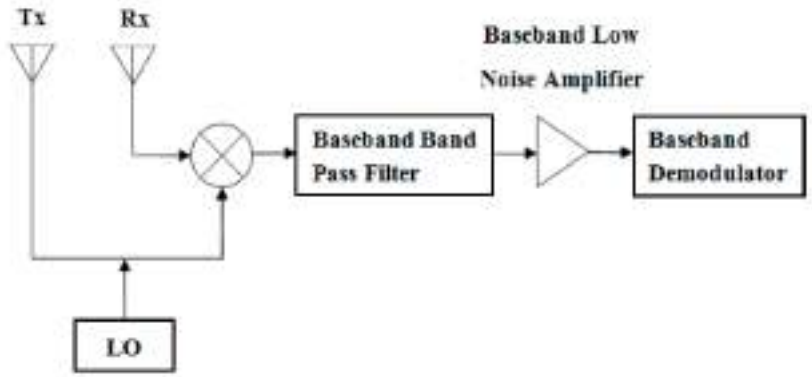

Figure 3. Homodyne architecture

Table 2 heterodyne v/s homodyne.

Architecture	Advantages	Disadvantages
Heterodyne	• Different received frequencies can be converted to same intermediate frequency (IF) • Circuit is easy to implement	• More passive components in circuitry • Sensitivity is degraded by 3 dB
Homo dyne	• Simple architecture • Highly sensitive	• DC offset introduced by system • PLL is required

V. Continuous Wave (CW) and Pulse Wave configuration

The continuous wave Doppler radar system transmits and receives narrow bandwidth signals continuously. Continuous wave radar has single source which can be used for transmission and reception of signal. Both above explained architecture can be used using CW configuration but homodyne architecture is commonly used with this configuration.

In the pulse wave doppler radar, the transmission and reception of signals requires a switch to pulse. The PW radar configuration has higher bandwidth. For the respiration rate estimation or vital sign extraction, as the target is at shorter range the used of PW configuration is limited to elimination of leakage. The complexity of PW configuration merely affects the performance of monitoring system and does not provide any additional benefit. Continuous wave configuration is particularly appreciated in the industry due to its simple hardware structure and low cost. Table 3 provides advantages and disadvantages of both configurations [24].

Table 3. Comparison for continuous and pulse wave configurations

Architecture	Advantages	Disadvantages
Continuous Wave	• Simplicity • Minimal spread in transmission spectrum • Unambiguous measure velocity of target	• Inability to separate reflections temporally • DC offset and low frequency noise
Pulse Wave	• Instant measure of target range • Strong short range echos	• Ambiguity in both velocity and range measurement

The schematic diagram for detection of respiratory movement for 10 GHz is shown in figure 4. [25] The circulator is used to differentiate received and transmitted signal or antenna pair can be used for differentiation of signal. The received signal is converted to baseband signal which is directly proportional to periodic displacement of chest during respiration of patient. For the setup homodyne architecture and continuous wave configuration is used.

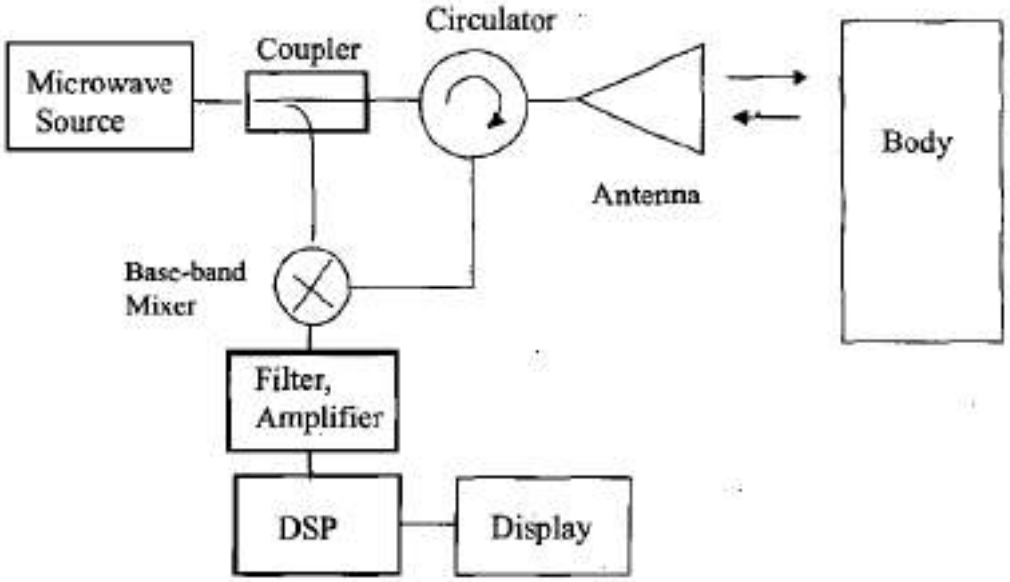

Figure 4. Setup used for respiration monitoring using 10 GHz EM Wave

The Doppler shift in frequency in general is expressed as

$$f_d(t) = \frac{2f}{c} v(t) = \frac{2v(t)}{\lambda} \quad (1)$$

Proportional to the displacement, the time varying phase shift can be expressed as

$$\phi_r(t) = \frac{2f}{c} * 2\pi x(t) = \frac{4\pi x(t)}{\lambda} \quad (2)$$

The transmitting signal can be expressed as

$$T(t) = A_T \cos(2\pi f t + \emptyset(t)) \quad (3)$$

Where A is amplitude of signal, f is frequency and $\emptyset(t)$ is phase

Denoting the displacement of target by x(t), the receiving signal can be expressed as

$$R(t) \approx KA_R \cos(2\pi f t - \frac{4\pi d_0}{\lambda} - \frac{4\pi x(t)}{\lambda} + \emptyset\left(t - \frac{2d_0}{c}\right) + \theta) \quad (4)$$

$$\theta = \frac{4\pi d_0}{\lambda} + \theta_0$$

Where K is decrease in amplitude due to reflections and path loss, λ is wavelength of carrier wave, d_0 is distance between the system and θ_0 is phase shift due to reflections from surface of chest.

The demodulated baseband quadrate outputs Q and I channels are

$$Q(t) = V_Q + A_Q \sin\left(\theta_0 + \frac{4\pi d_0}{\lambda} + \frac{4\pi x(t)}{\lambda} + \frac{4\pi y(t)}{\lambda} + \Delta\emptyset t\right) \quad (5)$$

$$I(t) = V_I + A_I \cos\left(\theta_0 + \frac{4\pi d_0}{\lambda} + \frac{4\pi x(t)}{\lambda} + \frac{4\pi y(t)}{\lambda} + \Delta\emptyset t\right) \quad (6)$$

$$\Delta\emptyset(t) = \emptyset t - \left(t - \frac{2d_0}{c}\right) \quad (7)$$

Where A_Q and A_I are amplitude gain constants of channels and VQ and VI are DC offsets of the channels, ϕ is phase noise of system oscillation and y(t) is function of heart which causes change in chest displacement.

In 10 GHz designed architectures for respiration monitoring, the distance between patient (subject) and antenna is kept 1 meter. During literature survey of various EM based respiration monitoring setups, respiratory rate was detected up to 91.52% of accuracy, heart rate was detected up to 91.29% accuracy, and apenea-hypopnea index was retrieved with overall accuracy of 85.8% shown in table 4.

Table 4.Contactless Doppler setups for vital sign monitoring

Measured physiological parameters	Findings on accuracy
Respiratory Rate	91.52% [26-29]
Heart Rate	91.29% [30-33]
Apenea-hypopnea	85.8% [34-36]

III. EXISTING ANTENNAS USED FOR RESPIRATION MONITORING/VITAL SIGN MONITORING APPLICATIONS

Several antennas for respiration monitoring using electromagnetic waves for respiration monitoring have been studied.

A. *Horn Antenna*

Horn antennas are most widely used for the vital sign/ respiration monitoring. Table 5 shows horn antenna used. The limitation of horn antenna is it is bulky in size, large also it makes the complete setup non compact. .

Table 5 Horn antennas used for contactless respiration monitoring.

Type of Antennas	Frequency (GHz)
Horn (Pyramidal) [37]	10-15
Horn (Pyramidal) [38]	12
Horn (Pyramidal) [39]	8.2-12.4
Horn (Pyramidal) [40]	8-10
Horn (Monopole) [41]	3.5
Horn (Double ridge) [42]	2.4-5.1

B. *Patch Antenna*

After horn type of antenna, patch antenna is widely used for respiration monitoring. Table 6 shows patch antennas used for various respiration monitoring setup. The limitation for patch antennas is that they do not provide wide bandwidth and has less directional radiation pattern which may interfere with other nearby devices .

Table 6. Patch antennas used for contactless respiration monitoring.

Type of Antennas	Frequency (GHz)
Patch Antenna [43]	10
Patch Antenna (4 Element Array) [44]	24
Patch Antenna [45]	1.99
Patch Antenna [46]	10
Patch Antenna [47]	2.4
Patch Antenna [48]	10

C. *Substrate Integrated Waveguide Leaky Wave Antenna*

Substrate integrated waveguide leaky wave antenna has advantage of low profile, compact and it offers wide bandwidth as compared with horn and patch antennas. The advantage of beam scanning of siw based leaky wave antenna provides ability to design to scan chest due to its directive beam. The SIW Leaky wave antenna is used for monitoring remote respiratory activity [49] . The size of antenna is $300 \times 55 \times 0.80$ mm, worked on 8 GHz.

D. *Other Antennas*

Other than horn and patch antennas. Parabolic [50], helical and yagi-uda antenna is also used for respiration monitoring setup. For comparisons, in a study, horn antenna has dimensions of $284 \times 184 \times 252$ mm [51] and the gain of antenna is 10 dB. In, another study, helical antenna is used for vital sign measurement which also has large size as shown in figure 5 [52] gain of antenna is 6dB.

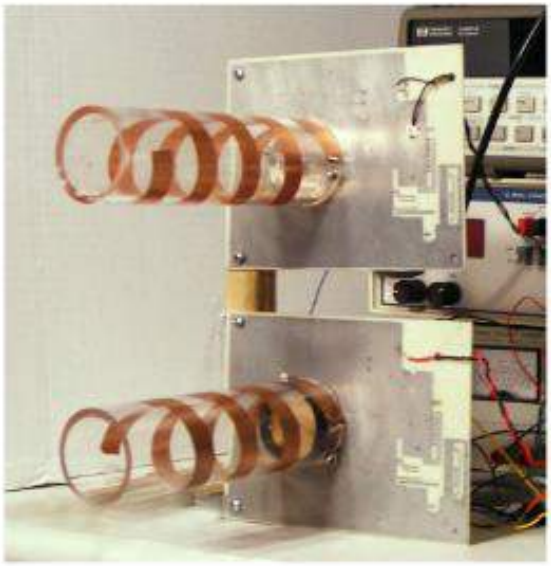

Figure 5. Helical Antenna used for vital sign monitoring

In another study, yagi-uda is used for monitoring vital sign has dimensions 90×50 mm, the gain of antenna is 8.69 dBi and angular separation or HPBW is greater than 120°. [53]. In same study, 2×1 patch antenna is also used with dimensions 137.4×82.7 mm. The antenna has gain of 6.38 dBi and HPBW of around 120°. In another study patch antenna with four element array design is fabricated and used for respiration monitoring in 24 GHz, the gain of antenna is 5.81 dB and HPBW is around 120° . [54] Table 7 shows various antennas used for vital sign monitoring

Table 7. Various antennas for vital sign monitoring

Year	Antenna Type	Size (mm)	Gain (dB)	Frequency (GHz)	Physiological activity measured
1997	Parabolic	600	~ 40	24	Respiratory and Heart rate
2001	Patch	99x107	7.5	1.99	Respiratory and Heart rate
2002	Patch	50x50	5	10	Respiratory and Heart rate
2006	Patch	99x107	7.5	2.4	Heart rate
2009	Horn	Not mentioned	10	5.8	Respiratory Rate
2011	Yagi uda	100x60	Not mentioned	2.4	Respiratory and Heart rate
2014	Patch	60x70	5	5.8	Respiratory and Heart rate
2017	Horn	Not mentioned	6	2.4	Respiratory and Heart rate
2017	Horn	Not mentioned	15	10	Respiratory and Heart rate
2017	Patch	97x49	9	10	Respiratory and Heart rate
2018	Horn	90x60x70	17	12	Respiratory and Heart rate
2017	SIW-LWA	300x55x0.80	10	8	Respiratory and Heart rate
2019	Yagi Uda	90x50	8.69	2.4	Respiratory and Heart rate
2019	helical	-	6	2.4	Respiratory and Heart rate
2019	Patch	137.4 x82.7	6.38	2.4	Respiratory and Heart rate
2021	Patch	Not mentioned	5.81	24	Respiratory and Heart rate

The limitations of currently used antennas include large and bulky setup in case of horn, helical and parabolic antennas. The HPBW from the radiation pattern in the study is found 75° for patch type antennas which limits the performance of antennas to be prone to interference due to nearby devices. On other hand, SIW structure based leaky wave antenna has better power handling abilities, lower radiation loss, high density integration, beam scanning ability and comparatively highly directive beam which makes this type of antenna highly suitable as the radiation from antenna can be focused on bed of patient.

IV. DESIGN OF SIW- LEAKY WAVE ANTENNA

During modeling of proposed SIW-LWA structure, firstly linear vertical slots were designed, the design structure is shown in figure 6 . The s_{11} at 10 GHz is around -48 dB as shown in figure 7. The radiation patter in shown in figure 8, which shows butterfly like structure, but the gain of design is 1.4 dB. The main beam is directed towards 30°.

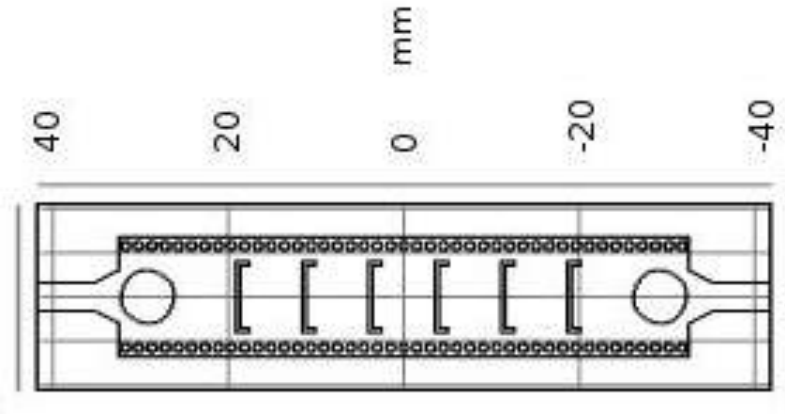

Figure 6.Design of SIW-LWA using linear vertical slots

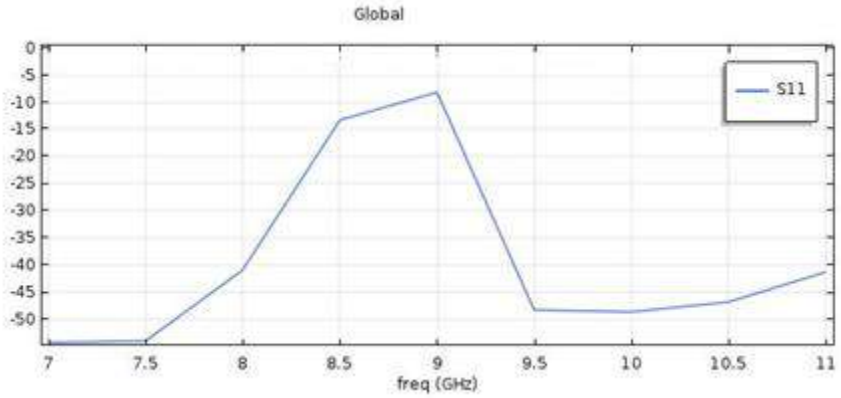

Figure 7. s_{11} at 10 GHz

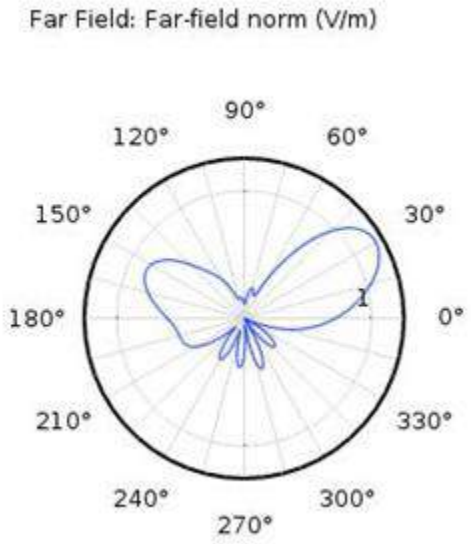

Figure 8. 2D radiation pattern of design

As the design using vertical slots has very less gain, the antenna was re-designed using linear horizontal slots. This is done due to the fact that vertical slots in the structure cut I_x i.e transverse current and the leakage constant of the structure decreases as the frequency is increased. On the other hand, the horizontal slots cut the I_z i.e longitudinal current and the leakage constant of the structure increases when frequency is increased. [55] Figure 9 shows, proposed antenna model of SIW-LWA as top view geometry. The fundamental mode i.e TE_{10} is open within the structure of SIW.

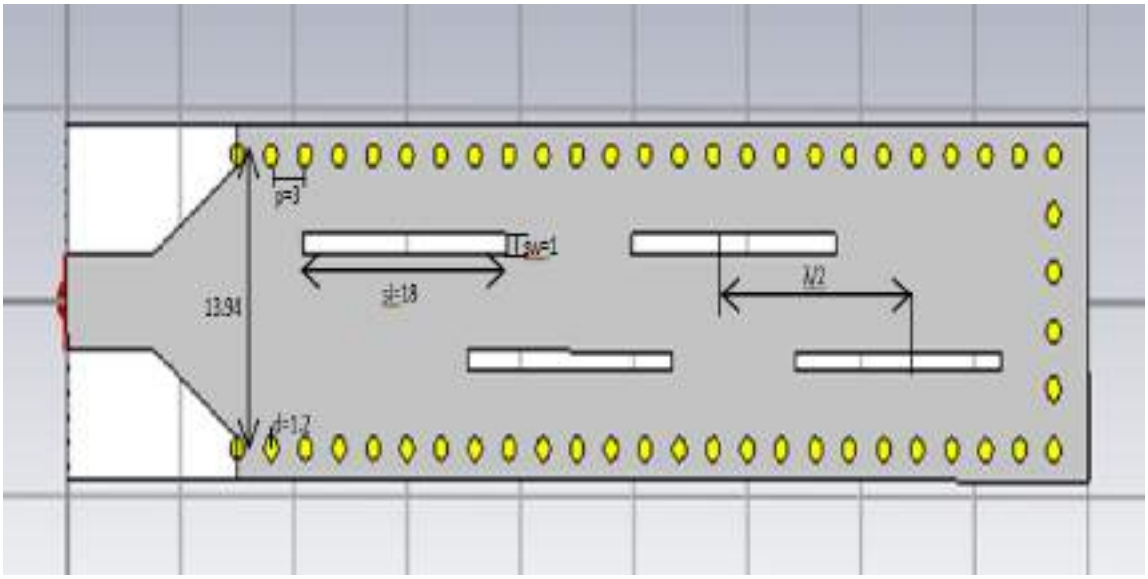

Figure 9. SIW based LWA structure

During modeling of proposed SIW-LWA structure, linear horizontal slots are placed upon the upper metal plane so that the leak of radiation comes from upper plane only. The linear horizontal slots cut Jx transverse current. The slot width does not affect radiation if it is taken less than half of slot length. Beam tilt angle is also decide by slot gap and is considered while modeling the design. We can steer the radiating beam with this. The slot gap is taken as λ/2 and the slots are taken at different length to avoid merging of two slots into one while radiating if taken in parallel. Table 8 shows the design parameters. Figure 10 shows proposed SIW-LWA design in three dimensions (3D).

Table 8. Dimension of Proposed SIW-LWA Antenna structure

Description	Value
Frequency sweep provided	8 GHz to 12 GHz
Microstrip Width	4.8 mm
Diameter of Vias	1.2 mm
Length of SIW	89.99
Substrate thickness (dielectric thickness)	1.55 mm
Effective width of SIW	13.94 mm
Width of waveguide	14.44 mm
Length of horizontal slot	18 mm
Width of horizontal slot	1mm
Gap between the slots	5.5 mm

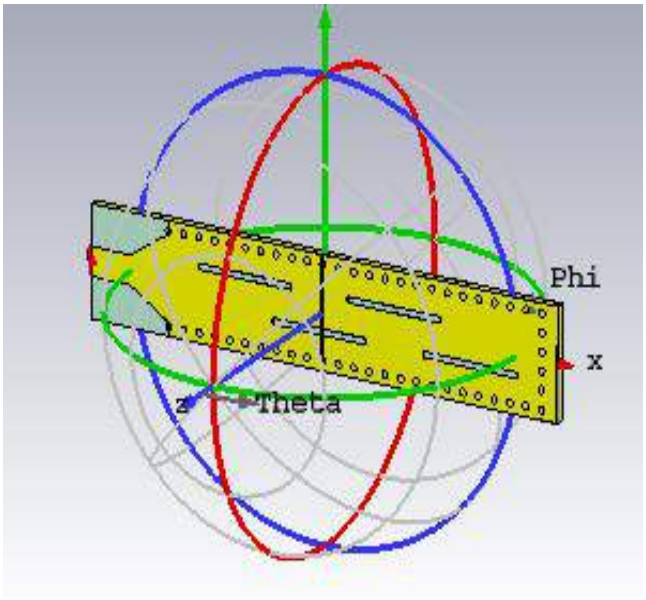

Figure 10. Geometry of designed SIW-LWA

V. EXPERIMENTAL FINDINGS

CST Studio is used to model the design and simulation is done on 4x2.60 GHz processor speed and 8 GB RAM. The electric field gets excited within the structure of waveguide and produces surface current which starts propagating over waveguide walls . Then the electric field radiates over the linear slots on upper plane. RT-5880 dielectric material is used as substrate in the proposed design with relative permittivity is taken as 2.2. The 2-D radiation plot at 10 GHz for RT-5880 dielectric is shown in figure 11. The simulated gain of proposed antenna is 9.52 dBi, main lobe direction is 9°. The 3 dB angular width or half power beam width is 37.5°. It can be observed from the figure of radiation plot that the beam is directive. This type of beam is required from the design as the radiating energy can be focused directly on patient without interfering nearby devices.

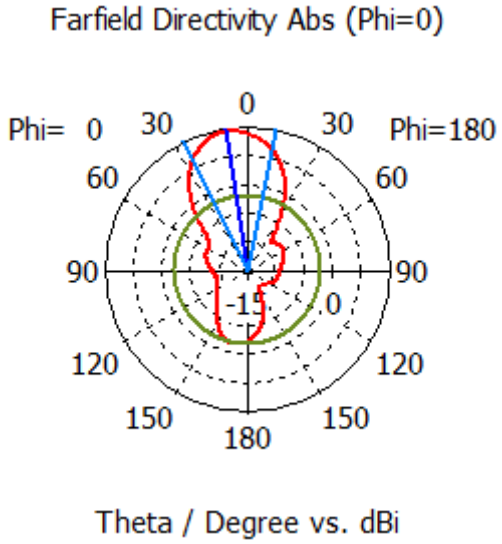

Figure 11 Simulated radiation plot for proposed antenna

The figure 12 shows return loss s_{11} while simulating the proposed antenna. From the plot it can be observed that the design has s_{11} value of -16dB. Figure 13 shows simulated VSWR of proposed antenna. The antenna has value of 5 which means 96% of power is radiated and 4% is returned back.

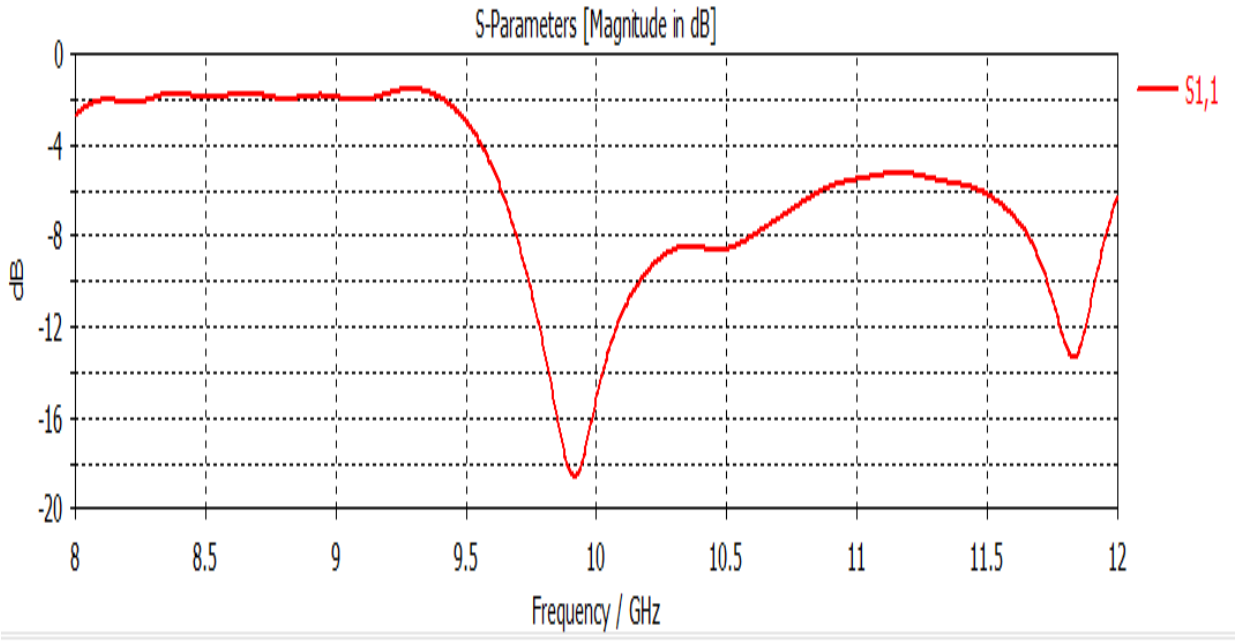

Figure 12. Simulated s_{11} for proposed antenna

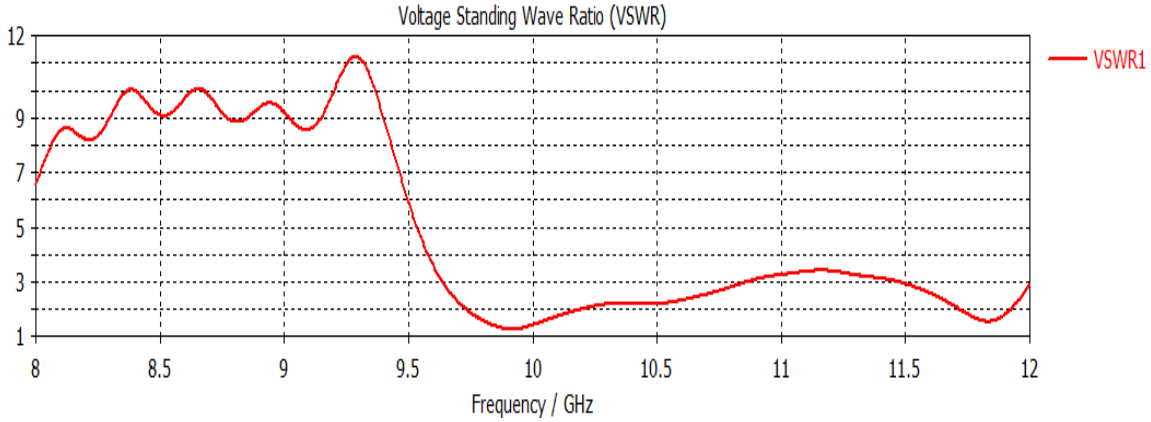

Figure 13.VSWR for proposed antenna

Table 9. Performance comparison of Proposed SIW-LWA

Parameters	**Parabolic**	**Horn**	**Helical**	**Patch**	**Yagi Uda**	**Proposed SIW based LWA**
Size	600 mm	284x184x252 mm	Not Mentioned But Bulky	137.4 x 82.7 mm	90 x50 mm	89.99x14.44mm
Gain	40 dB	10dB	6 dB	6.38 dB	8.68 dB	9.31 dB
Half Power Beam Width	Not shown	Not shown	Not mentioned	120°	More than 120°	37.5°

From the comparison table 9, it can be observed that proposed antenna can work better as compared to previously used antenna for vital sign and respiration monitoring applications as the antenna has better gain, compact in size and better HPBW. The proposed antenna can give better results when integrated with the setup of real time respiration monitoring.

The proposed antenna can also be used for other medical applications like Microwave Ablation [51], DNA Extraction [52], treatment of viruses [53], skin cancer treatment, uterine fibroids, etc other than medical applications for proposed antenna, Mobile and Wireless Community Enablers for the Twenty-Twenty Information Society (METIS) identifies 10 GHz frequency band as potential band for 5G applications [54].

VI. CONCLUSIONS

As the respiratory activity failure is tough to be predicted in advance. This leads to have more accurate and robust healthcare monitoring and diagnosis facilities. A study has been carried out for different architectures used for setups of extracting respiration rate using contactless manner. Different antennas used for same applications have studied and design of leaky wave antenna using substrate integrated waveguide structure is proposed for vital sign/respiration monitoring in contactless manner. The antenna is fabricated, validated and experimental results are compared and analysed with other antenna previously used for vital sign measurement. The proposed antenna showed better performance parameters in terms of gain, HPBW from other currently used antennas studied. When compared in terms of dimensions, proposed antenna is smaller and compact in size. The radiation pattern of proposed antenna is pretty much directional which can provide advantage of eliminating nearby device interference. The proposed fabricated antenna can be used for vital sign/respiration monitoring application. The proposed antenna can also be used for other medical applications like skin cancer treatment, uterine fibroids, microwave ablation, DNA extraction, treatment of viruses etc. 10 GHz frequency is also used for treatment of SARS-CoV-2 virus recently. Other than this the proposed antenna can be used for 5G applications and RADAR applications.

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Hexagon Shape Sierpinski Carpet Wearable Fractal Antenna for Wireless Applications

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***Abstract*— In this paper Hexagon Shape Sierpinski Carpet Wearable Fractal Antenna (HSSCWFA) is designed for wireless applications. The projected HSSCWFA is designed on 1mm thick Jean as a wearable substrate which has dielectric constant value is 1.7. The conducting ground plane of projected HSSCWFA is defected to achieve resonant nearest to 2.4 GHz. The projected HSSCWFA is designed by removing Hexagon shape geometry from the patch. The projected HSSCWFA is planned up to second iteration. The projected antenna is simulated using High Frequency Structure Simulator (HFSS) Software Version 13. The performance of the projected antenna is measured in terms of S(1,1), VSWR, Radiation Patterns and Surface current distribution. The projected antenna resonates at 6 different frequencies (2.42, 5.26, 5.82, 7.62, 7.86 and 9.16 GHz) working at 1 to 10 GHz frequency range. At these six different resonant frequencies the project antenna gives acceptable value of VSWR and stable radiation patterns.**

Keywords*— *Hexagon, Sierpinski, Wearable, Jean, VSWR

I. INTRODUCTION

In research foundations wearable telecommunication become famous starting around 1997. There are three types of wearable communications standards i.e. on body, in body and off body. Wearable antennas are in on body communication standards because body worn devices communicate with base units. For the design of wearable antennas the first preference is to choose the wearable substrate material [1-5]. Wearable textile materials are divided into two categories i.e. conducting and non-conducting materials. Zelt, Polyester, Flectron etc. are conducting materials, while Silk, flannel fabric, fleece are non conducting materials. For selection of textile substrate material we have to gain knowledge about the properties such as permittivity, dielectric loss tangent and bulk conductivity etc [6-11].

The simple microstrip patch antennas have limitations such as less bandwidth, small no. of resonant frequencies, less efficiency and big size. To reduce these limitations fractals antennas are designed [12-15]. Webster's dictionary define a fractal "derived by Latin word 'fractus' that means broken or uneven into various irregular shapes or curves and that shape or curve repeat itself at any scale to which it is examined." Fractals geometries are normally independent of scale and self-similar. There are many types of fractal geometries such as Sierpinski Carpet, Sierpinski Gasket, Hilbert Curve, Meander Curve and Koch Curve etc. In this manuscript Sierpinski carpet approach is used to design [16-21].

Osam M.A.R. [22] et al. proposed wearable textile antenna for monitoring medical applications. This antenna is Ultra-Wide Band (UWB) made of fully textile materials like as substrate and the conducting parts of the antenna. This compact size antenna has 17 GHz bandwidth. This antenna has properties like washable and flexible. The antenna performance is measured in phrases of bandwidth, return loss, radiation pattern, gain, efficiency and current distribution. Survase S.C. et al.[23]presented design and simulation of wearable antenna for application of telemedicine. The design of this antenna includes microstrip yagi patch antenna. Software HFSS is used for design and simulation for the planned antenna. This antenna gives improved return loss value and small front to back ratio. Singh A.G. et al.[24] presented wearable antenna is modified as microstrip fed dielectric resonator. Dielectric resonator antenna makes the logo application in clothing apparels. The work has been done by using the ansoft HFSS 13.0 software. This antenna has a broad frequency range from 5-6.24 GHz. The analysis of this antenna is made on four different substrates jeans, polycot, wash cotton and polyester materials. Afridi A. et al. [25]presented dual band planar dipole wearable antenna using the metamaterial. The dual bands are on 2.4 and 5.8 GHz frequency. The both antenna performance is compared and investigated under different conditions of bending of human leg and arm of different radius. The design of antenna is so obtained to reduce specific absorption rate and to improve the gain to 4.45 dBi. This proposed antenna is analyzed and simulated in computer simulation technology microwave studio.Gil I. et al. [26] presented a Planar Inverted F Antenna (PIFA) is implemented on substrate of jean for network of wireless body area. This antenna is made by sandwiching the ground plane by two substrates of jeans material which require 50×16 mm area. This antenna operates on frequency 2.45 GHz and has a gain 1.98 dBi with 29.1 % efficiency.

II. PROJECTED HSSCWFA DESIGN

Al The projected HSSCWFA is designed over jean textile substrate having dielectric constant 1.7, height 1 mm and dielectric loss tangent 0.025. Above the substrate there is a conducting Patch and below the substrate there is a conducting defected ground

plane. The ground plane is defected to achieve the antenna resonance at desired frequencies. The 50 ohm microstrip line feed of width 4mm and length 3mm is used to excite HSSCWFA. The projected HSSCWFA design is shown in figure 1. Hexagon geometry is selected for the design of Sierpinski carpet. For the design of base iteration firstly the antenna design parameters are calculated by using transmission line model equations from 1 to 4

$$W = \frac{c}{2f_r\sqrt{\frac{(\varepsilon_r + 1)}{2}}} \quad (1)$$

Where W = width of the patch
f_r= resonant frequency
c = velocity of light in free space
ε_r = dielectric constant.

$$\varepsilon_{reff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{-1}{2}} \quad (2)$$

Whereε_{reff} = effective dielectric constant
w = width of the substrate
h = height of the substrate:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff+0.3})\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff-0.258})\left(\frac{W}{h} + 0.8\right)} \quad (3)$$

Where ΔL= extension in patch length.

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \quad (4)$$

Where L = patch length.

For the design of base iteration the patch is divided into equal nine segments and then in the middle segment hexagon shape of side length 7.5mm is removed from the patch. For the design of next iterations this procedure is applied again on the remaining segments. Table 1 shows the dimensions of design parameters of the projected antenna.

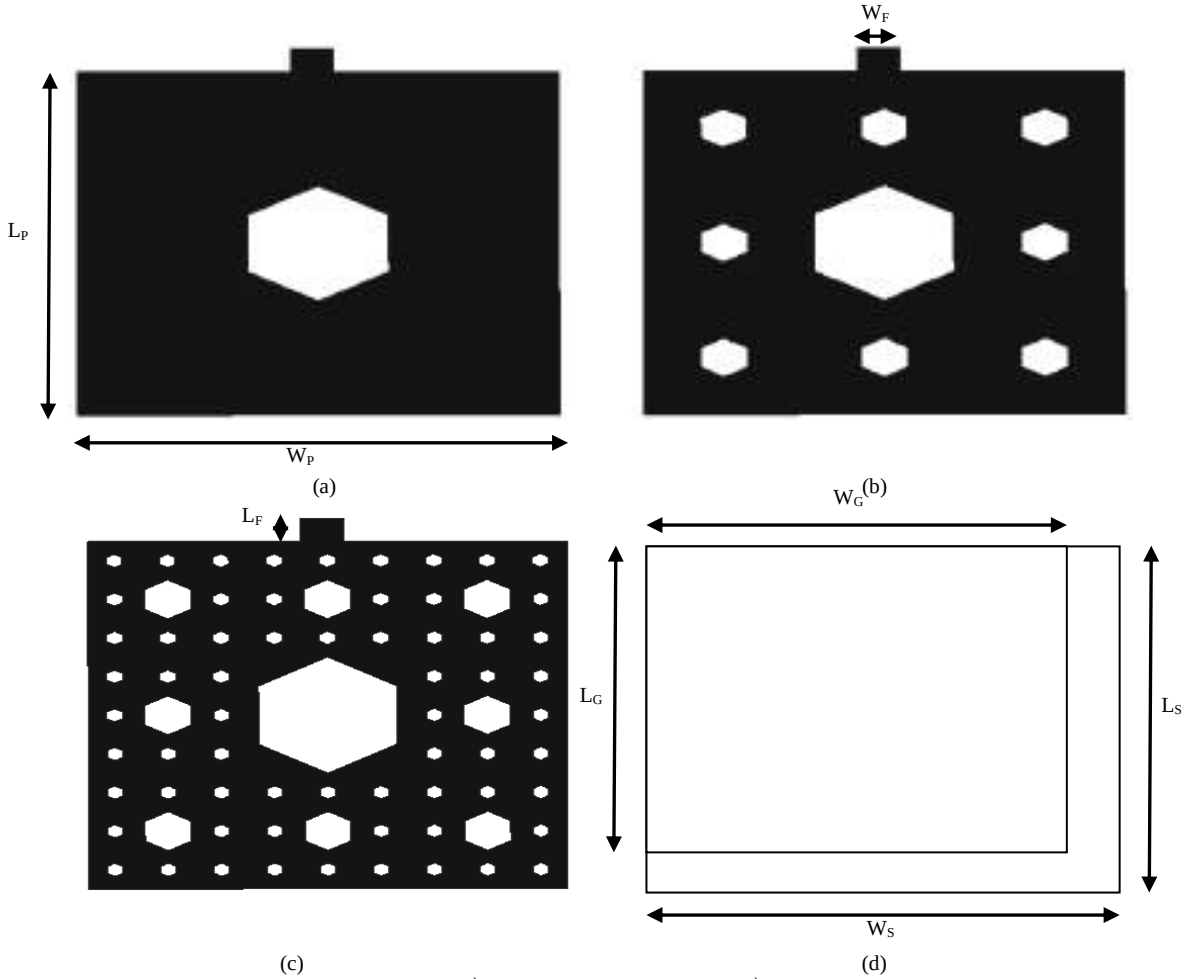

Fig. 1 Design of HSSCWFA (a) 0th iteration (b) 1st iteration (c) 2nd iteration (d) defected ground plane

TABLE VIII
DIMENSIONS OF THE PROJECTED ANTENNA

Parameter	Size in mm
Width of Substrate ($W_{S)}$)	51
Length of Substrate ($L_{S)}$)	51
Width of Patch ($W_{P)}$)	45
Length of Patch ($L_{P)}$)	45
Width of Ground Plane (W_G)	45
Length of Ground Plane ($L_{G)}$)	45
Width of line feed ($W_{F)}$)	4
Length of line feed (L_F)	3
Side length of hexagon in 0^{th} iteration	7.5
Side length of hexagon in 1^{st} iteration	2.5
Side length of hexagon in 2^{nd} iteration	0.83

III. RESULTS AND DISCUSSION

The projected HSSCWFA is designed and analyzed in HFSS software in this paper. The simulations are carried for HSSCWHFA for frequency sweep ranging from 1 to 10 GHz range. The second iteration of the projected antenna have six frequency bands are examined with centre frequencies 2.42, 5.26, 5.82, 7.62, 7.86 and 9.16 GHz, respectively. The corresponding value of S(1,1) to the resonant frequencies are -17.20, -15.56, -15.38, -17.78, -17.65 and -32.29 dB respectively. The simulated S(1,1) parameter of the projected HSSCWFA is shown in figure 2.

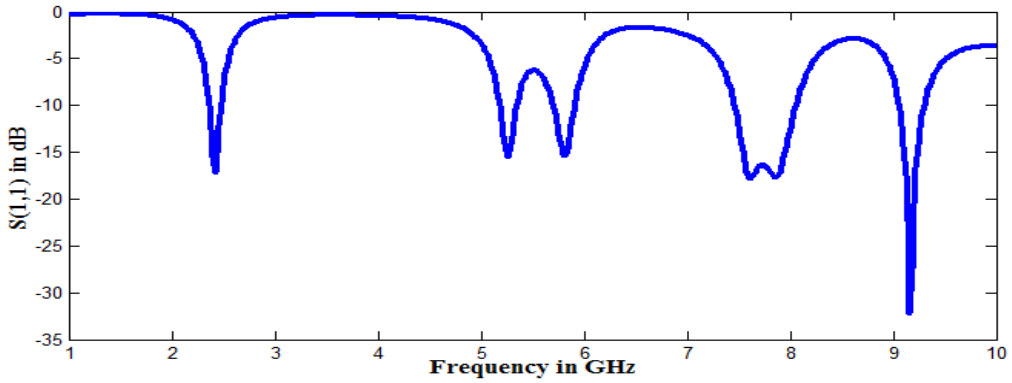

Fig. 2 S(1,1) parameter of HSSCWFA for 2^{nd} iteration

Figure 3 shows the Voltage Standing Wave Ratio (VSWR) characteristics of the projected antenna. Figure shows that at resonant frequencies, the value of VSWR is less than 2. Hence good impedance matching is achieved in the projected antenna.

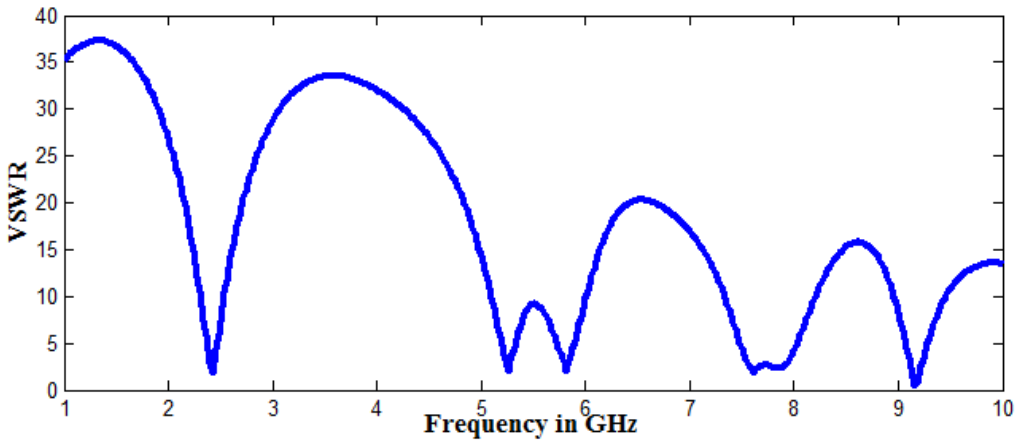

Fig. 3 VSWR of HSSCWFA for 2^{nd} iteration

The simulated surface current distribution of the projected HSSCWFA is shown in the figure 4. It specifies its radiation characteristics and

performance of antenna surface in an effective manner. Figure 4 show that the current flows approximately at all surface area of the patch. Its value is maximum near the feed line and centre of the patch. The minimum value of surface current is observed at the lower side of the patch.

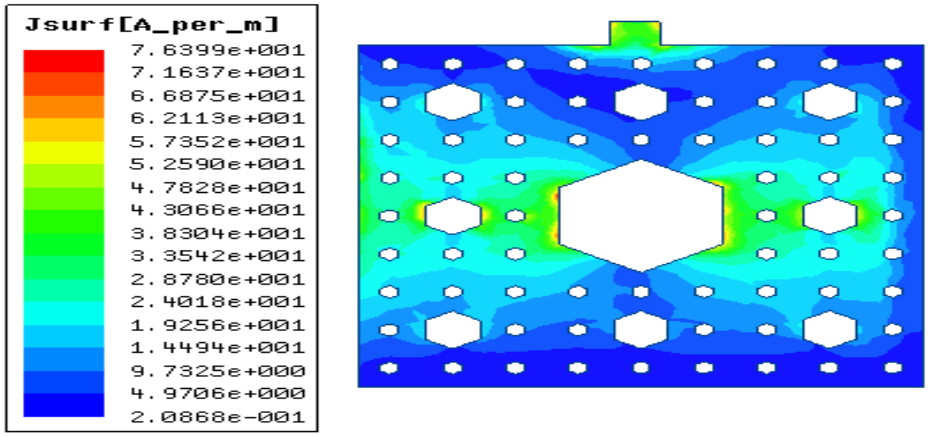

Fig. 4 Surface current distribution of HSSCWFA for 2nd iteration

Figure 5 shows the radiation patterns of the projected HSSCWFA in co and cross polarization at resonant frequencies 2.42, 5.26, 5.82, 7.62, 7.86 and 9.16 GHz respectively.

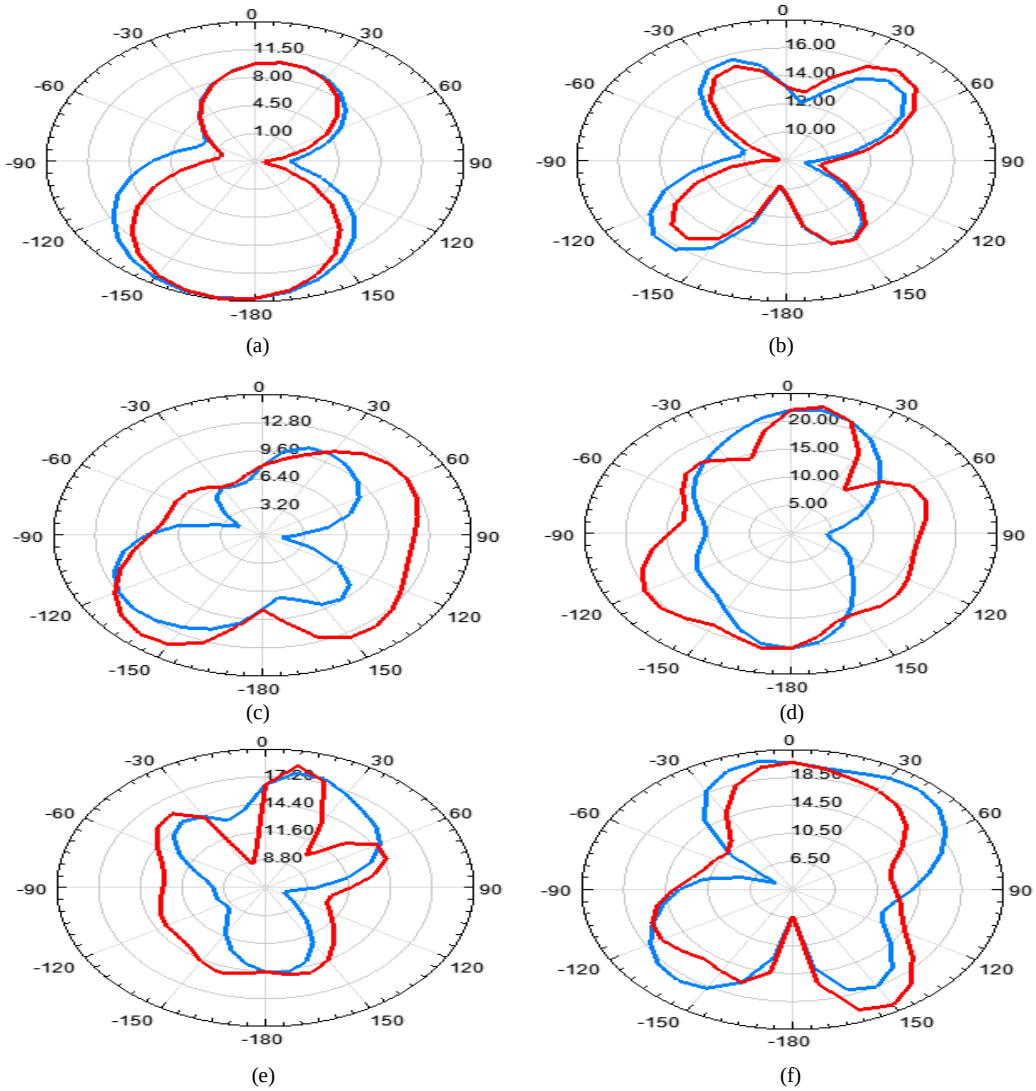

Fig. 5 Radiation pattern of projected antenna (blue line cross-polarization and red line co-polarization) at (a) 2.42GHz (b) 5.26GHz (c) 5.82GHz (d) 7.62GHz (e) 7.86GHz (f) 9.16 GHz

IV. CONCLUSIONS

Hexagon shape Sierpinski Carpet wearable fractal antenna using defected ground plane is presented in this manuscript. The proposed HSSCWFA is designed up to 2nd iteration and 50 Ohm transmission line feed is used to excite it. Parametric model is developed to find the exact feed location for the patch. The proposed HSSCWFA 2nd iteration using defected ground plane resonates at six frequency bands i.e. 2.42, 5.26, 5.82, 7.62, 7.86 and 9.16 GHz with good value of impedance bandwidth and improved S(1,1) parameters. Due to wide range of resonant frequencies the proposed HSSCWFA is suitable for wireless applications such as Bluetooth, WIMAX, RFID, Aircraft Surveillance and radio navigation etc.

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Decrypting the Crypto currency: Is this the right time for Investment in Bitcoin

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Abstract: Digital mindsets and technology transformation is an inevitable want that organizations, businesses and people cannot ignore any longer. Cryptocurrencies and Bitcoin are simply two of the buzzwords everywhere in the news in recent times. Bitcoin and blockchain technology have the potential to revolutionize the means we predict regarding cash, transactions and on-line identity. Cryptocurrency could be an extremely risky investment, however trust issue conjointly associated with its use. Bitcoin could be a currency that no one will influence. Bitcoin involves virtual investment, however not actual investment and acts like investors are gambling. This paper will investigate cryptocurrencies and what they exactly are. It'll conjointly analyze the role of blockchain technology in Bitcoin and its doable risk connected factors. Cryptocurrency is an incredibly speculative and volatile buy. Stock trading of established companies is generally less risky than investing in cryptocurrencies such as Bitcoin. A SWOT analysis of Bitcoin is bestowed, that illuminates a number of the recent events and movements that would influence whether Bitcoin contributes to a shift in economic paradigms.
Keywords: Crypto currencies, Bitcoin, Blockchain, Investment, Risk, Economic value.

The Bitcoin Origin Story

In late 2008, round the time of the money crisis, a ground-breaking post appeared on a little-known net forum entitled Bitcoin: A peer-to-peer electronic money system. It was written by a mysterious person known as Satoshi Nakamoto, a nom de guerre wont to disguise the author's true identity.

Satoshi thought that the banks and governments had an excessive amount of power that they utilized in their own self-interests. Satoshi envisaged a replacement style of cash known as Bitcoin that would modification that: a Cryptocurrency that wasn't controlled or pass central banks or governments, that you just may send anyplace round the world for gratis, with nobody or establishment guilty.

At first no one paid attention to Satoshi's wild concepts – however slowly additional and additional individuals started shopping for and mistreatment of Bitcoin. Several believed it absolutely was the long run of cash, and also the worse the large banks behaved the additional well-liked it became.

Since it absolutely was developed and launched in 2009, Bitcoin has mature to a network of around 10000 "nodes" or participants that use the Proof of labor system to validate transactions and mine Bitcoin.

This democracy was widespread until certain mining computers, known as ASICs, overtook alternative less powerful machines and companies began to take full advantage of their mining and mining technology reserves. It's still doable for a private to require half within the Bitcoin method, however it's costly to line up and also the come on investment fluctuates with the extremely volatile worth of Bitcoin itself.

Today, huge mining pools area unit closely-held or controlled by giant companies and power is integrative once more. This evolution has somewhat undermined Satoshi's original vision for blockchain during which the "power" of participants was designed to be equally distributed - however is currently focused within the hands of half a dozen mining conglomerates.

Trading for profit is a big part of the appeal of these unregulated currencies, with speculators occasionally driving up prices.

"Many companies have created their own currency, also known as a token. This is often listed only for the products or services they offer." Look at them as if you were carrying along arcade tokens or casino chips. Crypto currencies work using a technology known as blockchain. Blockchain may be suburbanized technology unfolds across many computers that manages and records transactions.

What are the reasons making people crazy about cryptocurrencies?

Cryptocurrencies are appealing to supporters for a variety of reasons.

- Supporters see crypto currencies like Bitcoin because the currency of the longer term and square measure athletics to shop for them currently, presumptively before they become additional valuable
- Some supporters just like the proven fact that Cryptocurrency removes central banks from managing the cash offer, since over time these banks tend to scale back the worth of cash via inflation
- Other supporters just like the technology behind cryptocurrencies, the blockchain, as a result of it's a decentralized process and audio system and might be safer than ancient payment systems

- Some investors are interested in cryptocurrencies because of their rising value, but they are unconcerned about the curr encies' long-term adoption as a means of exchange.

The aspects that are recurring in all these definitions are that fact that a Cryptocurrency:

- Decentralized network
- Peer-to-peer system
- Uses of internet network
- Uses public-key cryptography style

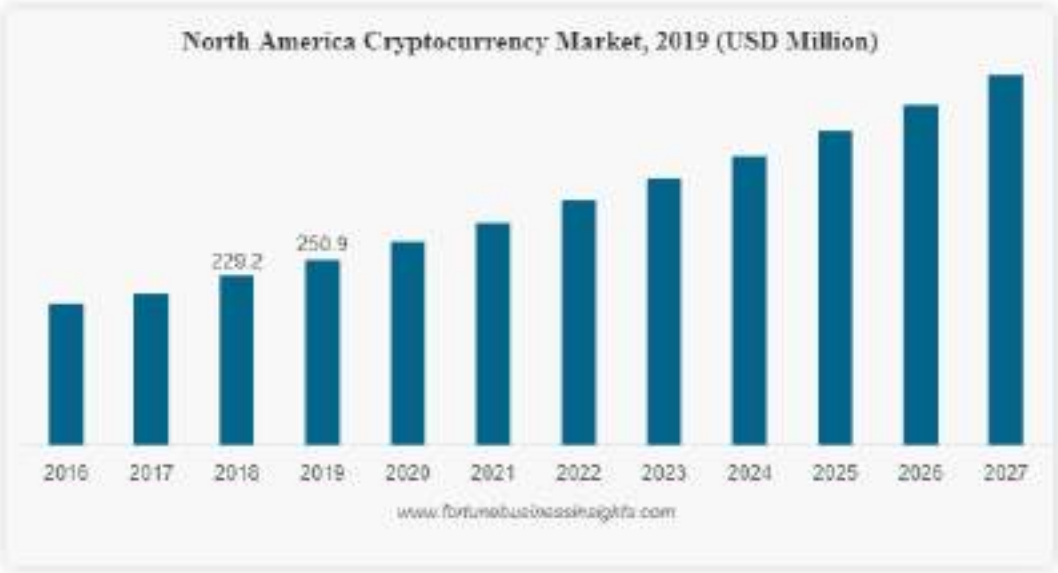
Objectives

The objective of this study is given below:

- To find out the impact of Cryptocurrency on Indian economy
- To review this standing of Cryptocurrency in India and also the future it holds.

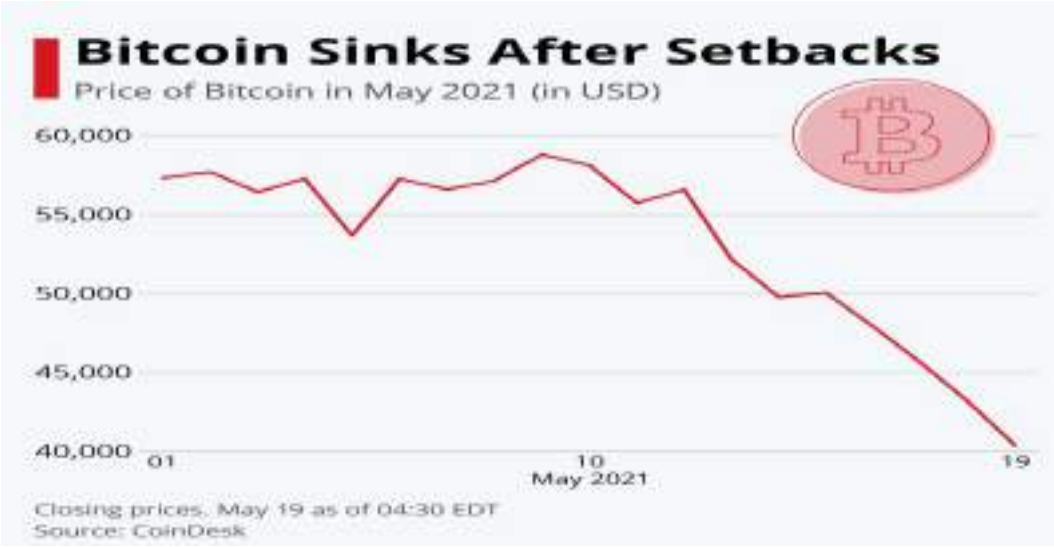
Research Methodology-Secondary data Used for this paper.

Market Trends:


North America Cryptocurrency Market, 2019 (USD Million)
229.2
250.9
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
www.fortunebusinessinsights.com


Percentage of Total Market Capitalization (Dominance)
Zoom 1d 7d 1m 3m 1y YTD ALL
Apr 29, 2013 – May 30, 2021
Percentage of Total Market Cap
75%
50%
25%
0%
2014
2015
2016
2017
2018
2019
2020
2021
Bitcoin
Ethereum
Tether
Cardano
Binance Coin
XRP
Dogecoin
USD Coin
Polkadot
Uniswap
Others

Bitcoin Sinks after Setbacks



Are cryptocurrencies a good investment?

Cryptocurrencies could go up in price; however several investors see them as mere speculations, not real investments. The reason? Similar to real currencies, cryptocurrencies generate no income, thus for you to profit, somebody has got to pay a lot of for the currency than you probably did.

This is known as the "Greater Fool" theory of investment. The difference from a well-run company that raises prices over time by increasing the profits and income of the business.

How to Keep Your Bitcoins Safe

The best way to keep Bitcoin secure is to store your private key in a non-digital format, such as a device or app that is not connected to the internet. If the private key is stored in a location that is not connected to the internet, it is called a cold wallet.

Is Bitcoin Safe?

- The three primary risks related with buying and owning of the Bitcoins.
- Bitcoins value may decrease or increase after you buy your Bitcoins.
- Unauthorized access can be possible after getting key.
- High risk of losing keys that allows accessing the details of Bitcoins.
- Government Regulations.
- Digital currencies are exceptionally volatile

Cryptocurrencies have no fundamental backing

You can look at the earnings history of publicly traded stocks to assess their value, or look at a country's economic performance in terms of GDP growth to assess currencies like the dollar, but digitally. There is no direct basic relationship between currencies. This makes valuing cryptocurrencies in the traditional sense particularly difficult, if not impossible.

Cryptocurrencies are banned in many countries

Cryptocurrencies may be the hottest ones since sliced bread, but they are not accepted everywhere. Due to its unregulated and decentralized nature, some countries have opted to completely ban the use and trading of digital currencies

Conclusion:

Cryptocurrency particularly Bitcoin offers a brand new, effective and engaging model of payment ways which will boost corporations and operators revenues. It conjointly provides different methodology of payment, with the exception of real cash, that permits users to create money activities like shopping for, selling, transferring and exchanging simply. Cryptocurrency will bring a lot of positive changes to e-Business and e-Payment sector but Cryptocurrency doesn't get that abundant of trust nevertheless several considerations, challenges and problems area unit existing in several Cryptocurrency platforms till Cryptocurrency is being well regulated and controlled, users ought to take additional precautions of exploitation such virtual cash that the lack of legislation is taken into account because the main concern in Cryptocurrency systems. The silence of the run batted in on the regulative standing of Bitcoins might influence be damaging. A trade has full-grown around Bitcoins in India- traders, exchanges and merchants World Health Organization settle for payments in Bitcoins. Bitcoins have already gained wide acceptance round the world- thence forbidding them wouldn't be a choice in India. Instead, this trade would wish to be regulated.

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Technological Advancement on Employee Performance – A Study in Private Bank in Bikaner

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***Abstract*: Banking is the section of the economy dedicated to holding financial assets for others, investing those financial assets as leverage to create more wealth, and regulating those assets by government agencies. The world is witnessing an information and technology revolution. This revolution touched all aspects of human life, including the banking sector. The banking sector is undergoing rapid changes to meet the challenges posed by new developments. This revolution has a big impact on the banking sector. Banks in India need to focus on three areas that are important for sustained development, such as technology, customer and consolidation. Advances in technology are enabling the delivery of banking products and services more cost effectively and efficiently than ever, thus creating a new basis for competition. The adoption of new technologies has brought about changes in the banking sector and its impact on officials, employees and customers.**

The purpose of this study is to check the impact of technological advancement on employee performance in banking sector.

***Methodology:* This paper was completed with the help of extensive literature on technological advancement and employee performance available on databases and websites. In this document, primary data was used to verify the impact of technological progress on employee performance. The SPSS 16 software package is used to analyze employee responses and statistical technique Regression analysis is used to verify the impact of technological progress on employee performance.**

***Findings:* A total of 140 questionnaires were distributed to private banks in Bikaner, of which 100 were completed and returned. After analyzing the data very efficiently, we found that technological advancement has a significant impact on employee motivation and training. Motivation has a significant impact on employee performance, but training does not have a significant impact on employee performance. On the other hand, like those interested in technological advancement and employee performance, there is a significant relationship between them.**

Research Limitations / Implications: More research will be require on this theory "Impact of Technological Advancement on Employee Performance in Banking sector"

Type: Quantitative Paper

Keywords: Technology advancement, employee performance, banks

INTRODUCTION

In this modern world of high-tech paid change, technological advancement will further accelerate the future. Technological progress is changing the policies and strategies of companies (Hampel and Martinsons, 2009). In any organization, most challenges are generated by competition, advanced technology, increased efficiency and paid employee growth, new leadership, and management (Madsen et al., 2005). Most research has shown that employee attitudes and behaviors for successful business performance must be developed (Bernerth, 2004).

Most of the companies have included in the management the employee who works in the implementation of technological advances. Companies invest in employee training to improve their knowledge and skills and develop them before adopting new technologies. You must ensure that unions take into account the impact of technological advances on their own physiology. It's clear that employees who worked in both the old and new systems expressed less positive attitudes toward their work, and these attitudes circulated throughout the organization because it became less engaged and more likely to leave. Therefore, companies must motivate employees to adopt new technology and the organization also encourages employees to perform better (Dauda and Akingbade, 2011).

In addition, companies purchase advanced technological tools to improve employee performance, facilitate work tasks, improve communication, increase efficiency, and make work management more effective. The introduction of advanced technology has changed the way of working. Advances in technology improved employee performance and reduced the amount of work and time required to get things done.

New technology is not only essential for business or government, it is also important for the nation. Businesses can't work with old technologies. Technology increases human performance when people or employees use technology for the benefit of the organization and use it with ethical values. A single person cannot easily adopt the technology and, on the other hand, a group of people can easily adopt the technology. The computer is a great invention; It is only useful in that case when employees use it for their work. The new technology can be used for both purposes, to break or to create purpose. The workload of employees is reduced thanks to technological progress. The number of employees to carry out a business is also small. Businesses don't require many more employees to get a job done. Human effort is also reduced through technological progress. A single employee can carry out their work without any impediment.

Human Resources Management uses advanced technological equipment to verify and evaluate employee production or performance. HRM chooses to leverage emerging technologies to increase productivity, and HRM will make the difference between a mediocre HR department and one that is truly a business partner. Current technology trends that will affect HR are outsourcing, technological advancements, and an ongoing focus on measuring the value that HR brings to the organization. The role of the HR professional has changed dramatically due to technology. The key competencies that have been developed are Human Resource Technology Mastery, Strategic Contribution, Personal Credibility, Human Resource Delivery, and Business Insight.

LITERATURE REVIEW

Technological Advancement and Employees Performance

Technological progress is the process of combining and reorganizing knowledge to generate new ideas. The development of technology has an impact on the company's performance (Mumford, 2000). Technological progress comes from internal progress (Pavitt, 1990) and internal progress comes from employee capacity. Therefore, there is a close relationship between technological progress and employee performance (Huselid, 1995). Technologies can lead to higher productivity or better performance only when they are combined with other resources effectively by human resources or when they are performed effectively and use technology productively and ethically (Dauda and Akingbade, 2011).

Advancement makes employees more efficient and firms more efficient (Lawless and Anderson, 1996). Technological progress can also improve business performance (Li and Deng, 1999). Employees can acquire new knowledge more quickly and improve their skills through training, Chi (1989). Employee motivation directly affects technological progress (Hennessey and Amabile, 1998). Employee performance is closely linked to technological progress. Technological progress can be effectively managed through employees.

Resource-based theory suggests that a company's resources are extremely important to the development of the company and that human capital is a key resource of a company. The function of this resource depends on the ability and enthusiasm of the employees and the efficient management of human resources (Mumford, 2000). Technological progress has an enormous influence on employee performance (Nohria and Gulati, 1996). Technological progress is an important factor in influencing performance improvement, Hitt (1997). Most studies have repeatedly demonstrated a positive relationship between technological advancement and business performance and concluded that technological advancement is important for employee performance (Foster, 1986).

Training and Technological Advancement

Training must be present in every organization; training corrects skill gaps known as the time of employee appointment and enables employees to face arising advancement challenges as well. Training not only motivate to employees but also working as a catalyst to doing any new task at work place (Amagada, 2006). Becker (1964) suggests that employee training allows employee to use the new skills. Firm’s employee with more advancement knowledge is important resources of the firms and they are continually attained new knowledge and skill for development of new technology. Training can improve the employee knowledge, competencies of advancement. Advancement involves the production of new ideas and that ideas can be implemented to solve some significant novel problem (Mumford and Gustafson, 1998). Training results, employees can more rapidly acquire new knowledge, and can increase their advancement ability,Chi(1989). Moreover, the people who have broad expertise and knowledge may produce more technological advancement (Mumford, 2000).

Organizations can improve its employee’s skills and competence through training and development. Research shows that investment on employees in the field of decision making, teamwork tasks and in problem solving results shows that firm’s outcome level increases. In some organizations research proves that training is positively correlated with employee output. Training is not short term process. It is nonstop and systematic process. Organizations have done employee’s study and also asses the need of firm. Then specified training program is adapted after that analysis. Organization adapts that method of training which is consistent with employees and as well as fulfil the goals of organization (Singh and Mohanty, 2012).

Training is not only beneficial for employees to enhance their abilities and skills regarding job but also important for organizations to achieve their goals. A skilful human resource cannot be copied. Organizations arrange training programs to augment employee’s skills that are required for doing jobs. One of the main motives of organizations is to produce values and profit for their shareholders by facilitating their customers by providing unique products and high quality services to their customers. To achieve competitive edge over competitor it is necessary for organizations to manage and develop highly skilled workers. For that purpose organizations arrange different types of training programs for their employees. Training programs not only fulfill firms needs to achieve their goals but also meets individuals own desires in the form of money, promotion and being well known in eyes of manager(Sultana, Irum, Ahmed, and Mehmood, 2012).

Due to global environment firms are encountered with different sort of problems that they never faced before. More competencies regarding job are required that are essential for achieving organizations goals. Firms should adopt these changes and furnish them with latest technology and develop their skills to use latest technology (Farooq and Khan, Impact of Training and Feedback on Employee Performance, 2011).

Technologies advancement to change the work nature and work task as well so employee requiring new knowledge and skill to doing the new task effectively. Training is one of effective strategy to give the new knowledge and skill to employee to doing a job effectively (Goldstein and Gilliam, 1990).Most recent studies shows that organization face two factor one is old age workforce second is increasing introduced a new technologies, so training is very important for further new technology introduction as well, such as webbased operation, computerized intelligent systems, and other task technologies, Colquitt (2000).

Motivation and Technological Advancement

Motivation is defined as a change in behavior that is not attributed to stable individual differences. Motivational averaging is characteristic of an individual who is willing to devote efforts to a particular set of behaviors (Quinone's, 1997).

Employee motivation has a direct effect on technological progress (Orpen, 199). The employee requires organizational incentives to improve the advancement process (Harsanyi, 1969). Incentives or employee can be divided into material incentives and non-material incentives; The material incentive is primarily economic gain and the non-material incentive is primarily social acceptance. Material and non-material incentives can meet the diverse needs of employees in technological advancement activities (Gruber, 1996).

Motivation is an inner feeling that comes from within. When employees are motivated towards their work, they are motivated to do more. When a person is not motivated, they can be fired or not be promoted further. For this reason it is necessary to provide a job for employees so that they feel motivated and perform better and better. Research shows that motivated employees play a vital role in the success of organizations. Motivation is an important factor that describes performance. It is a driving force contained by individuals). It is about the behaviors of individuals and people take action to get something that meets their needs (Saeed and Asghar, 2012).

Motivation is very important from an organizational aspect because it transforms human resources into action. And this improves the efficiency level of employees and leads to the achievement of organizational goals. Reasons are the key to human behavior. It plays an important role in performance and other activities and as such the manager needs to know what motivation is and how subordinates can be motivated for performance (Ali, Abrar & Haider, 2012).

Work is not done properly until employees are motivated and provided with a suitable work environment. There are two types of motivation, namely extrinsic motivation and intrinsic motivation. Both types of motivation affect individual performance. Rewards in the form of compensation, bonuses affect extrinsic motivation, while verbal appreciation affects intrinsic motivation. The main factors that motivate the employee to work harder and improve performance are Salary / Bonus, Organizational Culture, Employee Participation, Relationship with Employee Management, Flexible Hours / Working Hours, Promotion (Chintalloo and Mahadeo, 2013). new technologies and changes in new workplaces.

Motivation and Employee Performance

There is a lot of evidence to suggest that making people feel valued and having their contributions important and recognized is the best foundation for a committed and motivated workforce that will do what it can. When employees understand that their achievements and efforts are recognized and rewarded, they will perform better. Our goal is to facilitate a cultural shift in terms of pay and transform the way people are managed, motivating ,employees for success and providing greater clarity about their objectives. Performance improvements and raising standards are key components that contribute to an organization's success and help us ensure that we have the best people in the right roles and that they are motivated to stay (Rudge, 2011).

In this literature, motivation is the variable that can influence the performance of employees in the organization. Here we have another variable which is motivation and we need to check its impact on employee performance if increased motivation or low motivation increases or decreases employee performance in the organization. Impact of motivation on employee performance this is the objective of this research. There are also other variables where each of them has a major impact on employee performance in the particular organization they work in, as well as technology, motivation, management behavior, and the work environment. (Khan, 2012)

Influencing employee motivation is very important to achieve the organization, as individuals predetermine goals. To achieve specific and unmet needs, this internal drive and motivates employees to form positive behavior in the organization that has a fairly positive impact on the work environment. Recognizing employees for their commitment and work in performing their duties, providing them with a healthy and needs-based work environment, building a pleasing work design with this little support from organizations, allows them to achieve their goals efficiently. In this way, performance increases with motivation. (Khan, 2012)

Attention to organizational performance and employee motivation has been working on an in-depth study in recent times. Organizations are more concerned with how to motivate their employees to achieve their mission and vision. In the public and private sectors, organizations are increasingly aware of employees, motivation and increased productivity. Worker Inspiration is a one- management policy to increase the effective functioning of managers and associations. Motivational staff respond quickly and provide guidance for your efforts towards the organization's goals and objectives. Motivation creates a more successful organization, because employees are constantly looking for an empowered and stimulated approach to getting the job done. The staff will do their best even in the most severe cases, it is one of the most stable and greasy challenges of the staff, which can inspire them to be possible.

Many of the biggest challenges facing the organization have moved knowledge away from the accumulation of knowledge, practicing it in the past is a good way to return to effective management practices. Employees are thrilled to accumulate, through knowledge of competitive advantage, what individuals within their organization have given them. People think that if knowledge of the organization provides sources of competitive advantage, it also provides individuals within an organization's competitive advantage. From an employee perspective, companies turn to them to share their desire to acquire positions and financial incentives and the progress they occupy. (Milne, 2007)

Learning to motivate employees is a major challenge for managers. While it's not about directly inspiring others, it's important to know how to influence people's motivation to deal with employees to determine their own well-being and the organization's overall goals. (Milne, 2007) The underlying motivations of the assumption include: the ability to make people act responsibly, naturally aspirated learning and understanding, and a desire to do good work and entertainment. With the evidence-based theory of human motivation, the theory of self-determination (TED) to solve the cognitive, emotional and psychomotor development of

some related basic concerns. Self- awareness, a person's goals and aspirations, psychosomatic and emotional desires, life, personal vitality, cultural and social impact on the environment all determine a person's ability to self- specify and the key issue is at the center of TED. Because motivation takes on a different dimension necessary to consider motivation and self-control of motivation and performance prediction as issues related to motivation. (Ankli and Palliam, 2012)

All areas of behavioral change as a result of power has been a widely reported effort. Deci and Ryan (2002) present the theory of self-determination (TDS), the theory of personality maturity and self-motivated behavioral change. SDT is a theory of cognitive assessment and assessment, which shows the impact of intrinsic motivation of extrinsic motivation. Intrinsic motivation is personal happiness derived from spontaneous activity itself. Extrinsic motivation, on the other hand, requires a physical or oral reward. Satisfaction with the results of the activity itself is not a cause but a consequence outside the event. (Ankli and Palliam, 2012)

Training and employee performance

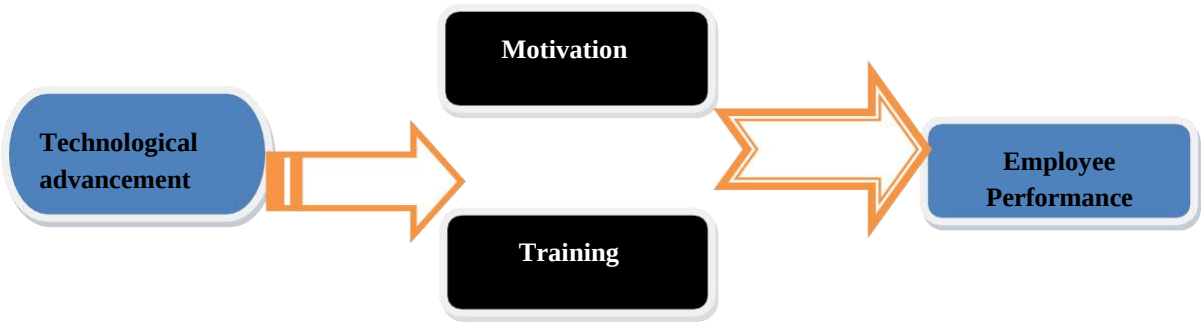
Training helps bridge the gap between employees and top management. It enables employees to participate in decision making and deliver active results in decision making. The coordination of employees with their colleagues, subordinates and with their senior officials increases after training. These types of steps create a better image in front of groups of experts who are working to maximize the value of the organization. More important to the organization, employee performance increases after training. Organizations operating all over the world. These organizations are more concerned about their employees. These types of organizations implement different types of training programs to create value in their employees. Global organizations train their employees on aspects of the workplace. Training not only develops employees' mental capacity, but also after training, employees can benefit physically, as active participation in decision making can free them from mental disorders (Farooq and Khan, 2011).

Employee performance is also related to employee commitment to the organization. High commitment leads to high performance and low commitment leads to low commitment. So, put simply, when employees are so engaged in the organization, we will determine that employee's performance is good. Training improves employee engagement with the organization. Engagement can be defined as employee work for the organization over a long period of time. Training improves the skills of employees who insist that the organization improve employee benefits and compensation. Academics and researchers accept that training increases employee engagement with the organization, but training produces the , desired results only in that situation where employees also accept that training program. It means that the training is only effective when the cooperation of both parties has taken place. Employees enter the training program with high expectations when these expectations are not met; It is the result of low employee engagement and high turnover. Because in case of low commitment, whenever they have the opportunity, they will prefer to leave the organization (BRUM, 2007).

Training has a greater impact on employee performance, but training is not only one factor that affects employee performance, there are other factors that affect employee performance as well. Other factors are employee skills, employee knowledge, motivation and reward. Trained employees are more efficient in teamwork because they are well aware of the expectations of other workers. Employees who follow regular training programs readily accept organizational changes. Whenever the organization launches innovative programs, it resists employees not attending regular training programs. Trained employees help the organization reduce the cost of training other employees. Because when an employee is fully trained, she will be able to train other untrained employees in the organization. Training helps employees perform different tasks in the organization and vice versa. Training is a systematic approach to behavior that allows employees to change their behavior in accordance with the organization's norms and values (Jagero and Komba, 2012).

Training is used to bridge the gap between current performance and desired performance after training. Training can be delivered through different methods such as coaching and mentoring, peer cooperation. This teamwork encourages employees to work harder for the organization. Training is not only useful for employees, but also valuable for the organization. Develop a competitive advantage for the organization in the market. Training develops in the employee's self-efficacy, useful for superior performance (Elnaga and Imran, 2013).

Theoretical Framework



I. HYPOTHESIS

H0: There is no significant relationship between technological advancement and motivation.
H1: There is significant relationship between technological advancement and motivation.

H0: There is no significant relationship between technological advancement and training.
H1: There is significant relationship between technological advancement and training.

H0: There is no significant relationship between motivation and employee performance.
H1: There is significant relationship between motivation and employee performance.

H0: There is no significant relationship between training and employee performance.
H1: There is significant relationship between training and employee performance.

RESEARCH METHODOLOGY

Data Collection

The data for this study are obtained from primary sources. For time reasons, employees from the Bikaner region are used as a research sample. First, the employees were identified and, if they were ready, they completed a questionnaire and collected the necessary data. A total of 140 questionnaires were distributed to various banks, 100 of which were completed and returned. The results are given below.

Results and Discussion

Table:1 **Independent variable: Technological Advancement Dependent variable: Motivation**

	Coefficient (B)	StandardError	T-Ratio	P value	AdjustedR Square
Constant value	.899	.234	3.848	.0000	0.133
Technologicaladvancement	.398	.099	4.031	.0000	

Above table shows there is a significance relationship between technological advancement and motivation. P value shows that Relationship is highly strong between these two variables.

Coefficient value indicate that one unit increase in technological advancement, it will increase .398 points of motivation. Its adjusted R Square value is 0.133 which indicates that a percent change comes in motivation of employees through technological advancement.

Table 2: Independent variable: Technological Advancement Dependent Variable: Training

	Coefficient(B)	Standard Error	T-Ratio	P value	Adjusted R Square
Constant value	.858	.274	3.135	.002	0.220
Technological advancement	.622	.166	5.377	.0000	

Above table shows that there is significant relationship between technological advancement and training. P Value indicates that there is highly significance relationship between these variables. Coefficient 0.622 shows that if one percent change occurs in technological advancement, it will cause .622 percent change in training of employees. Its adjusted R Square value is 0.220 which indicates that a 22 percent change comes in training of employees through technological advancement.

Table 3: Independent variable: Motivation Dependent Variable: Employee Performance

	Coefficient(B)	Standard Error	T-Ratio	P value	Adjusted R Square
Constant value	1.413	.178	7.928	.000	0.039
Motivation	.210	.093	2.247	.027	

Above table shows that there is significant relationship between motivation and employee performance. Coefficient value indicates that if one unit increases motivation, it will be resulted in increment of .210 points of employee performance. Its adjusted R Square value is 0.039 which indicates that a 3.39 percent change comes in employee performance through employee motivation.

Table 4: Independent variable: Training Dependent variable: employee performance

	Coefficient(B)	Standard Error	T-Ratio	P value	Adjusted R Square
Constant value	1.899	.186	10.199	.000	-0.007
Training	-.045	.077	-0.582	.562	

Above table shows that there is insignificant relationship between training and employee performance. P value 0.562 indicates that training does not have impact on employee performance. In other way we can say that our target population performance is not much influenced through training.

CONCLUSION

The study shows that employee performance is influenced by technological advances. Basically, three main variables (technological progress, motivation and training) are used as independent variables to evaluate the performance of employees. In the first stage, technological progress is used as the independent variable and motivation and education as dependent variables. Technological progress has been observed to have a significant influence on variables, motivation and training. That is, we can say that as technology advances, there is a tendency for employees in the banking sector to feel motivated to do their work and that there are more training needs for the skills and knowledge of employees about this particular technology. In the second stage, motivation and education are used as independent variables and employee performance as the dependent variable. And it has been observed that motivation has a significant impact on employee performance, but in addition to caring about employee training, training was found to have no significant impact on employee performance. In other words, we can say that when employees are motivated by their work, they perform better than those who are not motivated by their work, and for training we can say that training does not improve employee performance much influenced. In the third stage, technological progress is used as an independent variable and employee performance as a dependent variable and determines that technological progress has a significant impact on employee performance.

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Overview of Localization algorithms in Wireless Sensor Network

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Abstract— **This paper provides the overview of Wireless sensor network (WSN) in which sensor nodes are placed in huge quantity to monitor various parameters for instance temperature, speed of wind etc. and these nodes have ability to communicate this information to other nodes or to the exterior source where user can access this information. There are various problems faced by WSN such as localization, routing etc. are described in this paper and concept of localization is discussed in detail. Further the classification of localization algorithms on the basis of mobility, anchor and range information, computational model and node connectivity are explained in detail. In addition to this various challenges in node localization such as security, mobility etc. is also discussed in this paper. Moreover, comparison of various localization techniques such as range based and range free, distributed and centralized localization, static and mobility based localization etc. are also presented in this paper.**

Keywords— **Localization, Anchor nodes, Mobility, Distance, Position.**

I. INTRODUCTION

A wireless sensor network (WSN) consists of hundreds or thousands sensor nodes for monitoring and recording conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, sound intensity and pollutant levels. A sensor node is also called "mote" which has small size, low power device and ability to sense, compute and communicate either among each other or directly to an external base-station (BS) [1-2]. A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Sensor nodes are deployed randomly or at pre-planned locations [3].

Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment. Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s) [4-6]. A special node called "gateway", "sink" or "base station" may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data [1, 7].

WSNs can be categorized into two parts Unstructured and structured WSN. An unstructured WSN comprises of group of sensor nodes. Sensor nodes may be randomly located into the field. In an unstructured WSN, network maintenance such as managing connectivity and detecting failures is difficult since there are so many nodes [4, 8]. A structured WSN is one in which fewer nodes can be deployed and since nodes are placed at specific locations to provide coverage while ad hoc deployment can have uncovered regions. The advantage of a structured network is that fewer nodes can be deployed with lower network maintenance and management cost [4, 8].

The remaining paper is organized as follows: Section 2 discuss the various issues in WSN and describe the node localization issue in detail. Section 3 explains the various localization algorithms in detail. The various challenges in node localization in WSN are discussed in section 4. The comparison of various localization algorithms is presented in section 5. Lastly, section 6 describes the conclusions.

II. ISSUES IN WSN

There are various problems faced by WSN such as localization, routing, network topologies, storage capacity etc. Localization is one of the main concerns in WSNs where the exact position of each sensor is computed in bi-dimensional area. There are several issues in localization such as node self-localization, node failure and minimum location error of unknown nodes [9-11]. Routing is another issue for the deployment of a large number of sensor nodes and these nodes are tightly constrained in terms of energy and storage capacities. There are several issues in routing such as limited energy capacity, finding optimal path, coverage rate, delay, synchronization, intrusion detection of sinkhole attack, limited lifetime of sensor nodes, etc. [12-14].

A. Localization

Localization is one of the foremost concerns in WSNs, as information about the sensors locations is supportive in many situations. The major aim of localization problem is to define the particular position of all the sensors in a bi-dimensional (2D) and three dimensional (3D) areas. The process of defining the place of every sensor is to fix the location of every node manually in the network. But the sensors have moving abilities when they deployed in large areas, so this approach is not feasible. The alternative solution is that each sensor can be equipped with a Global Positioning System (GPS) [15]. However, this approach may also not be practicable, due to the high cost and complexity of inserting the equipment in the sensor, as well as great energy consumption and it also increases the sensor size [16-18]. The block diagram of localization process is shown in Fig. 1.

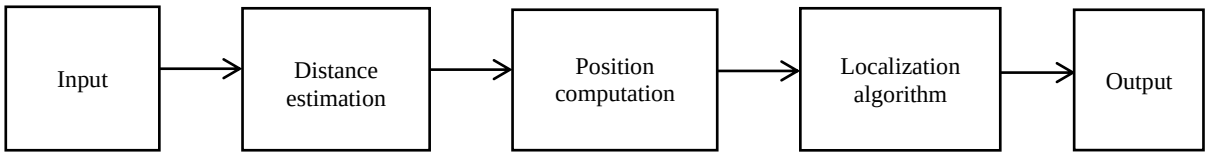

Fig. 16 Block Diagram of Localization Process [16]

The problem of node localization is to discover the locations of every node or the subgroup of wireless sensor nodes. On the basis of input data the process of localization confines the sensor nodes in WSN. If anchor node is available in WSN then inputs to localization process are the positions of beacon nodes and other input depends on the measurement methods [16].

Localization techniques are broadly classified into two types i.e. range based and range free localization techniques. For range free approaches the second input for localization is connectivity information and for range based localization the other input is angle or distance between the nodes [16].

The position of the sensor nodes whose coordinates are not known is found out through localization methods. These nodes are known as Target Nodes. With the help of a few nodes called as Anchor nodes the position of the target nodes can be calculated. To estimate the distance between anchor nodes and target nodes various techniques such as Time of Arrival (TOA), Time Difference of Arrival (TDOA), Received Signal Strength Indicator (RSSI) and Angle of Arrival (AOA) has been used [19-20].

III. LOCALIZATION ALGORITHMS

Every sensor node sends a signal in the wireless sensor network. The receiver nodes will process the signal in order to compute the hops or to find the ranges [19]. On the basis of node connectivity, anchor and range information, computational model and mobility the localization algorithms are classified into five categories which are shown in Fig. 2.

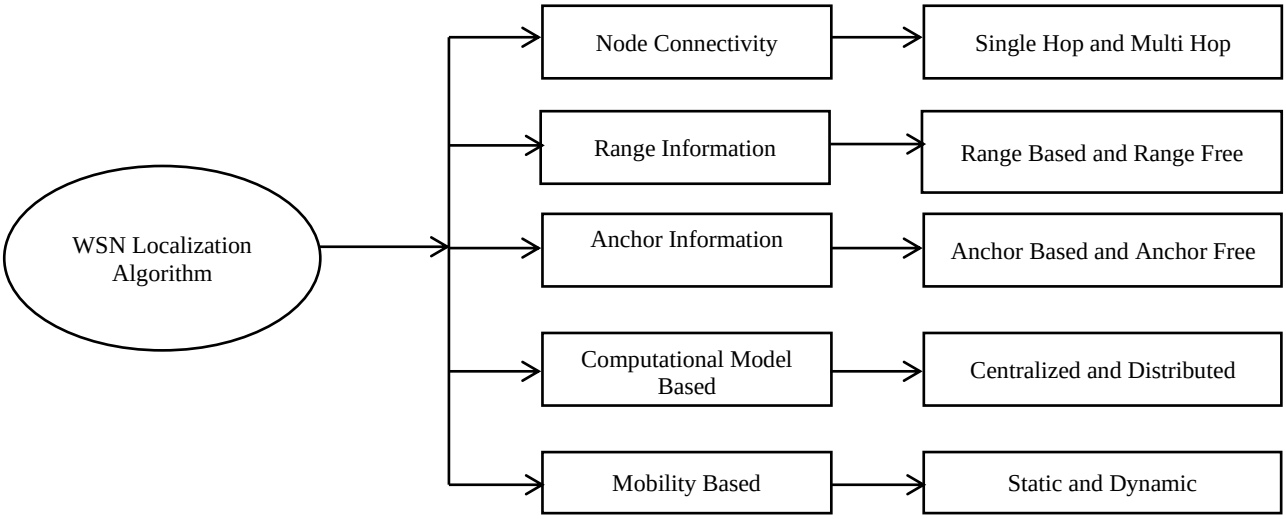

Fig. 2 Classification of WSNs Localization Algorithms [19]

B. Single Hop and Multi Hop Localization

In single hop localization approach the node whose coordinates are not known which is to be localized is one hop neighbour of appropriate number of anchor nodes whose positions are known. TOA, AOA, TDOA and RSSI are single hop localization techniques.

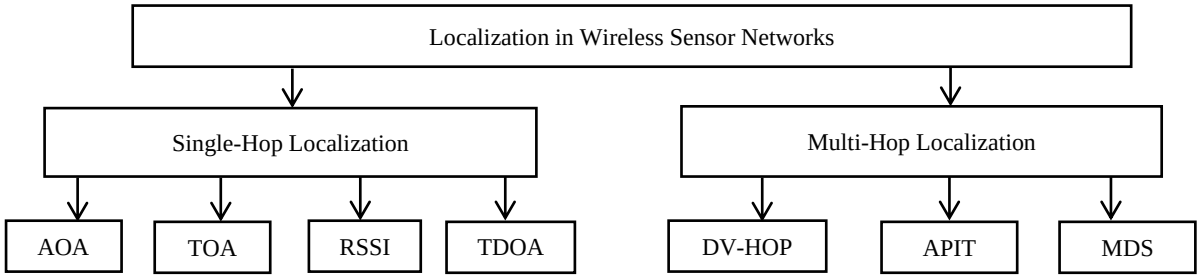

Fig. 3 Localization Taxonomy [19]

For multi-hop localization the target node which is to be localized is not the one hop neighbour of the beacon nodes [20]. Distance vector hop (DV-Hop), approximate point in triangle (APIT) and multidimensional scaling (MDS) are multi hop localization techniques [19]. Various single hop and multi hop localization techniques are shown in Fig. 3.

C. Range Based and Range Free Localization

The information about range is not essential for range free localization techniques [19]. Due to numerous constraints for e.g. cost it is not possible to obtain range measurements. Under these situations, the vicinity information is delivered by the radios which are attached to the sensor nodes and provide satisfactory solutions for the node localization problem in WSN [21]. The connectivity between sensor nodes is mostly used to find the positions of unknown nodes without using any ranging techniques [22]. Several range free techniques which are based on the anchor information are DV-Hop, Centroid MDS and APIT algorithms [19]. The accuracy obtained by range free localization techniques is less as compared to range based localization algorithms [16].

The range information about the anchor node is necessary for localizing the target nodes for range based localization techniques [19]. In range based methods measurements are based on RSSI, AOA, TOA and TDOA. The basic idea is to calculate the Euclidean distance between anchor node and target node with their broadcasting signals by using various methods such as RSSI, TOA etc. For mobile anchor nodes after calculating three different Euclidean distances, to discover the target node location trilateration or multilateration methods can be used [21]. Range based localization techniques calculate the distance between transmitting and receiving nodes precisely by using various distance estimation approaches [16].

Range based localization is classified into four types which are TOA, AOA, TDOA and RSSI as shown in figure 4 [21]. These techniques are discussed in detail as follows:

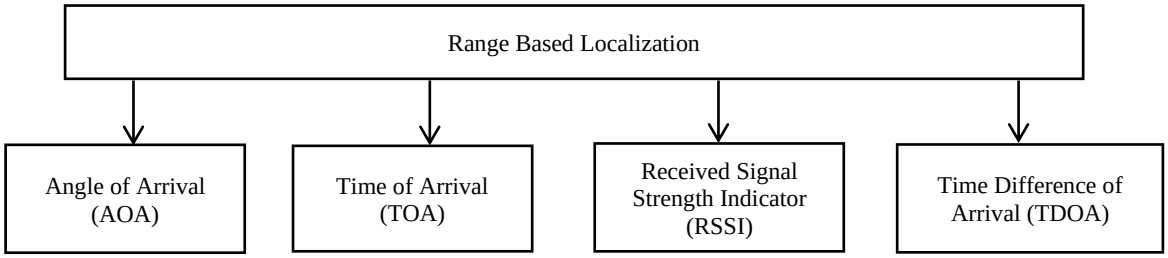

Fig. 4 Taxonomy of Range based localization in WSNs [21]

1) *Time of Arrival (TOA):* For localizing the unknown nodes time of arrival (TOA) approach evaluates the time that the signal takes to reach at various sensor nodes. The requirement of TOA approach is to find out the time at which the signal is sent. Therefore, time synchronization between transmitter and receiver is required in most of the cases [17, 21]. TOA measurement is accomplished in two steps:

2) In the first step the mobile anchor transmits a ranging request which is received by every target nodes in its radio range. In the second step, an acknowledgment is send back to the mobile anchor node by the target node in response to the request message. Before sending the acknowledgment message the sensor node whose coordinates are not known accomplishes a random or schedule back-off in order to avoid the collision [21].

3) *Time Difference of Arrival (TDOA):* Time differences of arrival (TDOA) methods are developed to overcome the disadvantage of TOA technique by removing the necessity to know the time at which the signal was transferred. In TDOA approach, range is computed as follows:

4) The mobile anchor node sends radio frequency signals and ultrasonic signals at regular intervals. Firstly, the radio frequency signal is send by the mobile anchor node. An ultrasonic signal is conveyed after small time period. An unidentified sensor node receives the radio frequency signals and ultrasonic signals and calculates the distance to neighbouring anchor node using the TDOA of radio frequency and ultrasonic signals [19, 21]. The time difference of radio frequency and ultrasonic signals i.e. δ is computed by unknown sensor node. Lastly the distance between the unknown node and mobile anchor is achieved by multiplying the speed of the ultrasonic signal which is normally 1.13ft/ms at room temperature [21].

5) *Angle of Arrival (AOA):* AOA is the angle between the line among the sender, receiver and the reference direction. It is denoted by θ and is defined as the AOA of the incoming massage from sender to the receiver. If the reference direction is not known to the sensor nodes AOA can also be expressed as the angle between two joining lines [19]. The localization approach based on AOA is an ability of measuring the angle of sensor nodes. The location of every unknown node is computed by using the angle of incoming message from target node to at least two anchor nodes. The meeting point of minimum two incoming signal is supposed to be particular position the unknown node [23-24].

6) The AOA based measurements can be achieved from two kinds of techniques i.e. from the receiver antenna's amplitude and phase response. These methods estimate the angle at which the message reaches from the anchor node to the unknown nodes. The area where the unknown node is situated is a line which has certain angle from the anchor node [17]. To determine the position minimum two anchor nodes are required in AOA based localization approaches [25-26].

7) *Received Signal Strength Indicator (RSSI):* RSSI is another kind of range measurement approach which calculates the distances between anchor node and sensor node from the received signal strength (RSS) measurements [21]. RSS measurement evaluates the distance between sender and receiver from the RSS of the signal at the receiver. Many sensors have the ability to compute the RSS. The distance determined from the RSS is a decreasing function [15]. The relation is illustrated by the following equation:

$$P_r(d)[dBm] = P_0(d_0)[dBm] - 10n_p log_{10}\left(\frac{d}{d_0}\right) + X_\sigma \qquad (1)$$

where $P_0(d_0)[dBm]$ is a reference power in dB milliwatts at a reference distance d_0 from the sender, n_p is the path loss exponent that estimates the rate at which the RSS decreases with the distance, X_σ is a zero mean Gaussian random variable with standard deviation σ and it deals with the random effect which is initiated by shadowing. Both n_p and σ are environment dependent. If the model parameters are known in advance, the distance between two sensor nodes can be calculated from the RSS measurements [17, 20 and 25].

D. Anchor Based and Anchor Free Localization

The anchor information is mandatory to compute the coordinates of unknown nodes for anchor based localization while anchor information is not required in anchor free localization techniques. With the help of GPS the anchor nodes know their positions in anchor based localization and relative coordinate are used in anchor free localization for localizing unknown nodes [19].

A small number of nodes called anchors or beacons which are inserted with GPS and it provides global position to the anchor nodes in anchor-based localization techniques. The nodes whose positions are not known gather information from the beacons to find their positions by self-localization. The unknown nodes also cooperate with other target nodes and exchange their mutual location information. Anchor-free localization algorithms do not require the position information of anchor nodes to evaluate the actual location of target nodes [27].

E. Centralized and Distributed Localization

The information exchange between the beacon nodes and target nodes is handled by the individual nodes in case of distributed localization and in centralized localization it is processed by a central processor [19]. In centralized algorithm, all target nodes contribute in network to exchange message with the base station (BS). The centralized algorithm runs on BS and it governs the relative places of the sensor nodes by using that algorithm. The centralized technique has several advantages that it can process huge amount of information with more accuracy and precision. But centralized algorithm is frequently costly to implement and it has data routing complexity, poor scalability and single point of failure [21].

In distributed algorithm, a sensor node is localized by exchanging message with anchors in its neighbourhood. When the density of the anchor is small these nodes can be away from unknown nodes by more than one hop. The network comprising of one-hop neighbours is not sufficient for approximating accurate positions of the target nodes. So for obtaining the more accurate positions, target nodes densities and the method of finding the spatial relation are required for the design of distributed localization techniques [21, 28-29].

F. Static and Dynamic Localization

When the sensor nodes are static or they not moving in the WSN the algorithms which are used for localization are named as static localization algorithms. When the node has certain moving capabilities, the methods which are used to find the coordinates of unknown nodes are known as dynamic localization algorithms [19].

In mobility aided method, a set of mobile anchor nodes coordinate to start the localization procedure. A signal is released by one or more mobile anchor nodes and one or more target nodes detect certain properties of the signal such as phase, received signal strength and arrival time etc. The position of unknown node is calculated by converting the signal measurements into location estimates by using localization algorithm [21]. The disadvantage of dynamic localization is significant localization delay. It is because the target nodes can be localized only when they receive adequate signals from mobile anchor nodes [21].

IV. NEED OF STUDY

There are some difficulties that need to be examined in order to improve the performance of localization process in WSNs [15]. Several challenges for localization are:

1. Location Accuracy
2. Mobility
3. Transmission Range
4. Scalability
5. Security
6. 3-D Localization
7. Energy Efficiency

These challenges are discussed in detail as follows:

G. Accuracy in Calculating Locations

Localization accuracy is defined as the distance between the actual position and estimated position of a sensor node. It is a great challenge to obtain accuracy up to the optimal level or to find the exact position of sensor node while using the localization algorithms. Various optimization algorithms can be used to obtain localization accuracy up to minimum level [19].

H. Localization in Mobile WSNs

The anchor nodes can also be used for localizing mobile unknown sensor nodes [30]. The mobile sensor nodes have several advantageous than static sensor nodes. The mobile WSNs are more flexible as compared to static WSNs and they can be placed in any situation and they required less communication overhead. Therefore, calculating the position of sensor node at regular intervals is an issue which is directed by mobile devices used in WSN [19].

I. Transmitting Range

Transmission range is another significant parameter that affects the performance of WSN localization. Transmission range defines how many anchor nodes will communicate with target node. If the transmission range is increased the number of neighbouring anchors nodes of an unknown node will also increase and it also decreases the localization error, the number of non-localized nodes. So ones need to properly set the transmission range of sensor node and it may be varied to acquire best performance [19].

J. Scalability

The scalability is a crucial feature to validate the localization system. It guarantees proper computation of localization when the wireless sensor network or distribution area becomes larger. The localization systems typically need scaling in two dimensions: geographical scaling and sensor density scaling. Geographical scaling means increasing the area of WSN and in sensor density scaling the number of sensor nodes are increased. But increase in number of sensor nodes results in collision of signals and hence there is loss of information. Therefore, the appropriate size of distribution area is an issue for localization procedure [19].

K. Secure Localization

Secure localization is significant issues of largely organised WSNs. WSNs may be positioned in unfriendly locations and there may be attack on sensor node to interfere with localization process or there may be attack on information so that attacker can alter the localization information which may results in estimating the incorrect location of sensor nodes. So security becomes a challenging task for localization techniques [19].

L. 3-Dimesional Localization

Most of the localization algorithms are developed for 2-dimensional (2D) surroundings. But in many applications such as Space monitoring, study of underwater ecosystem and environmental monitoring etc. the nodes are required to be placed in 3-dimension (3D). So localization in 3-Dimensional (3D) situations is a challenging task [19].

M. Energy Efficient Localization

The foremost design goal of a WSN is energy efficiency because WSNs are resource constrained in nature. If small amount of energy is provided to sensor nodes it bounds the lifetime of the whole network. Since sensor nodes perform various operations such as sensing, communication between node and other applications. So the sensor node should be energy efficient [19].

V. Comparison of Various Localization Algorithms

Various localization approaches have been used in the previous years. The comparison between distributed and centralized localization, static and mobility based localization, range based and range free localization and various range based localization techniques such as TOA and TDOA, AOA and RSSI are shown below:

TABLE 1
Comparison of Distributed and Centralized localization

Sr. No.	Distributed Localization	Centralized Localization
1	Information is managed by each node and decisions are taken locally.	The network formation is controlled by a single device.
2	Interconnection devices are not required.	Interconnection devices are required.
3	Communication is only between neighbouring nodes.	Communication is between sensor nodes and base station.
4	Less energy efficient.	It allows more efficient energy management.
5	Network coverage analysis is complicated.	Network coverage analysis is simplified.
6	It is easy to implement.	It is difficult to implement.
7	There are less chances of failure in the network.	There is single point of failure.
8	It is suitable for distributed applications for example: Self Organized Systems.	It suffers from poor scalability.

The comparison between distributed and centralized algorithm is shown in Table 1. Centralized algorithm suffers from poor scalability and it is controlled by single device. The central device failure affects the performance of entire WSN [19]. Centralized algorithm has several advantages over distributed algorithm such as it is inexpensive, easy to implement and it provides better efficiency. Distributed algorithm can be used in various applications such as Self-Organized systems [21].

TABLE 2
COMPARISON OF STATIC AND MOBILITY BASED LOCALIZATION

Sr. No.	Static Localization	Mobility Based Localization
1	Deployment of nodes is less flexible.	More flexible deployment of nodes.
2	Energy consumption is more.	Less energy consumption.
3	Deployment cost is more.	Deployment cost is less.
4	It required more communication overhead.	Less communication overhead is required.
5	Instalment cost is more.	Instalment cost is less.
6	Localization accuracy is less.	Localization accuracy is more.
7	There is less localization delay.	Significant localization delay.

The comparison between Static and Mobility based localization algorithm is shown in Table 2. Mobile WSNs can be deployed in any scenario and they provide better accuracy as compared to Static localization algorithms [19]. But localization delay is more in case of mobility based localization algorithms [21].

TABLE 3
COMPARISON OF RANGE BASED AND RANGE FREE LOCALIZATION

Sr. No.	Range Based Localization	Range Free Localization
1	Sensor node need to measure physical distance related properties.	Do not involve distance estimation.
2	The euclidean distance between two sensor nodes is calculated by using TOA, TDOA, RSSI etc.	It uses topological information for example hop count rather than range information.
3	It is also known as distance based localization algorithms.	It is also known as connectivity based localization algorithms.
4	Range based approaches are based on 1. Angle of arrival(AOA) 2. Received signal strength indicator(RSSI) 3. Time of arrival(TOA) 4. Time difference of arrival (TDOA)	Range free approaches are based on 1. DV-Hop (distance vector hop) 2. APIT (approximate point in triangle) 3. MDS (multidimensional scaling)
5	Use exact measurements like point to point distance estimate or angle estimate.	Only need the existences of beacon signals.
6	More expensive.	Cost effective.
7	Accuracy is more.	Accuracy is less.

The comparison of Range based and Range free localization algorithm is shown in Table 3. Range based localization provides more accuracy as compared to range free localization but they are more expensive [16]. Range based localization is based on distance measurements or angle measurements but range free localization required the presence of anchor nodes [21].

TABLE 4
COMPARISON OF TIME OF ARRIVAL AND TIME DIFFERENCE OF ARRIVAL

Sr. No.	Time of arrival (TOA)	Time difference of arrival (TDOA)
1	It requires synchronization between sender and receiver.	It does not require synchronization between sender and receiver.
2	It is difficult to calculate when signal was transmitted.	It eliminates the need to know exact time when signal was transmitted.
3	Distance measurements are less accurate.	Distance measurements are more accurate.
4	There is no need of additional hardware.	There is requirement of additional hardware.
5	There is no occurrence of collision.	There is possibility of occurrence of collision and interference.
6	It suffers from non-line of sight (NLOS) error.	It introduced location estimation error in range measurement.
7	TOA increased system complexity.	System complexity is less.

The comparison of Time of arrival and Time difference of arrival based localization algorithm is shown in Table 4. TDOA provide more accuracy than TOA but it needs extra equipment. TDOA overcome the disadvantages of TOA technique. TDOA does not require synchronization and complexity is less as compared to TOA [21].

TABLE 5
COMPARISON OF ANGLE OF ARRIVAL AND RECEIVED SIGNAL STRENGTH INDICATOR

Sr. No.	Angle of arrival (AOA)	Received signal strength indicator (RSSI)
1	At least two receivers are needed to calculate the position.	Evaluate the distances between mobile anchor and sensor node from the received signal strength measurements.
2	High power consumption.	Low power consumption.
3	Smart antennas are required.	No additional hardware is required.
4	Localization accuracy is more.	Localization accuracy is less.
5	AOA is difficult to implement.	It is easy to implement.
6	It is expensive.	Less costly.
7	Spatial separation of antennas leads to the differences in amplitudes, phase and in arrival times.	In free space the received signal strength decrease with square of distance.

The comparison of Angle of arrival and Received signal strength indicator based localization algorithm is shown in Table 5. RSSI provides less accuracy than AOA but it has several advantages over AOA approach such that it is simple, less expensive and consumes less power [21].

VI. CONCLUSIONS

The performance of wireless sensor network is significantly affected by location of sensor nodes in the deployment field. So node localization has important role in WSN. In this paper several issues in WSN such as localization of sensor nodes is discussed. This paper provides the overview of various localization techniques and various issues in node localization process are also described. The localization algorithms are divided into single hop and multi hop, range based and range free, static and dynamic, anchor based and anchor free, centralized and distributed localization techniques. The range based algorithms are further classified as time of arrival, time distance of arrival, received signal strength indicator and angle of arrival and these algorithms are also described in detail. In last comparison of these localization algorithms are also shown in this paper.

ACKNOWLEDGMENT

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Design of a Gaussian Apodized Uniform FBG Sensor for Multi-parameter Sensing and Predictive Analysis using Machine Learning

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Abstract— **Fiber Bragg Grating (FBG) sensors are beneficial for measuring different physical parameters such as temperature and strain among various types of fiber optic sensors due to their multiple advantages like small size, small weight, and immune to electromagnetic interference, etc. In this paper, sensing of multi-parameter has been discussed by using FBG sensor. A Gaussian Apodized uniform FBG is designed using Opti grating software to measure strain and temperature based on the shifting of Bragg wavelength, which is sensitive to both temperature and strain. Effect of Bragg wavelength shift has also been discussed with the changes of temperature and strain. Machine learning models have also been introduced for predictive analysis of Bragg wavelength shift to validate the survivability and reliability of the designed apodized uniform FBG sensor. It has been observed that shifting of Bragg wavelength increases with increasing temperature and strain value. From the designed FBG sensor, the obtained sensitivity for temperature and strain is ± 0.0135 nm / °C and ± 0.0012 nm / μstrain.**

Keywords—**Fiber Bragg grating, Fiber Optic Sensor, Temperature, Strain, Wavelength, Machine Learning**

I. INTRODUCTION

FBG sensors are distributed sensors and widely used to measure various physical quantities like – strain, temperature, pressure etc. Distributed sensors follow a technique that enables continuous and real-time measurement of multiple parameters along the length of a particular optical fiber. FBG sensors introduce many advantages such as, small size, less weight, resistance to corrosive, potential for distributed sensing etc [1]. FBG sensors are also unsusceptible to electromagnetic interference, which implies low signal noise, which can be beneficial for hazardous environments. In this paper, a gaussian apodized uniform FBG sensor is designed to calculate the temperature and strain in various ranges. The changes in Bragg wavelength have also been discussed for the difference in temperature and strain value. FBG sensor operates on the principle of wavelength shift of reflection spectrum, known as Bragg wavelength. Bragg wavelength is sensitive to both temperature and strain. When FBG is attached within a particular structure, the value of the strain-optic and thermo-optic coefficient differs from that of the optical fiber. So, shifting of Bragg wavelength occurs, which can be either left side or right side of the central wavelength. Apodization functions are essential for measuring various parameters as they remove the side lobes from the reflection spectrum. In this paper, the gaussian apodization function has been used to remove the side lobes. It has been observed that the shifting of Bragg wavelength increases with increasing strain and temperature value as Bragg wavelength is sensitive to physical parameters like strain and temperature. A comparative study between two machine learning model has been discussed to perform the predictive analysis of Bragg wavelength shift for the designed FBG sensor. As FBG operates on the principle of wavelength shift, it is essential to study the predictive analysis of wavelength shift of the FBG by using a specific machine learning model. In this paper, Linear Regression and Random Forest models have been used for predictive analysis purposes. It has been observed that the performance of Random Forest is better than Linear Regression for the designed FBG sensor data. Because of the higher coefficient of determination value, Random Forest has been used for predictive analysis of Bragg wavelength shift regarding the temperature and strain.

II. THEORY

FBG is a kind of distributed Bragg reflector that can be used as a sensor device to calculate various physical parameters, e.g., temperature, strain, pressure, displacement, acceleration, vibration, etc. FBG sensor functions on the principle of Bragg wavelength shift. Bragg wavelength is sensitive to the temperature and strain. The Bragg wavelength also depends on the core effective refractive index and the period of FBG grating [2].

A. Working Principle

The working principle of FBG is based on the change in the refractive index in the core of optical fiber towards the longitudinal direction. So, in general, a periodic perturbation in the refractive index of the core region of the optical fiber can signify any FBG. Operation of FBG is based on the diffraction phenomenon by using a particular type of grating structure inside the core region of the optical fiber. The grating can be considered as a periodic structure through which period of grating changes occur in the refractive index of the core of the optical fiber [3].

When an optical signal or light from an optical source incident in the core region of the fiber and propagates through the grating, the grating inside the fiber reflects some portion of the wavelength of incident light. It transmits the remaining portion of incident light [4]. That portion of reflected wavelength is known as Bragg wavelength (λ_B). Bragg wavelength (λ_B) can be written as:

$$\lambda_B = 2\,\Lambda\, n_{eff} \qquad \text{……. (i)}$$

where λ_B = Bragg Wavelength;

Λ = Period of Grating structure;

n_{eff} = Effective refractive index of the core region of the fiber

The effective refractive index can be expressed as:

$$n_{eff}(Z) = n_0 + A(Z)\,.\,\Delta n.\,v.\cos\left(\left(\frac{2\Pi}{\Lambda}\right) Z + \theta(Z)\right) \qquad \text{…… (ii)}$$

where n_0 = Core Refractive index before inscription;

$A(Z)$ = Apodization function;

Λ = Grating Period

Δn = Amplitude modulation of refractive index;

v = Visibility of Fringe

Z = Direction of Propagation along the axis;

$\theta(Z)$ = Chirp function of grating = $\frac{2\Pi}{\Lambda} cz^2$; c = Chirp Parameter

In this work, we have used gaussian apodized uniform FBG where chirp function is not present. So, no chirp means constant period.

B. FBG Design

FBG can be classified as - (i) Uniform FBG (ii) Chirped FBG (iii) Tilted FBG (iv) Super structure FBG (v) Long period grating and (vi) Phase - shifted FBG. In this paper, uniform FBG with constant grating period is used because it can be specified by the periodic perturbation of core refractive index and functions on the basis of Bragg's law. As a result, it can be used as a narrow band reflection or transmission filter. Uniform FBG is the most extensively used FBG, especially for sensing applications. In this paper, uniform FBG is designed by using Opti grating software. Figure 1 shows the structure of uniform FBG. The grating plane for uniform FBG can be located perpendicular to the axis of the optical fiber. Uniform FBG is useful for dispersion compensation, optical filtering in optical communication, and measurement instruments as sensors. Grating is designed to introduce various grating parameters like – grating shape, grating length, grating period, and index modulation. At the same time, focusing on three essential parameters (high reflectivity, narrow bandwidth, and no side lobes) for sensing applications is highly desirable for development of FBG. Profile parameters of single mode fiber are chosen for FBG design slightly based on the corning SMF 28 fiber because it is very much useful to cover various advantages related to so many sensor network applications. Single mode fiber is highly efficient for long distance communication because of low loss. Modes of the single mode fiber have been calculated by using Opti-grating software. Parameters that have been used to design the FBG are shown in Table 1.

Single Mode Fiber (SMF) Profile		Uniform Fiber Bragg Grating (FBG) Profile	
Parameter	Value	Parameter	Value
Core Width	4150 nm	Grating Length	10^7 nm
Core Refractive Index	1.446	Grating Period	536.4792 nm
Cladding Width	8000 nm	Grating Shape	Sine
Cladding Refractive Index	1.444	Index Modulation	0.00011
Central Wavelength	1550 nm	Average Index	Uniform

Table 1: Design Parameters of FBG

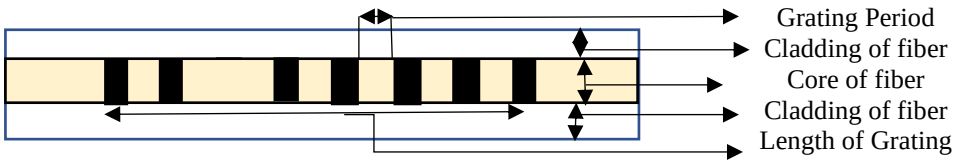

Figure 1: Structure of Uniform FBG

C. Apodization Profile

Apodization profile helps to improve the performance of FBG. The apodization function suppresses the side lobes of the reflected spectrum and group delay response [5]. Side lobe suppression is very much essential for the measurement of temperature and strain. It can also be applicable in the wavelength division multiplexing (WDM) domain for removing cross talks. The existence of the side lobe generally brings down and misuses the overall reflected power. That is why side lobe suppression is essential for measuring different physical parameters such as temperature and strain. This paper uses the Gaussian apodization function to suppress the side lobes [6].

Gaussian Apodization function: $A(Z) = exp\left\{-\ln 2\left[\frac{2\cdot\left(Z-\frac{L_g}{2}\right)}{S\cdot L_g}\right]^2\right\}$

where S = Taper parameter = 0.5 and L_g = Grating Length = 10^7 nm

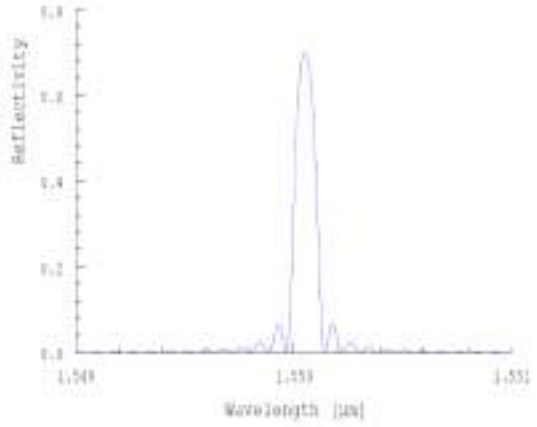

Figure 2(a): Uniform Apodization with Side lobes

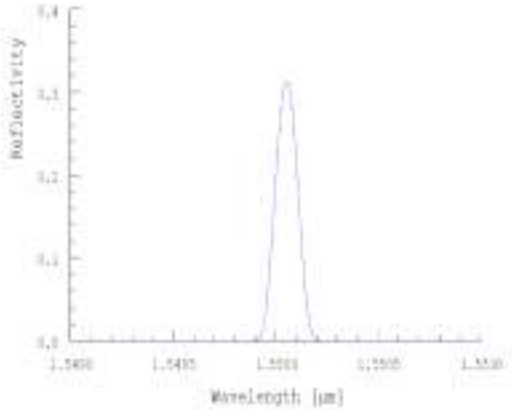

Figure 2(b): Gaussian Apodization with No Side lobes

The above figure shows that side lobes are present in the case of a uniform apodization profile in Figure 2(a). But gaussian apodization (Figure 2b) removes all the side lobes from the reflection spectrum. We can improve the reflectivity of the gaussian apodization profile by increasing the grating length as the grating length is proportional to the reflectivity. So, the gaussian apodization profile is advantageous in sensing applications because it removes all the side lobes, which can be highly desirable to measure the parameter value in a harsh environment.

D. FBG Sensing Mechanism

The fundamental mechanism of the FBG sensor is based on the principle of wavelength shift of reflection spectrum [7]. Bragg wavelength of fiber Bragg grating depends on parameters, including period of grating and effective refractive index according to the coupled-mode theory. Shifting of wavelength will occur either in the left or right side of the central wavelength if the parameters of FBG is affected by any external sensing parameter like temperature, strain etc.

Suppose, a parameter x which can be represented as temperature, strain, pressure. The Bragg wavelength depends on this parameter and is measured by taking differentiation of the Bragg equation (i) with respect to parameter x.

$$\frac{d\lambda_B}{dx} = 2\frac{d(\Lambda\eta_{eff})}{dx} \quad \text{..... (iii)}$$

$$\frac{d\lambda_B}{dx} = 2\Lambda\frac{dn_{eff}}{dx} + 2\eta_{eff}\frac{d\Lambda}{dx} \quad \text{.. ..... (iv)}$$

As the Bragg wavelength is dependent on the period of grating and effective core refractive index of FBG, the parameter x will change effective refractive index of the core and period of grating of FBG depending on the type of different parameters like temperature strain [8].

Strain in any material can be expressed as a partial increase in its original length when stress is applied. The variation of strain in the grating region can be calculated by shifting wavelength from the FBG sensor [9].

So, the amount of strain is measured by the changes in the Bragg wavelength shift can be illustrated as:

$$\lambda_B{}' = \lambda_B\,(1-P)\,\Delta\epsilon \quad \text{....... (v)}$$

where $\lambda_B{}'$ = Bragg wavelength shift due to strain effect

$\Delta\epsilon$ = Changes in Strain

P = Effective strain - optic coefficient = $\frac{\eta_{eff}^2}{2}[P_{12} - \nu(P_{11} + P_{12})]$ ……. (vi)

where P_{11} & P_{12} = Strain - optic parameters; ν = Poisson's ratio

Now differentiating the Bragg equation for temperature provides a relationship between changes in wavelength and temperature that can be expressed as:

$$\lambda_B' = (2\Lambda \frac{d\eta_{eff}}{dT} + 2\eta_{eff} \frac{d\Lambda}{dT}) \, dT \qquad \text{……. (vii)}$$

After dividing (vii) / (i) we will get

$$\frac{\lambda_B'}{\lambda_B} = \left(\frac{1}{\eta_{eff}} \frac{d\eta_{eff}}{dT} + \frac{1}{\Lambda} \frac{d\Lambda}{dT} \right) dT \qquad \text{…… (viii)}$$

now, $\frac{1}{\eta_{eff}} \frac{d\eta_{eff}}{dT}$ = Thermo optic coefficient = ϵ_T and $\frac{1}{\Lambda} \frac{d\Lambda}{dT}$ = Thermal Expansion coefficient = α

Bragg wavelength shift due to temperature sensitivity becomes: $\lambda_B' = \lambda_B (\epsilon_T + \alpha) \Delta T$ ….. (ix)

So, if the strain will be applied on FBG with a range of varying temperature and vice versa, then the Bragg wavelength shift can be calculated as:

$$\lambda_B' = [\lambda_B (1 - P) \Delta\epsilon] + [\lambda_B (\epsilon_T + \alpha) \Delta T] \qquad \text{…… (x)}$$

E. Predictive Analysis using Machine Learning Model

Machine learning technique is the most important aspect of data processing for predictive analysis of FBG sensed data. By using machine learning, it is comparatively less complex to process a large amount of data. It also helps to reduce the development cost of the sensing system by establishing hidden trends in data to work, particularly in a harsh environment where measuring the sensitivity of any parameter is challenging. Machine learning can be classified as (i) supervised learning (ii) unsupervised learning (iii) reinforcement learning. In this paper, research focuses on a supervised learning-based model because the data received from the designed sensor is purely structured. Supervised learning is further classified into (i) regression and (ii) classification. In this paper, machine learning models have been introduced to perform the predictive analysis of the shifting of Bragg wavelength. As the wavelength is a numerical value, then regression models are used here to do predictive analysis. Regression models aim to predict future values based on past value from the designed FBG sensor data. For exploratory data analysis, the entire data has been split into two-part (i) testing data and (ii) training data. The model will learn through the training data and testing data is used to observe the performance of a particular model on unknown set of data. In this paper, cross validation method has been used to split the data for further analysis. Cross validation is a process in which the data set can be randomly split up to N number of groups. One of the groups can be used as a test set, and the remaining are used as the training set. Random forest and linear regression models are regression models that are used in this paper. The advantage of random forest is that it works both for classification and regression-based problems, and missing values can be automated [10]. Linear regression is used to establish a linear relationship between the independent variable and dependent variable. Linear regression is useful for continuous variable [11]. In this paper, temperature and strain are independent variables, whereas wavelength shift is the dependent variable. The shifting of wavelength depends on the temperature and strain value. The coefficient of determination (R^2) has been used to analyze the performance of the machine learning model. Coefficient of determination is a statistical measurement that illustrates the proportion of variance for a particular dependent variable that can be explained by an independent variable in a regression model [12]. Correlation method has been introduced to analyze any form of relation between dependent and independent variable for predictive analysis. Predictive analysis performance of random forest and linear regression can be evaluated by different statistical measurements such as mean absolute error (MAE) and root mean squared error (RMSE) [13]. MAE calculates the absolute average distance between the measured value and the predicted value. In contrast, RMSE is the square root of the average of the squared difference between the measured value and predicted value [14].

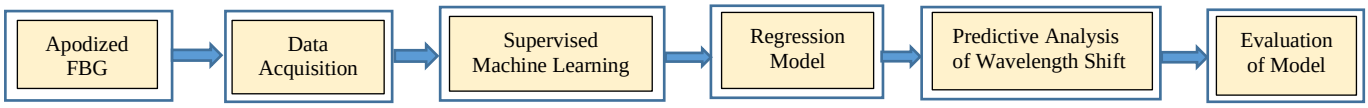

Figure 3: Block Diagram of Predictive Analysis Using Machine Learning

Figure 3 shows the block diagram of implementation of supervised machine learning model for the predictive analysis of wavelength shift.

III. Results and Discussion

Results illustrate the measurement of temperature and strain sensitivity by using gaussian apodized uniform FBG. Perfect linearity has been obtained between the wavelength shift and different values of temperature. Another excellent linearity has also been obtained between the wavelength shift and different values of strain. It shows constant sensitivity during the temperature and strain measurement as linearity has been obtained between temperature and strain with respect to the wavelength shift at different parameter with the same slope for all the values. Strong linearity has been observed between the wavelength shift and temperature at different values of strain. Apart from that, linearity has also been observed between the wavelength shift and strain at different temperature values. The obtained sensitivity for temperature and strain is ± 0.0135 nm / °C and ± 0.0012 nm / µstrain respectively. Machine learning models are significant to process large amounts of FBG sensed data because of various advantages. As FBG operates on the principle of wavelength shift, it is essential to study the predictive analysis of shifting of wavelength by using different machine learning models. FBG sensors can be highly reliable, particularly in a harsh environment, because it is immune to electromagnetic interference. Predictive analysis plays a vital role for FBG sensing applications, particularly in a difficult environment to measure accurately the sensitivity of different parameters. In this paper, two machine learning models have been used for predictive analysis of wavelength shift to measure temperature and strain sensitivity. Random forest and Linear regression machine learning models are used in this paper to perform the predictive analysis. It has been observed that the coefficient of determination (R^2) for temperature sensitivity measurement is 0.7291 using random forest and 0.5265 using linear regression. The coefficient of determination (R^2) observed for strain sensitivity measurement is 0.7409 using random forest and 0.5263 using linear regression. After comparing these two models, the performance of random forest has been considered better than the linear regression model. Because of better performance, the random forest model has been used for predictive analysis of wavelength shift and temperature at different values of strain and wavelength shift and strain at different values of temperature. Different statistical measurements such as, mean absolute error, root mean squared error and correlation have been used to analyze the performance of predictive analysis performed by random forest and linear regression machine learning models. Figure 11 shows the distribution of measured and predicted values of wavelength shift at different temperature value and Figure 12 shows the distribution of measured and predicted values of wavelength shift at different strain value. Performance analysis of random forest model is found to be better than linear regression so random forest model has been used for the predictive analysis of wavelength shift for multi-parameter. Table 4 shows the performance of random forest model in terms of various statistical measurements. Figure 13 – Figure 16 show the graphical representation of measured and predicted values of wavelength shift (nm) for different applied Strain (µstrain) at 25°C, 45°C, 55°C and 65°C Temperature respectively. Figure 17 – Figure 20 show the graphical representation of measured and predicted values of wavelength shift (nm) for different applied temperature (°C) at 60 µstrain, 180 µstrain, 240 µstrain and 320 µstrain respectively. Value of the wavelength (nm) after Bragg wavelength shift is illustrated as wavelength shift (nm) on y axis label of all the figures expressing results.

F. Temperature Sensitivity vs. Wavelength Shift

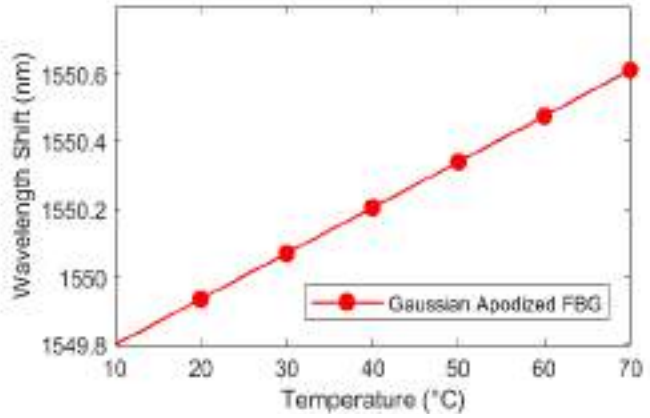

Figure 4: Linearity between Wavelength Shift (nm) and Temperature (°C)

Strong linearity has been observed in Figure 4 between the wavelength shift and temperature. FBG sensor operates basically on the principle of Bragg wavelength shift. Shifting of Bragg wavelength increases with increasing temperature value. So, wavelength shift and temperature are proportional. Wavelength shift depends on the temperature value. It has been observed that for every 10 °C temperature, there is a wavelength shift of ± 0.135 nm. The sensitivity is ± 0.0135 nm / °C. So, the temperature sensitivity has been obtained for designed gaussian apodized uniform FBG is ± 0.0135 nm / °C.

G. Strain Sensitivity vs. Wavelength Shift

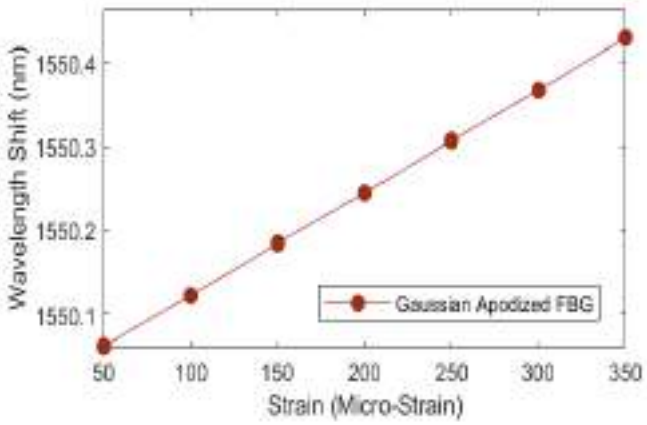

Figure 5: Linearity between Wavelength Shift (nm) and Strain (µstrain)

Strong linearity has been observed in Figure 5 between the wavelength shift and strain. Strain is the deformation or displacement of material that results from an applied stress. It is the ratio of changes in length to that of the original length. FBG sensor operates basically on the principle of Bragg wavelength shift. Shifting of Bragg wavelength increases with increasing strain value. So, wavelength shift and strain are proportional. Wavelength shift depends on the strain value. It has been observed that for every 50 µstrain there is wavelength shift of ± 0.06 nm. The sensitivity is ± 0.0012 nm / µstrain. So, the strain sensitivity has been obtained for designed gaussian apodized uniform FBG is ± 0.0012 nm / µstrain.

H. Effect on Wavelength Shift for Multiple Parameters

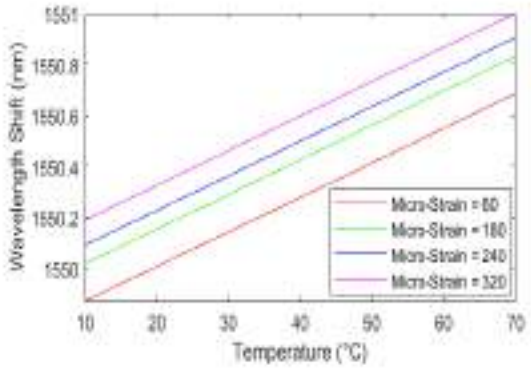

Figure 6(a): Linearity between Wavelength Shift (nm) and Temperature (ºC) at different values of applied strain (µstrain)

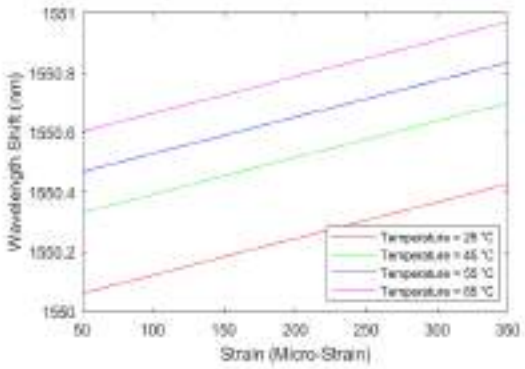

Figure 6(b): Linearity between Wavelength Shift (nm) and Strain (µstrain) at different values of applied Temperature (ºC)

It has been observed that shifting of wavelength occurs when both temperature and strain are applied on a the gaussian apodized uniform FBG. A strong linear relationship has been noticed in Figure 6(a) and Figure 6(b) when both temperature and strain are applied on the FBG. If the value of the temperature and strain increases then the wavelength shift also increases.

I. Predictive Analysis of Wavelength Shift at different Temperature value

FBG sensor operates on the principle of Bragg wavelength shift. Shifting of wavelength can be in the right side or left side of the central wavelength. As wavelength shifting is very important for the FBG sensing mechanism, the study of predictive analysis of wavelength shift with respect to the measured value of wavelength shift is highly desirable to perform sensing activities in an extremely harsh environment. Random forest and Linear regression machine learning model have been used for predictive analysis of Bragg wavelength shift based on the measured data. Based on the performance, one model will be optimized for further analysis based on the FBG sensed data. The coefficient of determination value can be used to conduct the predictive analysis

performance of the machine learning models. In this paper, Table 2 shows the predicted value of wavelength shift by using random forest and linear regression model at different temperature value.

Temperature (ºC)	Predicted Wavelength Shift (nm) Random Forest	Predicted Wavelength Shift (nm) Linear Regression
10	1550.0296	1550.2371
20	1549.9714	1549.9319
30	1550.2029	1550.0675
40	1550.3381	1550.2371
50	1550.3233	1550.3382
60	1550.4881	1550.2371
70	1550.3233	1550.6089

Table 2: Predictive analysis of Wavelength Shift (nm) for Temperature (ºC) Sensitivity Measurement

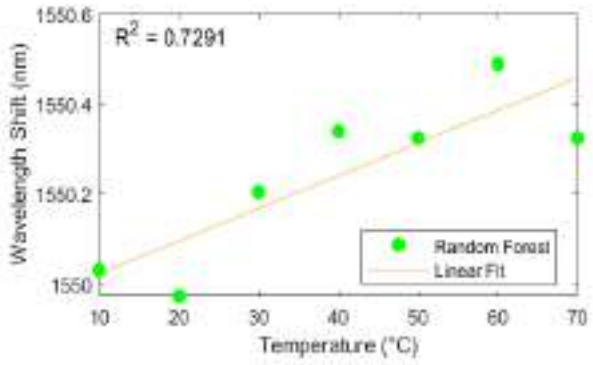

Figure 7: Predictive analysis of Wavelength Shift (nm) at different Temperature (ºC) using Random Forest

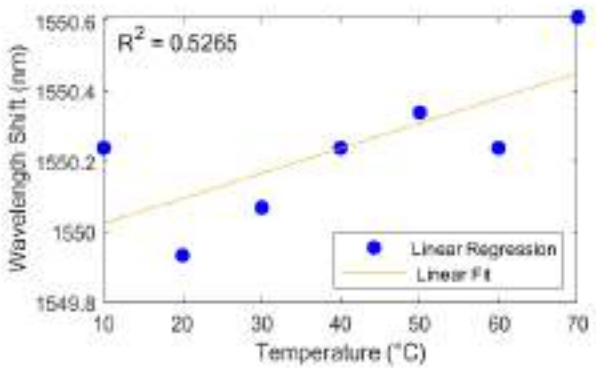

Figure 8: Predictive analysis of Wavelength Shift (nm) at different Temperature (ºC) using Linear Regression

It has been observed in Figure 7 that the coefficient of determination (R^2) value for random forest is 0.7291 whereas in Figure 8 the coefficient of determination value for linear regression is found to be 0.5265. The coefficient of determination (R^2) value has been calculated by linear fitting the predicted values of wavelength shift in MATLAB. Based on the designed FBG dataset, predictive analysis performance for wavelength shift at different temperature values using random forest is better than the linear regression model.

J. Predictive Analysis of Wavelength Shift at different Strain value

The changes in strain in the grating region can be determined by shifting wavelength from the FBG sensor. When FBG is placed on a surface the strain optic parameter differs from that of the optical fiber. Due to the variation in strain value, the shifting of wavelength also changes. As FBG sensor operates on the principle of Bragg wavelength shift, it is very important to study the predictive analysis of wavelength shift due to different strain value to work in particularly any hazardous environment. In this paper, random forest and linear regression models have been used to predictive analysis Bragg wavelength shift for different strain values. In this paper, Table 3 shows the predicted value of wavelength shift by using random forest and linear regression model at different strain value.

Strain (µstrain)	Predicted Wavelength Shift (nm) Random Forest	Predicted Wavelength Shift (nm) Linear Regression
50	1550.1664	1550.2602
100	1550.1402	1549.1227
150	1550.2441	1550.1837
200	1550.3062	1550.2602
250	1550.2901	1550.3054
300	1550.3466	1550.2602
350	1550.2987	1550.4272

Table 3: Predictive analysis of Wavelength Shift (nm) for Strain (µstrain) Sensitivity Measurement

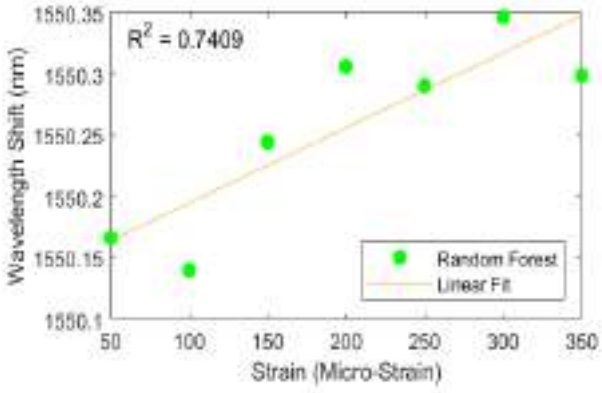

Figure 9: Predictive analysis of Wavelength Shift (nm) at different Strain (µstrain) using Random Forest

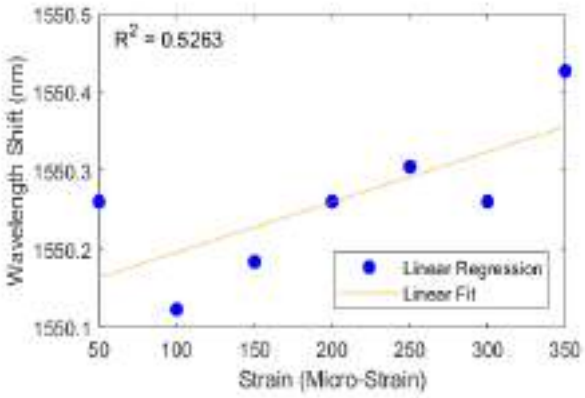

Figure 10: Predictive analysis of Wavelength Shift (nm) at different Strain (µstrain) using Linear Regression

Figure 9 illustrate that the coefficient of determination (R^2) value for random forest is 0.7409 whereas the coefficient of determination value for linear regression is found to be 0. 5263 in Figure 10 for strain measurement. In this paper, the coefficient of determination (R^2) value has also been calculated by linear fitting the predicted values of wavelength shift in MATLAB. Based on the designed FBG dataset, the predictive analysis performance of wavelength shift at different strain values using random forest is found to be better than the linear regression model.

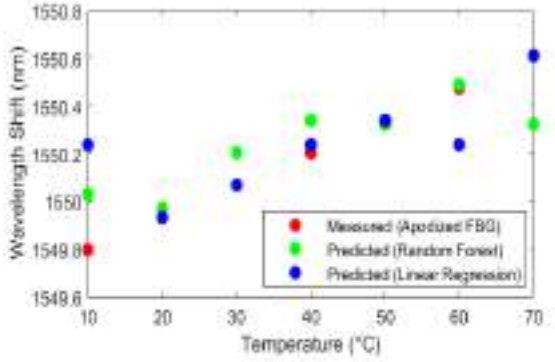

Figure 11: Measured and Predicted Values of Wavelength Shift due to Different Temperature Value

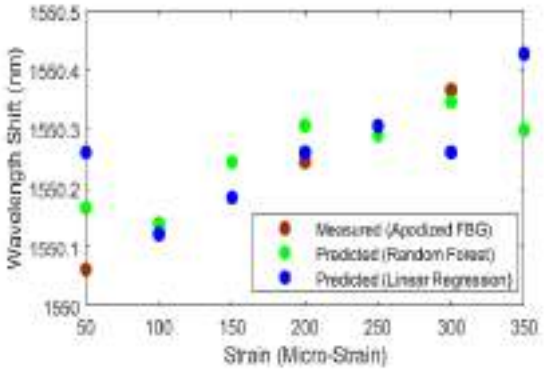

Figure 12: Measured and Predicted Values of Wavelength Shift due to Different Strain Value

Applied Temperature (ºC) at Different Strain Value		Applied Strain (µstrain) at Different Temperature Value	
Statistical Measurement Analysis	Value	Statistical Measurement Analysis	Value
Correlation coefficient Value	0.9781	Correlation coefficient Value	0.9632
Mean Absolute Error (MAE)	0.0558	Mean Absolute Error (MAE)	0.0722
Root Mean Squared Error (RMSE)	0.0636	Root Mean Squared Error (RMSE)	0.0857

Table 4: Performance Analysis of Random Forest Model for Predictive Analysis of Wavelength Shift for both Applied Temperature and Strain effect on Designed FBG

K. Predictive Analysis of Wavelength Shift for Multiple Parameters

Wavelength shift depends on the various parameters such as, temperature and strain because refractive index and grating period are generally sensitive to the temperature and strain. It is essential to perform predictive analysis of Bragg wavelength shift to work, particularly in a harsh environment where temperature and strain occur. Based on the coefficient of determination (R^2) value, random forest model has been used to perform predictive analysis. In this paper, designed FBG have measured the wavelength shift for both the applied temperature and strain value. Measurement of wavelength shift for multiple parameters is also useful for health monitoring of any civil structure. It has been observed that the coefficient of determination value for the predictive value of wavelength shift by using random forest is high, which implies close to the measured value.

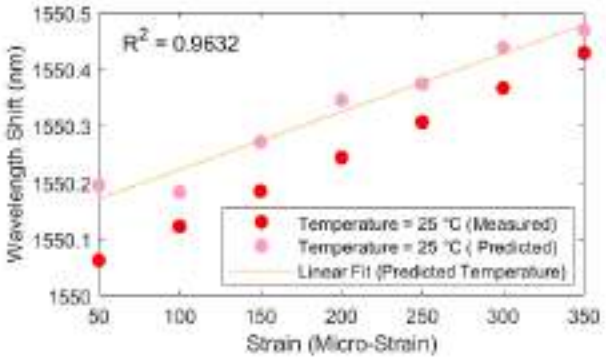

Figure 13: Predictive analysis of Wavelength Shift (nm) for different applied Strain (µstrain) at 25°C Temperature

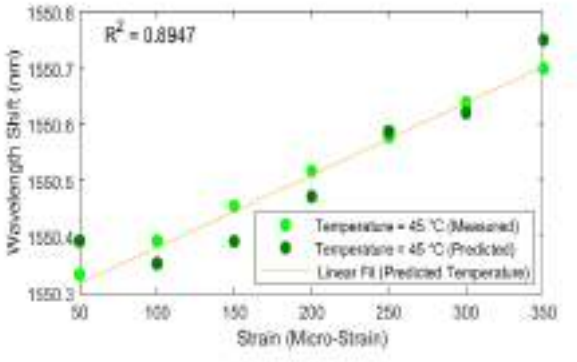

Figure 14: Predictive analysis of Wavelength Shift (nm) for different applied Strain (µstrain) at 45°C Temperature

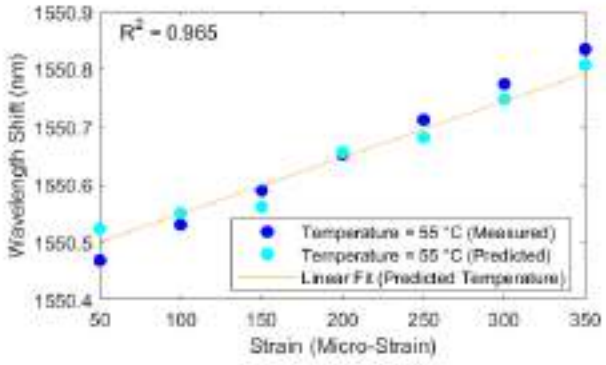

Figure 15: Predictive analysis of Wavelength Shift (nm) for different applied Strain (µstrain) at 55°C Temperature

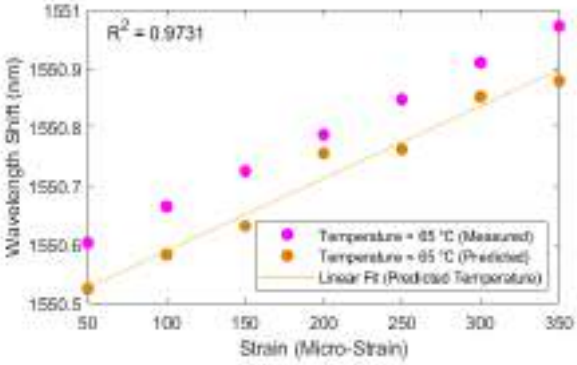

Figure 16: Predictive analysis of Wavelength Shift (nm) for different applied Strain (µstrain) at 65°C Temperature

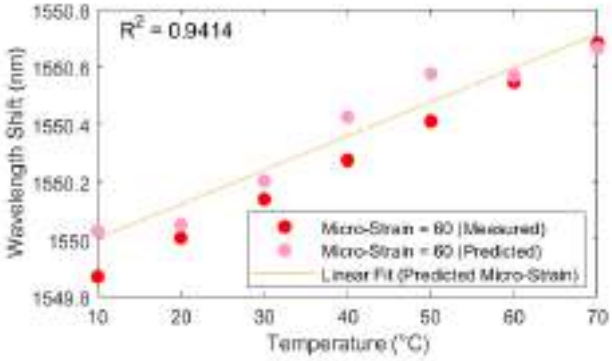

Figure 17: Predictive analysis of Wavelength Shift (nm) for different applied Temperature (°C) at 60 µstrain

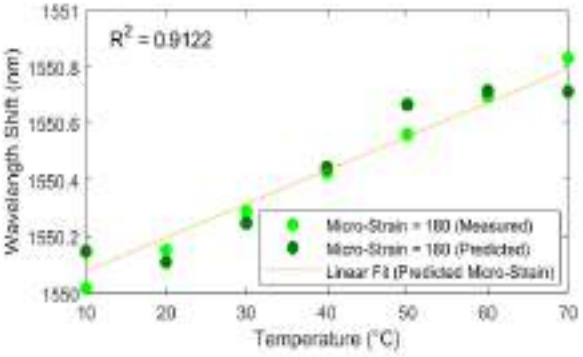

Figure 18: Predictive analysis of Wavelength Shift (nm) for different applied Temperature (°C) at 180 µstrain

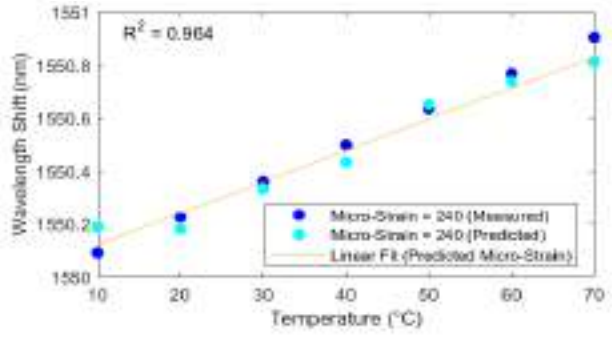

Figure 19: Predictive analysis of Wavelength Shift (nm) for different applied Temperature (°C) at 240 µstrain

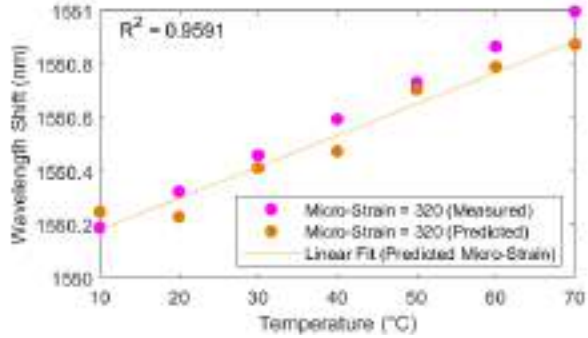

Figure 20: Predictive analysis of Wavelength Shift (nm) for different applied Temperature (°C) at 320 µstrain

FBG functions on the principle of Bragg wavelength shift and shifting of Bragg wavelength can be occur either in the left side or in the right side of the central wavelength. So, shifting of wavelength is much more important with respect to the central wavelength to perform various sensing applications. Table 2 shows the predicted value of wavelength (nm) after Bragg wavelength shift by using random forest and linear regression model at different temperature value. It has been observed that, linear regression predicted same wavelength value at 10^{o}C, 40^{o}C and 60^{o}C respectively. So, the coefficient of determination (R^2) value for linear regression model is found to be 0.5265, which can be considered as not good. It infers that linear regression is not suitable for predictive analysis of wavelength shift at different temperature value based on the designed FBG sensor data. Whereas, random forest predicted same wavelength value for 50^{o}C and 70^{o}C respectively. R^2 value for random forest model is 0.7291 and found to be better than linear regression model for predictive analysis of wavelength shift at different temperature value. Similarly, it has been observed at Table 3 that, linear regression predicted same wavelength value at 50 µstrain, 200 µstrain and 300 µstrain respectively. Whereas, no repetition of predicted wavelength has been identified by random forest model for predictive analysis of wavelength shift at different strain value. Again, R^2 value is found to be better for random forest (0.7409) than the linear regression model (0.5263) in this case. Based on the comparative result between random forest and linear regression, random forest is found to be suitable and better model for predictive analysis of wavelength shift at different strain and temperature value for the designed FBG sensor. That is why linear regression is opted out because of poor performance and repetition of same predicted wavelength shift value at different temperature and strain. Random forest is further considered for the predictive analysis of wavelength shift for multi-parameter sensing when both temperature and strain are applied on the designed FBG. Excellent results have been observed for predictive analysis of wavelength shift for multi-parameter sensing by using random forest model.

IV. CONCLUSIONS

In this paper, we have designed a gaussian apodized uniform FBG for multi-parameter sensing. Sensitivity measurements of temperature and strain have been calculated. Strong linearity has been observed for temperature and strain sensitivity measurement with respect to the wavelength shift. It has also been observed that Bragg wavelength shift is sensitive to both temperature and strain. As the FBG sensor operates on the principle of wavelength shift, we have also discussed the wavelength shifting due to both temperature and strain applied on the FBG. It has been observed that wavelength shift is directly proportional to the temperature value. If we increase the temperature then wavelength shift also increases. Apart from that, wavelength shift is also directly proportional to the strain. So, wavelength shift will also increase with increasing strain value. A strong linearity has been observed in wavelength shift when both temperature and strain of different value applied on the designed FBG. In this paper, it has been noticed that the designed FBG gives constant sensitivity during temperature and strain measurement. As FBG sensor mainly follows the Bragg wavelength shift, it is very important to perform predictive analysis of wavelength shift to work in the hazardous environment. Sometimes it might be difficult to measure the parameter based on the wavelength shift particularly in extremely harsh environment. Machine learning models have been used to perform predictive analysis of wavelength shift based on the designed FBG sensed data to resolve this issue. Random forest and Linear regression model have been used for predictive analysis of wavelength shift. The performance of random forest model is found to be better than linear regression model. It has been noted that the predictive analysis of Bragg wavelength shifts due to different values of both temperature and strain by using random forest model is highly desirable because coefficient of determination value is very high for multi-parameter sensing which is closed to the designed FBG measured value.

ACKNOWLEDGMENT

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Performance Analysis of Deep Transfer Model For Cervical Cancer Detection

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Abstract—**Cervical cancer is the fourth most common cancer among the other female cancers and develops in the women cervix. The main cause of cervical cancer is human papillomaviruses (HPVs). This cancer has a better chance of being preserved during its early stages; however the absence of symptoms during this phase makes it difficult to make an early diagnosis. Various Vaccinations and screening services are currently available for the prevention of cervical cancer. The Pap (Papanicolaou) smear is a simple and cost-effective test that is well suited for resource poor settings. However, these manual screening procedures requires large number of individuals, this is a difficult solution. As a result, these programs do not yield immediate results for future research. Therefore, it is necessary to develop automated detection techniques that should be combined with existing detection techniques, thus making screenings more effective and objective. The main objective of this paper is to develop a cervical cancer detection model based on deep transfer learning techniques that will classify the cervix images. Also this paper is to set the references for further developing classification techniques. The classification of the cervical cancer is performed using a variety of deep transfer model including RESNET-50, RESTNET-152, VGGNET-16 and VGGNET-19. With evaluation the performance metrics of the VGG-16 model is achieved the higher accuracy on the SIPAKNED Pap smear dataset, and obtained an accuracy rate of 95.87%. In future, an ensemble of multiple classifiers may also be considered to provide the best results.**

Keywords— **Cervical cancer, Deep transfer Learning, RESNET-50, RESTNET-152, VGGNET-16 and VGGNET-19**

I. INTRODUCTION

Worldwide, cervical cancer (CC) is the fourth most common cancer in women. It has been estimated that 6,04,127 women have been diagnosed with cervical cancer worldwide in 2020, and approximately 3,41,831 women are predicted to die from this cancer, or 6.5% of all cancers in women [1]. The principal cause of cervical cancer is human papillomaviruses (HPVs), which are transmitted from person to person through sexual contact. [2]. Cervical cancer has a better chance of being preserved during its early stages; however the absence of symptoms during this phase makes it difficult to make an early diagnosis. Thus, prevention programs are essential to reduce cancer occurrence and mortality [3]. Vaccinations and screening services are currently available for the prevention of cervical cancer. Human papillomavirus is generally prevented by vaccination once one has stimulated intraepithelial cervical neoplasm (CIN), which contributes to the development of cervical cancer. HPV tests are often included in a screening system as a first step of screening. Afterwards, a cytology test (or Pap smear) and a colposcopy examination are performed. A cytological screening involves manually staining and smearing the cells under the guidance of an expert who is able to distinguish between liquid-based and conventional cytology. There are certain advantages associated with this approach, such as the lack of dense regions as a result of uneven cellular distribution or the absence of blood or other artifacts; however, the cost is approximately five to ten times that of conventional cytology [4].

Although, this procedure should only be performed by qualified medical professionals having experience diagnosing the condition, which may be difficult in low-income countries due to a lack of resources, including qualified medical personnel. There are a variety of signs and symptoms that patients may experience depending on the stage of the disease, but patients with cervical cancer experience no symptoms until they have reached an advanced stage. The principal symptom of this condition is irregular bleeding in the vagina, which can occur during or after sex, between menstrual cycles, and after menopause. Additional symptoms include pelvic irritation, dyspepsia (painful or difficult urination), smelly discharge, and lower back pain [5]. Constipation, swelling in the legs and blood in the urine are common symptoms in the early stages of the disease. In low-income countries where death rates are high, screening and prevention programs are critical [6].

Nowadays, it is possible to reduce the risk of cervical cancer by obtaining a vaccination. For instance, Gardasil prevents the most toxic forms of cervical cancer by providing protection against HPV, including HPV-16 and HPV-18. This vaccination can prevent cervical cancer, however, its safety cannot be guaranteed. All women should be screened for cervical cancer, regardless of whether they have received a vaccination. It is possible to treat this cancer in a variety of ways, depending upon its stage. During the early stages of the disease, the most common procedures involve the removal of the cervix and a portion of the uterus, radiotherapy or both. The most common types of treatment for advanced stages of the disease include surgery, radiotherapy, and chemotherapy [8]. The Pap (Papanicolaou) smear is a simple and cost-effective test that is well suited for resource poor settings. Cervical cancer digital images are developed and transmitted over the Internet during Pap smear procedures. In the case of screening programs that involve a large number of individuals, this is a difficult solution. As a result, these programs do not yield immediate results for future research. Therefore, it is necessary to develop automated detection techniques that should be combined with existing detection techniques, thus making screenings more effective and objective.

The rest of the paper is followed the following format: Section 2 introduces a current literature review on classification approaches used in cervical cytology; Section 3 describes the proposed methodology and provides information about the datasets and its metrics. Results were obtained along with a comparison of different existing approaches in section 4; section 6 provides a conclusion and offers suggestions for future improvement.

II. Literature Review

This section presents an overview of the most current techniques for detecting cervical cancer. Yu et al. developed a Gated Recurrent Convolutional Neural Network (GCNN) to analyze colposcopy images using both time series and combined multistate cervical images in 2021 [4]. For evaluating the proposed dataset, they have used a variety of approaches. Hand-crafted features extraction methods and deep learning algorithms were used to verify the performance of the multistate colposcopy image dataset (MSCI). In comparison with handcrafted feature extraction methods and classic deep learning approaches, the proposed GCNN model showed the highest classification accuracy in CIN grading. According to the study, the results showed an accuracy of 96.87 %, a sensitivity of 95.68 %, and a specificity of 98.72 %. A deep learning-based cervical cell classification method was proposed by Ramaman et al. (2021) [5] using HDFF and LF models. HDFF achieves higher classification accuracy than LF, based on the performance metrics. SIPAKMED's classification accuracy was 99.85%, 99.38%, and 99.14% for 2-class, 3-class, and 5-class problems, respectively. For binary classification, Herlev's dataset is 98.91% accurate, and for seven-class classification, it is 90.32% accurate. Peng et al. [6] proposed a method for detecting cervical cancer based on comparing pre- and post-acetic images. K-means clustering was used to extract the cervix region, followed by CNN training (VGG 16, ResNet50, and DenseNet121). Additionally, the model was trained at a learning rate of 0.001, but no information was provided on how this was optimized and scheduled to improve the model's performance. It was determined that the accuracy of classification is 86.3%, the sensitivity is 84.1%, and the specificity is 89.8%. Aina et al. (2021) [7] classified images of the cervix as normal and cancerous using a CNN model. A model based on these datasets had an accuracy of 96.3%, a specificity of 98.86%, and a sensitivity of 94.97%. Khamparia et al. (2020) [8] proposed a classifiying approach based on IoT using transfer learning. Pre-trained InceptionV3 models, VGG19 models, SqueezeNet models, and ResNet50 models were added to denser and flatter layers. A variety of techniques are used to detect malignant cells, including K-nearest-neighbors, Naive Bayes, logistic regression, random forests, and support vector machines. An accuracy rate of 97.89% was achieved using the ResNet50 CNN pre-trained model on the Herlev Pap smear dataset. A. Gioneim et al. (2020) developed a new method for the detection of cervical cancer using convolutional neural networks (CNNs). The features have been extracted using shallow, VGG-16-net, and caffenet, and extreme learning (ELM) was used for classification. Researchers evaluated the performance of the Herlev database and found that 99.5% of two-class problems were accurate, and 91.2% of seven-class problems were accurate. W. William et al. (2019) [13] presented a fuzzy c-means algorithm that classified cervical cancer effectively. The features were selected using a wrapper and simulation. An analysis of the DTU/Herlev datasets from the Mbarara Regional Referral Hospital found an accuracy rate of 95.2% for the complete slides. Mask regional convolutional neural networks (Mask R-CNNs) were used by Sompawong et al. (2019) [16] for the classification of cervical cancer on the basis of Pap test images. To compare the proposed methods, 178 liquid-based images were obtained from Thammasat University Hospital. A majority of data sets are used for training and validation, with only 20% of sets used for testing. A resNet-50 network is pretrained on the ImageNet dataset in order to extract features from Mask R-CNN. Before a network can be trained, images need to be resized and enhanced. The accuracy, sensitivity, and specificity values obtained are 89.8%, 72.5%, and 94.3% respectively.

III. Proposed Methodology

A detailed description of the implementation process is provided in the following block diagram. Initially, the publicly available dataset was obtained from an internet source. After acquiring the dataset, it was split into training and testing datasets. The parameters of pre-trained models were fine-tuned by training the model on the target dataset. The proposed architecture is illustrated in Fig 1. It uses the set of cervix images for training. Since the training images are of different sizes, these images are randomly cropped to the size of 224x224. Following this, the entire dataset is divided into two datasets: the testing and training dataset. Images are considered from the training dataset to tune the hyper-parameters of the model. After this, the proposed model was evaluated on the testing dataset. The following steps provide a detailed overview of the same process.

- Step 1: The entire cervix images dataset are cropped to 224x224 pixels in order to speed up processing.
- Step 2: The cervix dataset is split into training and testing datasets. Testing dataset is further subdivided into validation and testing dataset.
- Step 3: The ResNet-50, ResNet-152, VGG-16 and VGG-19 CNN models are used to tune hyper-parameters on the Cervix dataset.
- Step 4: The performance of deep transfer models (ResNet-50, ResNet-152, VGG-16, and VGG-19) are evaluated in terms of accuracy, recall, precision, and F1-score.

A. Database

The publically available SIPKMED dataset contains 4049 images of isolated cells that have been manually cropped from 966 cluster images of Pap smear slides (which were also included in the database). An optical microscope (OLYMPUS BX53F) was used to acquire images using a CCD camera. The cervical cancer is classified into two classes and further two classes are categorized into five sub classes: Superficial-Intermediate cells (class-1), Parabasal cells (class-2), Koilocytotic cells (class-3), Metaplastic cells (class-4) and Dyskeratotic cells (class-5) are shown in Table. I. Following sections provide a brief description of each cell type.

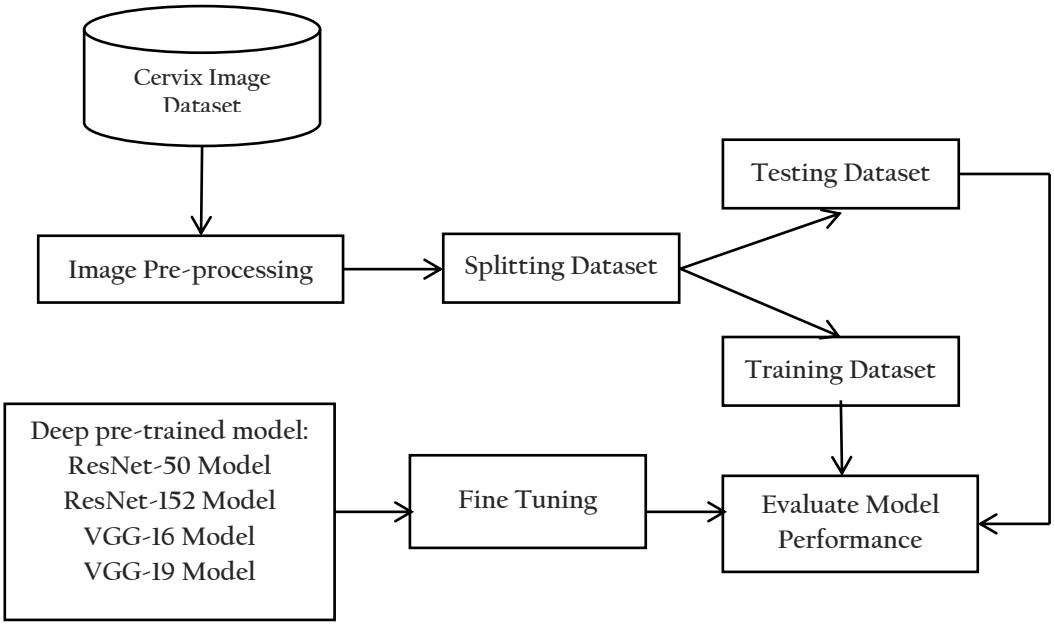


Fig.1 flowchart of proposed methodology

B. Database

The publically available SIPKMED dataset contains 4049 images of isolated cells that have been manually cropped from 966 cluster images of Pap smear slides (which were also included in the database). An optical microscope (OLYMPUS BX53F) was used to acquire images using a CCD camera. The cervical cancer is classified into two classes and further two classes are categorized into five sub classes: Superficial-Intermediate cells (class-1), Parabasal cells (class-2), Koilocytotic cells (class-3), Metaplastic cells (class-4) and Dyskeratotic cells (class-5) are shown in Table. I. Following sections provide a brief description of each cell type.

TABLE IX
FIVE TYPES OF CLASSES FOR SINGLE PAP-SMEAR CELLS

CLASS		CELL TYPE	NO. OF IMAGES	NO. OF CELLS
1	Normal	Superficial/ Intermediate	126	813
2		Parabasal	108	787
3	Abnormal	Koilocytotic	238	825
4		Metaplastic	271	793
5		Dyskeratotic	223	813
Total			966	4049

8) *Normal Class:* Squamous epithelial cells (normal class) are categorized according to their location at the epithelium layers and their maturation degree. Squamous epithelial cells exhibit two pathognomonic changes: Superficial-Intermediate and Parabasal.

- Superficial-Intermediate cells (CLASS-1): A majority of the cells found in Pap smear tests originate from these cells. In general, these cells are flat with an oval, polygonal or round shape (Fig. 2(i)). Cytoplasm is mostly eosinophilic or cyanophilic. Cycnotic nuclei are located in the center of the cells. These cells have well-delineated cytoplasms that are large, polygonal, and easily distinguishable (small, pycnotic nuclei in the superficial nuclei, vesiculated nuclei in the intermediate cells). Koilocyticatypia is the morphology of more severe lesions that occur on these types of cells.
- Parabasal cells (CLASS-2): It has the smallest epithelial cells in a vaginal smear and they are immature squamous cells (Fig 2(ii)). Generally, cytoplasm is cyanophilic, and it has a large vesicular nucleus. Class-2 cells have similar morphological characteristics to metaplastic cells, and they are difficult to distinguish from them.

9) Abnormal Class: Pathological conditions are characterized by morphological changes to structures of an abnormal class. Most cervical cancers are caused by the human papillomavirus (HPV). Squamous cells exhibit two pathognomonic changes: koilocytosis and dyskeratosis.

- Metaplastic cells (CLASS-3): In MP cells, the parabasal cells are large or small, have prominent cellular borders, have eccentric nuclei, and sometimes possess an intracellular vacuole (Fig. 2(v)). There is typically a light brown staining in the middle portion, different from the marginal portion. Moreover, the cytoplasm of the Metaplastic cells is larger and darker, and its shape is well defined, almost round, unlike that of the parabasal cells. Pap tests are associated with a high detection rate of precancerous lesions.

- Koilocytotic cells (CLASS-4): Koilocytotic cells are typically found in mature squamous cells (intermediate and superficial) and rare in metaplastic koilocytotic cells (Fig. 2(iii). Many cyanophilic, very lightly stained, and lyophilic cells have a large perinuclear cavity. There is a dense staining of the cytoplasm around the periphery. Koilocytotic cells have enlarged nuclei, which are eccentrically positioned, hyperchromatic, and exhibit an irregular nuclear membrane contour. The cells are often multinucleated or binucleated. The presence of koilocytic cells is a pathognomonic sign of HPV infection. It depends on the stage of the infection and the type of infection how degenerated the nuclei of these cells usually are.
- Dyskeratotic cells (CLASS-5): The Dyskeratotic cells are squamous cells with an abnormal keratinization that results in three-dimensional clusters (Fig. 2(iv)). Their cytoplasm is orangeophilic. KC cells are characterized by their vesicular nuclei. The presence of koilocytes is a pathognomonic sign of HPV infection, and it sometimes occurs even in the absence of koilocytes. The nucleus and cytoplasm margins are difficult to distinguish because they tend to be clustered densely in three dimensions.

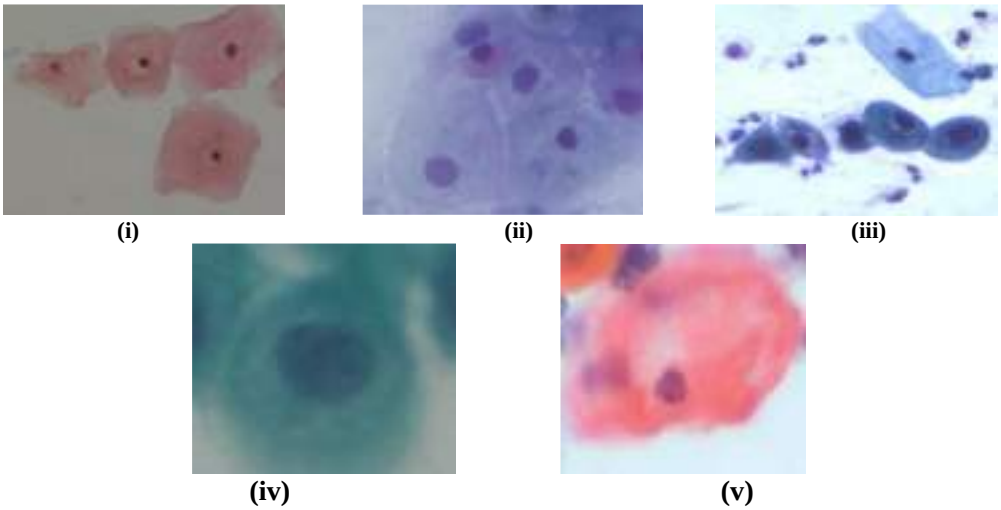


Fig. 2 SIPKMED database is classified into five categories: (i) Superficial-Intermediate cells, (ii) Parabasal cells, (iii) Koilocytotic cells, (iv) Dyskeratotic cells, (v) Metaplastic cells

C. Splitting Database

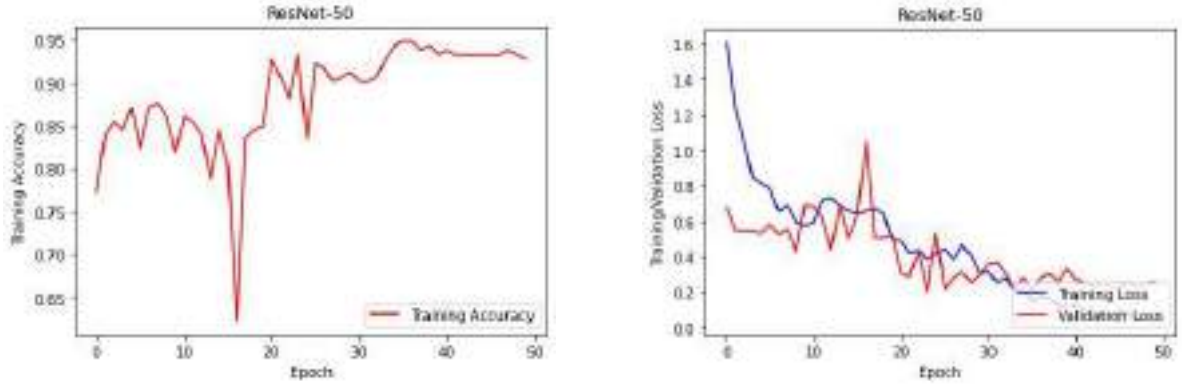
The proposed CNN models (ResNet-50, ResNet-152, VGG-16, and VGG-19) are evaluated using ratio sets. The images are split into three sets namely training, validation, and testing datasets using the train_test_split() function from sklearn.model_selection import train_test_split library. The splitting is based on the following ratios: 60% training, 20% validation and 20% testing. After splitting the dataset, the training dataset consists of 576 images, 194 images for validation, and 196 images for testing. Furthermore, the entire dataset consists of 4049 cells, of which 234 and 732 images represent normal and abnormal cluster cells, respectively.

D. Deep pre-trained model

Deep transfer learning is a method of transferring knowledge from an existing model to previously unknown paradigms without being restricted to any specific task [15]. The Convolutional neural network (CNN) is the most commonly used deep learning network for the classification of images. A CNN is a neural network that consists of an input layer, a hidden layer, and an output layer. This makes it a deeper neural network since there are thousands of hidden layers. A raw image consists of the pixel values of the input layer, and a set of neurons is output by the output layer, corresponding to the number of output classes. For example, a problem of cervix classification requires the image of a cervigram as input and the probability that the image corresponds to a particular class as output. The final layer of the convolution layer utilizes the SoftMax activation layer. Due to the limited number of datasets available in the medical field, the dataset is insufficient to provide significant results. Consequently, the proposed model uses the weights of some pre-trained models. The pre-trained models are tuned with same set of configuration of hypermeters. EPOCH's number is 50 for fine-tuning the weights of models; Batch_Size is 10; Image resolution is 224×224 pixels. So, proposed model uses the following four pre-trained models are listed below:

RESNET-50: The RESNET-50 architecture is one of the most widely used pre-trained models. It consists of 50 layers and is trained on a million images from the ImageNet dataset. This model is able to distinguish thousands of objects and contains approximately 23 million parameters that can be trained. In RESNET, identity mapping is used in residual blocks. The following diagram shows the differences between a plain block and a residual block. There are challenges associated with RESNET-50 model. The training accuracy of a neural network can increase initially as the number of layers increases. However, it is observed that the training accuracy quickly saturates, and is even decreased. In order to prevent this, the identity mapping concept has been introduced. Thus, if there is a degradation resulting from the stacked layers, it may be overcome by adding the input vector directly to the output. In addition, RESNET uses bottleneck architecture to reduce dimensionality by introducing convolutions with 1*1

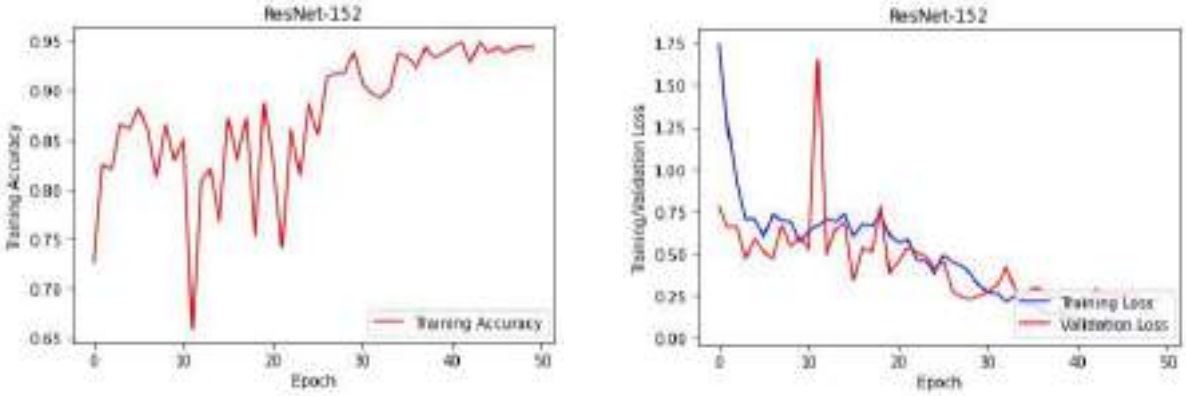
filters. The RESNET-50 model was trained for 50 epochs, and the maximum training accuracy was achieved at 94.84% as shown in figure.3 (i). The training and validation loss for 50- layers of ResNet are shown in figure 3(ii).



(i) (ii)

Fig. 3 RESNET-50 model: (i) the training accuracy (ii) the training and validation loss

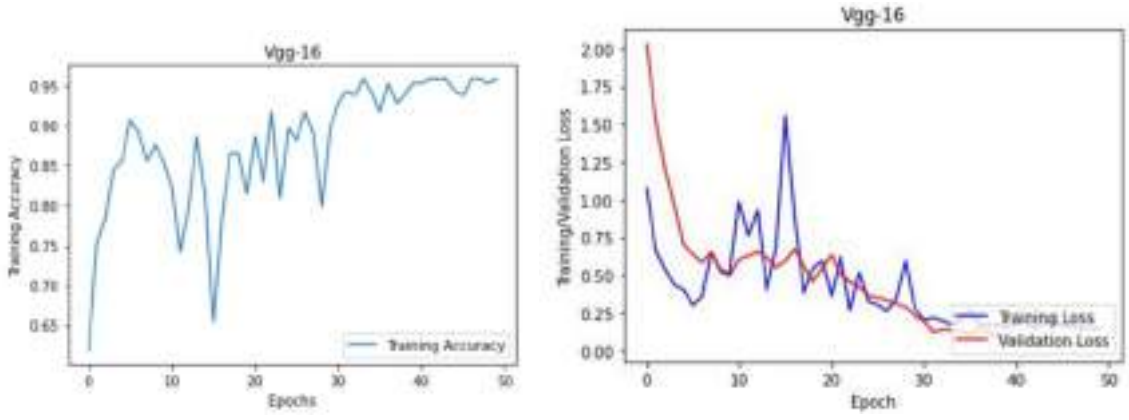
RESNET-152: RESNET-152 is one of the deepest architectures trained on the ImageNet dataset. It was a deepest network, but it was less complex than VGG16, which was only a 16-layer deep architecture. RESNET-152 was trained for 50 epochs, and the maximum training accuracy was 94.91% as shown in figure 4(i). The train loss and validation loss for 152- layers of ResNet are shown in figure 4(ii).



(i) (ii)

Fig. 4 RESNET-152 model: (i) the training accuracy (ii) the training and validation loss

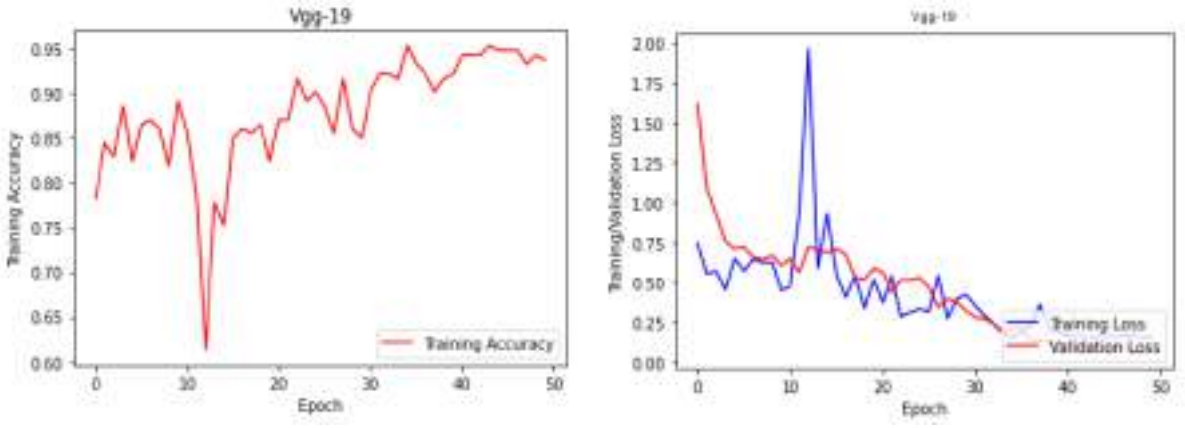
VGGNET-16: On the basis of the ImageNet dataset, VGGNET-16 was found to be the most effective model. In this model, the large convolution filters (11x11, 5x5, 3x3) were replaced with multiple 3 x 3 Kernels for convolution [19]. Using this approach, the model was able to learn deeper details and, therefore, extract more complex features. The architecture occupies more than 500 megabytes of memory and is trained with 138 million parameters in total. The VGGNET-16 model was trained for 50 epochs, and the maximum training accuracy was achieved at 95.87% as shown in figure.5 (i). The training loss and validation loss for 152- layers of ResNet are shown in figure 5(ii).



(i) (ii)

Fig. 5 VGGNET-16 model: (i) the training accuracy (ii) the training and validation loss

VGGNET-19: VGGNET-19 differs from VGGNET-16 only in terms of the number of layers. Researchers found that accuracy did not improve much as the number of layers was increased. For this reason, this architecture has not been explored further [20]. The VGGNET-19 model was trained for 50 epochs, and the maximum training accuracy was achieved at 95.36% as shown in figure.6 (i). The train loss and validation loss for VGGNET-19 are shown in figure 6(ii).



(i) (ii)

Fig. 6 VGGNET-19 model: (i) the training accuracy (ii) the training and validation loss

IV. Experiment Result and Discussion

Confusion matrix is the visual representation to evaluate the accuracy of a classification. Table II represents the confusion matrix for the ResNet-50 model. Class-5 and Class-1 are correctly classified without any misclassifications. There are total of six images that are incorrectly classified in Class-4 which is the worst case for this model. This model is achieved accuracy of 93.87%. Table III presents the performance matrices for all five classes which depicts perfect result is obtained in the Class-5 and Class-1 with 100% recall matrices. However, only Class-2 and Class-1 are performed 100% result in precision and F1-score matrices respectively.

TABLE XI
CONFUSION MATRIX FOR RESNET-50 MODEL

Cervix Classes	Class-5	Class-4	Class-3	Class-2	Class-1	Total
Class-5	45	0	0	0	0	45
Class-4	3	41	3	0	1	48
Class-3	2	2	51	0	0	55
Class-2	0	0	1	21	0	22
Class-1	0	0	0	0	26	26
Total	48	43	55	21	27	196

TABLE XI1I
PERFORMANCE MATRICES FOR RESNET-50 MODEL

Cervix Classes	Precision	Recall	F1-Score
Class-5	0.90	1.00	0.95
Class-4	0.95	0.85	0.90
Class-3	0.93	0.93	0.93
Class-2	1.00	0.95	0.98
Class-1	0.96	1.00	1.00

TABLE XIIV
CONFUSION MATRIX FOR RESNET-152 MODEL

Cervix Classes	Class-5	Class-4	Class-3	Class-2	Class-1	Total
Class-5	43	2	0	0	0	45
Class-4	1	42	4	0	1	48
Class-3	0	0	55	0	0	55
Class-2	0	0	1	21	0	22
Class-1	0	1	0	0	25	26
Total	44	45	60	21	26	196

The RESNET-152 model is found to perform best among all four pre-trained models. Table IV shows the confusion matrix for the Resnet-152 model. Using this model, all the 55 images are correctly classified for the Class-3. A significant deviation is still observed in the case of Class-2 due to their visual similarity to Class-3. This model achieved an accuracy of 94.89%. Table V. presents the performance matrices for all five classes. The Class-3 and Class-2 are performed perfectly in the matrices of recall and precision respectively. Additionally, the worst recall value is observed in the Class-4.

TABLE V
PERFORMANCE MATRICES FOR RESNET-152 MODEL

Cervix Classes	Precision	Recall	F1-Score
Class-5	0.98	0.96	0.97
Class-4	0.93	0.88	0.90
Class-3	0.92	1.00	0.96
Class-2	1.00	0.95	0.98
Class-1	0.96	0.96	0.96

The VGGNET-16 model is performed efficiently in Class-2, with an accuracy of 92.85%, which is the lowest among the all four models as shown in table VI. Furthermore, in the table VII, Class-2 is performed perfectly in all matrices (Precision, Recall, and F1-score). Additionally, the worst recall value is observed in the Class-3.

TABLE VI
CONFUSION MATRIX FOR VGGNET-16 MODEL

Cervix Classes	Class-5	Class-4	Class-3	Class-2	Class-1	Total
Class-5	43	2	0	0	0	45
Class-4	1	43	3	0	1	48
Class-3	3	2	49	0	1	55
Class-2	0	0	0	22	0	22
Class-1	1	0	0	0	25	26
Total	48	17	52	22	27	196

TABLE VII
PERFORMANCE MATRICES FOR VGGNET-16 MODEL

Cervix Classes	Precision	Recall	F1-Score
Class-5	0.90	0.96	0.92
Class-4	0.91	0.90	0.91
Class-3	0.94	0.89	0.92
Class-2	1.00	1.00	1.00
Class-1	0.93	0.96	0.94

The VGGNET-19 model is nearly performed well as similar to VGGNET-16 in Class-2. In addition, there is only one misclassification in the Class-1 as mentioned in table VIII. This model achieved an accuracy of 94.38% which is slightly higher than VGG-16 model. Table IX represents the performance matrices for all five classes. There are no perfect recall and F1-score in all of the classes, but a precision of 100% has been observed in the Class-2 and Class-1.

TABLE VIII
CONFUSION MATRIX FOR VGGNET-19 MODEL

Cervix Classes	Class-5	Class-4	Class-3	Class-2	Class-1	Total
Class-5	43	2	0	0	0	45
Class-4	0	43	5	0	0	48
Class-3	1	1	53	0	0	55
Class-2	0	0	1	21	0	22
Class-1	0	1	0	0	26	26
Total	44	47	59	21	25	196

TABLE IX
PERFORMANCE MATRICES FOR VGGNET-19 MODEL

Cervix Classes	Precision	Recall	F1-Score
Class-5	0.98	0.96	0.97
Class-4	0.91	0.90	0.91
Class-3	0.90	0.96	0.93
Class-2	1.00	0.95	0.98
Class-1	1.00	0.96	0.98

V. CONCLUSION AND FUTURE SCOPE

Cervical cancer is the most common cancer among women. Currently, there are several methods for diagnosing the Papanicolaou test (Pap smear). These methods are the most cost effective and time efficient. However, despite its simplicity, it was determined that after extensive research, it is extremely comprehensive and contains plenty of useful information. The objective of this paper is to present a technique that uses Deep Transfer Learning to assist in the diagnosis of diseases. In this study, SIPAKMED dataset is used that is more relevant than many previous published datasets. The classification involved five categories: Superfical–Intermediate cells (Class-1), Parabasal cells (Class-2), Metaplastic cells (Class-3), Koilocytotic cells (Class-4), and Dyskeratotic cells (Class-5). The VGG-16 pre-trained model is performed the best among the classifiers is shown in fig 7. However, the classifications can still be improved significantly. These results are limited to visual properties of a single dataset. The scope of this study will be expanded in the future to include multiple datasets of similar pap smear tests for the purposes of increasing accuracy. This work has the advantage of avoiding the limiting environmental parameters. Furthermore, an ensemble of multiple classifiers may also be considered to provide the best results.

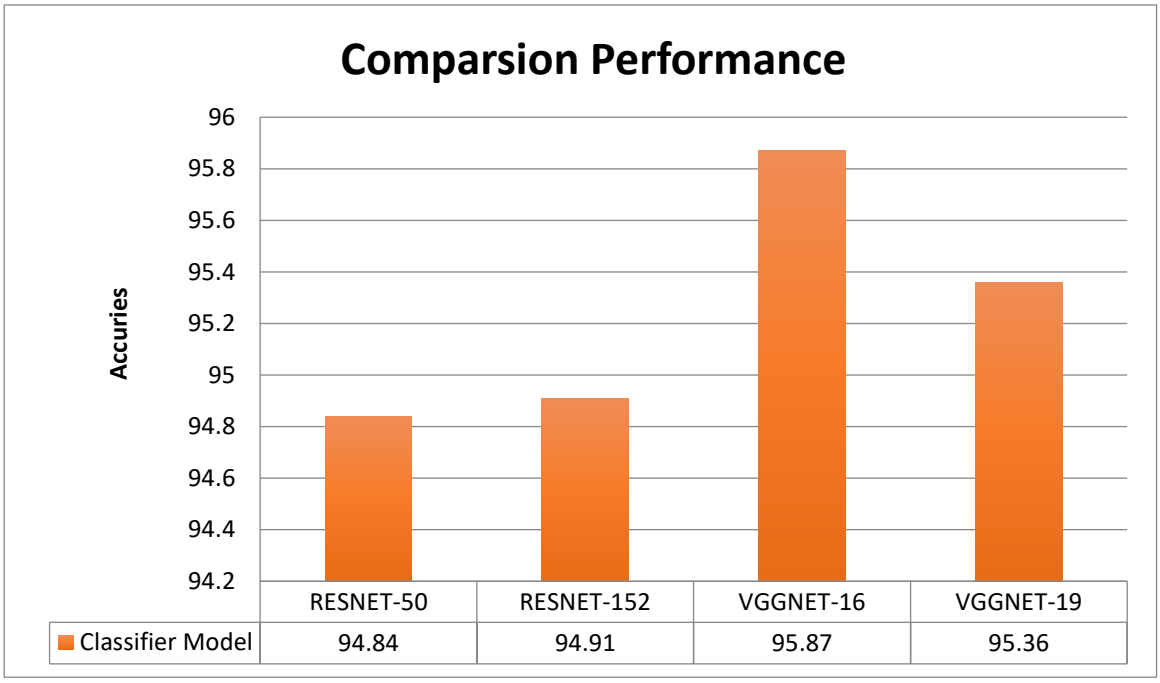


Fig. 7 Comparison performance of testing accuracy for all four classifiers model

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A No-Reference Blur Assessment Algorithm Based on Edge Analysis and Probability density function of blur detection

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***Abstract*— Image blur is a kind of image distortion that occurs frequently. As a result, there is an increasing need for no-reference blur detection algorithms that can reliably estimate the quality of blurred images. This paper proposed a no-reference image blur assessment algorithm, based on a study of probability density function of blur detection at various contrast levels and edge analysis. This method estimates the blur score of global edges from vertical edges based on the various contrast levels and blur score of significant edges is estimated by the edge analysis using canny edge detector. The final blur score is a weighted combination of both blur scores because distinct edges have different matching weights. This enhances the accuracy of predictions. The proposed algorithm's performance is demonstrated by comparing it to existing no-reference blur assessment algorithms for LIVE image database which is a publicly available image database.**

***Keywords*— No-reference blur assessment, Edge analysis, Blur score of global edges, Blur score of significant edges, probability density function, prediction parameter**

I. INTRODUCTION

The image blur causes a loss of information and a reduction in edge sharpness in the content space. Spectrum attenuation, poor quantization of high-frequency discrete cosine transform (DCT) coefficients and transmission bit error or noise are all potential causes of blur. Different assessment systems might be designed for various purposes. As a result, this section begins with a review of existing no-reference blur assessment algorithms before moving on to the merits of the proposed algorithm.

Pixel-based/spatial domain, spectral domain and hybrid domain algorithms are three key trends in modern blurriness assessment methods. The Pixel-based/spatial domain approaches are depended exclusively on the image's spatial characterisation. Spectral domain methods can be used in the spectral domain, while hybrid domain methods integrate spectral and spatial domain methods. The bulk of pixel-based or spatial-domain approaches consider that blur is perceptually noticeable at edges. As a result, the smoothing effect of blur on edges was approximated in these algorithms [1-2]. For instance, A just noticeable blur (JNB) approach based on the probability summation model was presented [3]. The spatial edge detection was done using the Sobel operator in this method. The test image was divided into 64×64 blocks and each block's pixel count were calculated. A threshold was used to identify the blocks as edge blocks. Based on just noticeable blur condition, the edge width and local contrast were determined. For each edge, the general edge width was computed, and the overall distortion was derived by pooling the overall blocks with $\alpha = 3.6$ and the inverse of the overall distortion yielded the proposed sharpness approach. Then an edge-based complicated blur approach with a low computing cost was suggested. To detect the blur of no-reference and full-reference images, a method was proposed. From the original image, the Sobel edge detector picked up on the strong vertical edges. It was decided to use the gradient threshold to remove of the fainted edges. The start and finish points of edges are used to calculate local blur [2].

In the spatial domain, the edge blur is defined in terms of the gradient energy as it related to nearby pixel within certain limits. The edge blur in the local pixels is calculated and neural network's adaptive model is used to estimate the blur for the LIVE database images [4]. Another method was proposed in which kurtosis of blocks of prominent edge pixels in the test image are compared to those of a purposefully re-blurred version [5].

Some academics have proposed hybrid approaches that combine pixel-based and transform-based methods. To quantify sharpness as seen locally, a block-based spectral and spatial method was presented. They calculate the magnitude spectrum's slope as well as the image's total spatial variation. Hybrid techniques have consistently outperformed pixel-based/spatial or spectral domain measures, however, this comes at the expense of more computing complexity [6-7]. A perceptual blur image quality assessment (PBIQA) method was presented in which the image was divided into three resolution levels and then wavelet transform was applied to each resolution level. The psychometric function was used to create the edge map and quantify the perceptual blur through resolutions [8].

The re-blur algorithm based on double Gaussian convolution was used to re-blur the test image [9]. In terms of local histogram form, the difference between test and re-blur images was calculated. Finally, the weighted variance of the histogram forms of the actual and blurred images was used to construct the blind image blur score. A parametric edge-based approach for calculating blur was presented. The contrast was estimated from each edge pixel using the parametric edge model and the edge width was estimated from standard deviation of blurring distortion [10]. The thresholding approach was used to compute the salient edges,

which were then used to calculate the blur. Tchebichef moments (orthogonal moments) were computed to identify the image shape. To determine the block's energy, the non-DC values of these moments are squared and added. The visual saliency map was created using the human visual system's adaption (HVS). The instant energy was normalised using block variances and a blur score was calculated based on the visual saliency map [11]. For no-reference images, a local total variation-based blur assessment algorithm (LTVBA) was suggested. The fluctuation of local contrast in the no-reference image was used to determine the perceived blurriness. The regions where the total local variation identified strong contrast were extracted. A five-parameter logistic function has been used to calculate the exact image blurriness. [12]. The anisotropic quality index (AQI) was proposed, which was calculated by the variance of a given image's expected entropy over a collection of orientations. This index was used to deal with the ill-posed noise types that delivers satisfactory or unsatisfactory performances [13].

This paper proposes a no-reference blur assessment approach based on human blur perception and edge analysis to increase the predictive performance of spatial domain algorithms. The remaining part of the paper is laid out as follows: The introduction and literature relevant to no-reference blur assessment methods are presented in Section 1. Section 2 contains the proposed algorithm as well as the method for calculating the blur score. In Section 3, the overall performance of the proposed algorithm has been evaluated by implementing the proposed algorithm on LIVE image database. The paper is concluded in Section 4.

II. PROPOSED ALGORITHM

This section presents the overview of no-reference blur assessment algorithm, which is a study of probability density function of blur detection at various contrast levels and edge analysis. In this method, the blur score of global edges is estimated probability density function and blur score of significant edges is estimated by the edge analysis using canny edge detector. Because supplying unique edges with different matching weights will increase predictive performance, the final score is a weighted average of both blur scores.

Figure 1 shows the flow chart for determining the blur score based on the probability density function of detected blur. The flow chart for obtaining the final blur score is shown in Figure 2. The detail of this two-step algorithm is given below:

Step 1: As shown in Figure 1, the test image is converted into grey scale image, then it is segmented into 64×64 blocks.

Step 2: The canny edge detection is performed and count the number of edge pixels N.

Step 3: Classify the blocks as edge and non-edge blocks applying the threshold $T_h = 0.002$ to each pixel.

Step 4: Calculate the edge width $W(E_i)$ of detected edges for each block as calculated in [2].

Step 5: Each block's contrast C determined by subtracting the lowest value from the highest value. For various contrast levels, the just noticeable blur $W_{jnb}(E_i)$ can be modelled as given below [2]:

$$W_{jnb}(E_i) = \begin{cases} 5, & \text{if } C \le 50 \\ 3, & \text{if } C \ge 51 \end{cases} \tag{1}$$

Step 6: At the pixel level, each edge pixel's width is measured by counting the number of pixels with ascending and descending grayscale values on the opposite sides simultaneously. The edge width plays the main role to detect probability of blur distortion at every edge pixel. The probability of detecting blur is described exponentially by a psychometric function as given below [3]:

$$P_{blur} = P_{blur}(E_i) = 1 - \exp\left(-\left| \frac{W(E_i)}{W_{jnb}(E_i)} \right|^{\beta} \right) \tag{2}$$

β is a model parameter, the value of which is determined via least squares fitting and it's value is set to 3.6. The probability of blur detection that is $P_{blur} = P_{jnb}$ is 63%, when $W(E_i) = W_{jnb}(E_i)$ [1, 3].

Step 7: The blur detection probabilities are normalised into a histogram, also known as probability density function, is determined as given below:

$$\text{Probability density function} = \frac{\text{Histogram of } P_{blur}}{\text{Total no of processed edge pixels}} \tag{3}$$

Step 8: The probability density function is used to determine the blur score of global edges $BS(G_E)$ as:

$$BS(G_E) = \sum_{P_{blur}=0}^{P_{blur}=P_{jnb}} P(P_{blur}) \tag{4}$$

Step 9: According to the flow chart as shown in Figure 2, the blur score of significant edges $BS(S_E)$ is estimated by the edge analysis using canny edge detector by applying a specific threshold value as given below:

$$BS(S_E) = \frac{\text{Total number of detected edges } (T_h = 0.002)}{\text{size of the test image}} \tag{5}$$

Step 10: The final score is determined by the weighted combination of blur scores calculated in equation (4) and (5) as given below:

$$Final\ BS = \alpha \times BS(G_E) + (\alpha - 1) \times BS(S_E) \quad (6)$$

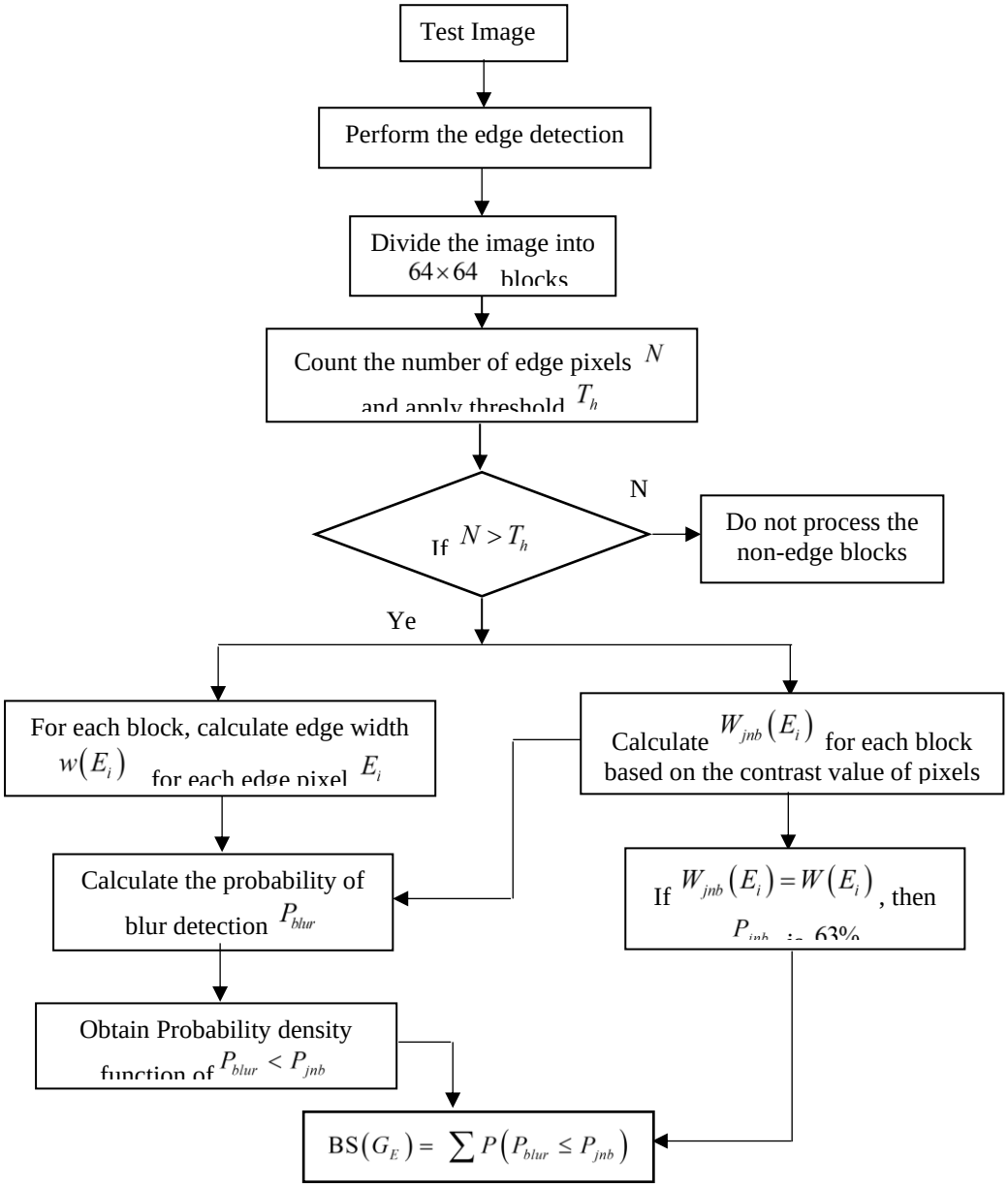

Fig.1 Flow Chart of blur score calculation for global edges

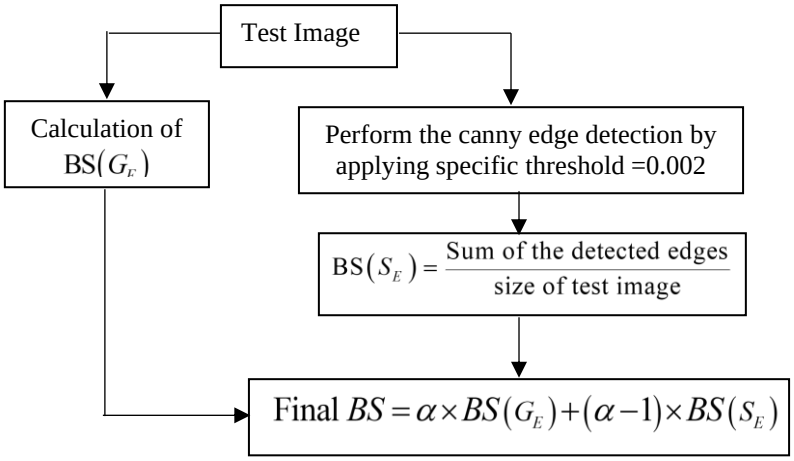

Fig. 2 Flow chart for final blur score calculation

III. PERFORMANCE RESULTS

This section contains results that demonstrate the effectiveness of the proposed method. First, the test set for the proposed algorithm is described, which consist of a range of Gaussian blurred images. The UT Austin LIVE database is made up of 29 high-resolution RGB colour images that are distorted using various distortion methods such as Gaussian blur and JPEG2000. Then subjective tests were done on several Gaussian-blurred images of LIVE database. In this process, each image is rated by 20–29 participants. The standard deviation of the processed score as well as the Mean Opinion Score (MOS) are then collected for algorithm performance assessment. The total 174 Gaussian blurred images of LIVE image database are used to assess the proposed algorithm's performance [15]. The results of proposed algorithms have been compared with three existing algorithms that is CPBD [1], JNB [3], EMBM [10].

As mentioned in the equation (6), the objective scores of test database are calculated from the weighted average of two blur scores. The α is weight factor and its value is varying between $0.1 \le \alpha \le 0.9$. The objective scores are calculated for each weight factor. The authors used the directions in the VQEG report to establish correlation between the blur score values to the provided MOS values [14]. A logistic fitting function is utilized to map the objective and subjective score values, as stated in [14]. The logistic fitting function that utilized is given as follows:

$$MOS_P = \frac{\beta_1 - \beta_2}{1 + e^{\frac{x-\beta_3}{abs(\beta_4)}}} + \beta_2 \tag{7}$$

The values of model parameters $\beta_1, \beta_2, \beta_3, \beta_4$ are determined by the best fit of subjective scores, and the MOS_P is computed using these model parameter values. The performance parameters i.e. Pearson linear correlation coefficient $(PLCC)$, spearman rank-order correlation coefficient $(SROCC)$, mean absolute error (MAE), root mean square error $(RMSE)$ and outliers ratio (OR) of the proposed algorithm are calculated using the values of MOS_P.

TABLE I

PERFORMANCE ANALYSIS USING LIVE (GAUSSIAN BLURRED) IMAGE DATABASE [15]

No-Reference Blur detection algorithm		Performance parameters				
		PLCC (%)	SROCC (%)	MAE	RMSE	OR
CPBD Algorithm [1]		0.9257	0.9444	4.7098	6.4662	0.0632
JNB Algorithm [3]		0.8498	0.8345	6.9317	9.0117	0.1322
EMBM Algorithm [10]		0.9230	0.9294	5.0592	6.5787	0.0632
Proposed Algorithm	$\alpha = 0.1$	0.9280	0.9221	5.0343	6.3699	0.0575
	$\alpha = 0.2$	0.9364	0.9357	4.5912	5.9998	0.0460
	$\alpha = 0.3$	0.9382	0.9408	4.4635	5.9182	0.0460
	$\alpha = 0.4$	0.9375	0.9431	4.4750	5.9488	0.0575
	$\alpha = 0.5$	0.9358	0.9438	4.5053	6.0245	0.0517
	$\alpha = 0.6$	**0.9338**	**0.9447**	**4.5523**	**6.1166**	**0.0517**
	$\alpha = 0.7$	0.9317	0.9449	4.5945	6.2115	0.0632
	$\alpha = 0.8$	0.9295	0.9455	4.6305	6.3029	0.0632
	$\alpha = 0.9$	0.9276	0.9453	4.6716	6.3881	0.0632

Tables I present the results of performance evaluations for existing and proposed algorithms for images with Gaussian blur from LIVE database. In results, the parameters *PLCC* is representing prediction accuracy, *SROCC* is representing prediction monotonicity, *MAE* and *RMSE* are representing prediction errors. The *OR* indicates for the total number of incorrect scores assigned by the objective scores. The regression analysis has been done for weight factor $\alpha = 0.1$ to $\alpha = 0.9$ by using the logistic function given in equation (7). The greater value of *PLCC* is 0.9382 for $\alpha = 0.3$, it means the objective scores are more accurate for this weight factor. The *SROCC* is monotonically increasing for $\alpha = 0.1$ to $\alpha = 0.8$ and it shows non-monotonic behavior at $\alpha = 0.9$ as its value decreases. The minimum values of *MAE* and *RMSE* are 4.4635 and 5.9182 respectively, which shows the minimum error is obtained at $\alpha = 0.3$. The minimum value of *OR* is obtained at $\alpha = 0.2$ and $\alpha = 0.3$ that is 0.0460, incorrect scores obtained at these weight factors are lesser as compared to other weight factors. The proposed algorithm has showed the comparative results to CPBD algorithm [1] at weight factor $\alpha = 0.5$ and $\alpha = 0.6$, but it shows the strongest correlation between objective and subjective scores for weight factor $\alpha = 0.6$. According to the results as shown in Figure 3, the proposed algorithm performs better than the CPBD [1], JNB Algorithm [3] and EMBM Algorithm [10] for Gaussian blurred images.

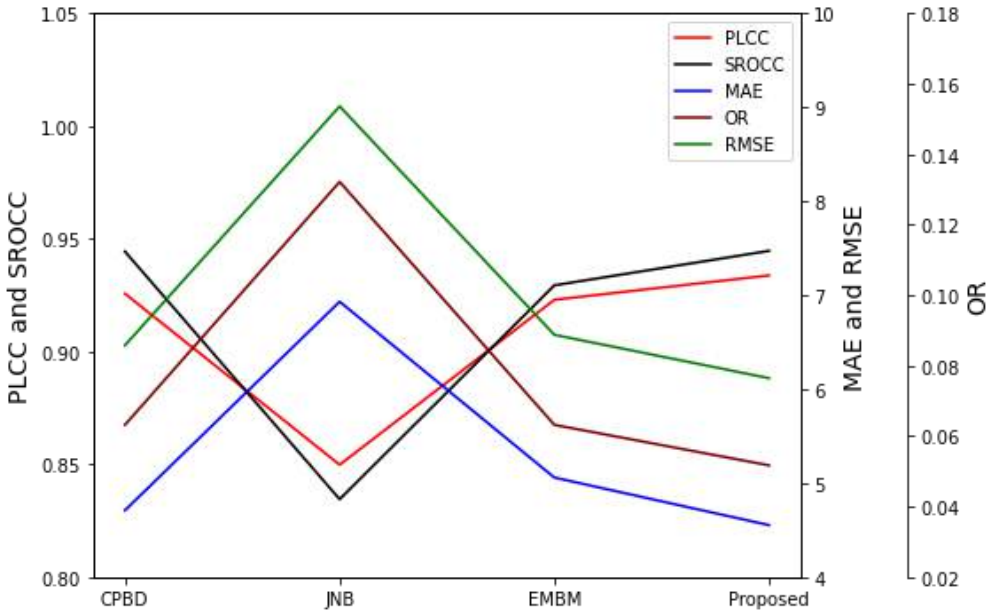

Fig.3 Performance comparison of CPBD [1], JNB Algorithm [3], EMBM Algorithm [10] and Proposed Algorithm

IV. CONCLUSIONS

A no-reference blur assessment algorithm is developed using edge analysis and the probability density function of blur detection to account for blurriness in images at varying contrast levels. By integrating the blur score produced from the probability density function model with the blur score obtained from edge analysis, the proposed technique has been shown to be able to fully predict the relative blur of images. In this work, the proposed no-reference blur assessment method outperforms over previous spatial domain approaches for Gaussian blurred images. The findings of this research reveal that the proposed metric has a lot of promise for usage in real-world blur evaluation applications. The method for detecting blur in movies and 3-D visual material might be expanded in the future to include other elements such as timing and depth consequences on blur perception.

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Optimized Dynamic Cluster Head Selection Algorithm for Wireless Sensor Networks

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Abstract— **Recent advances in sensor technology, increases the use of Wireless Sensor Networks (WSNs)in various application areas such as monitoring, surveillance, health, defense and many more. Sensor nodes (SNs) are deployed with self supported batteries and needs to be utilized efficiently for long network lifetime. Clustering is done to achieve the energy efficiency and stable network performance. In this research, an Optimized Dynamic Cluster Head Selection Algorithm (ODCHSA) is proposed to elect cluster head (CH) for estimating performance of WSNs. Here the proposed ODCHSA algorithm utilizes the goodness of stochastic gradient descent algorithm in addition to Artificial Bee Colony algorithm for dynamic clustering. The parametric performance is evaluated in terms of average execution time, packet loss during transmission and energy consumption and compared with the existing algorithms Ant-lion Optimization (ALO) and Genetic Algorithm (GA). The proposed work improves the quality of service of the network by providing more packet transmission with lesser time of execution and reducing energy consumption. The simulated results for ODCHSA show better performance in selecting the CH only in 2% computational time as compared to high execution time of GA and ALO. The network communication is enhanced significantly as only 4% of the packets lost during transmission as compared to existing GA and ALO and also consumes only 3% of energy whereas GA and ALO use very high energy.**

Keywords— **Cluster head selection; Energy consumption; packet loss; clustering; Optimization algorithm**

I. INTRODUCTION

Wireless Sensor Networks (WSNs) and Internet of Things (IoTs) areas currently attracted researchers and industry aspirants because of the eminent scope of these fields. Massive development of the sensors is utilized in different application areas such as disaster management, intrusion detection system, physical monitoring, inventory control operations and defense surveillance services etc [1]. This network comprises of number of self organized and spatially separated small sensors donated as nodes [2]. They perform the function of sensing attributed, processing and communicating data. Battery operated sensor are the most important element of the WSNs and they perform computations with the small embedded electronics. The major challenges in WSNs is to provide low energy consumption, enhancing network lifetime, minimizing interference in communication, improving data rate, balancing network load and quality network functioning etc. Network performance can be enhanced by dividing the total number of nodes among the network into various groups called clusters and the methodology by which the clusters formed is called clustering. Moreover CH election is an important task for WSNs. One sensor node from each cluster can be elected as cluster leader called cluster head depending on the highest energy level to provide the effective and efficient life-cycle of the network. The existing traditional techniques couldn't be applied on WSNs directly as they failed to define dynamic clustering. Some of the traditional schemes don't consider higher cluster size and some creates multiple clusters associating single node that leads to energy wastage. LEACH (low energy adaptive clustering hierarchy) was the first innovated classical approach for clustering. LEACH divides the communication process into rounds with each round including a set-up phase and a steady-state phase. It relies on cluster formation and selection of a head for each cluster. WSNs nodes are grouped into a number of clusters randomly. Based on the available energy in each sensor node; nodes elect themselves to be chosen as a CH [3]. Election process takes place to select cluster head based on the probability factor of the available energy in each node. The latter elected cluster head is responsible for the data aggregation from cluster nodes to base station [4]. LEACH-C (LEACH-Centralized) is an upgraded version of LEACH where stimulated annealing algorithm is used for optimizing CH election. The communication occurs between all the cluster members and cluster heads. Similarly, cluster heads communicate to the sink/base station (BS) node. To enhance the performance various energy efficient algorithms such as Low-Energy Adaptive Clustering Hierarchy (LEACH) and Hybrid Energy Distributed Clustering Approach (HEED) etc. are available for energy conservation of the WSNs. The mechanisms described in these algorithms relatively increase the utilization of the power in packet transmission and lengthen the life of the sensor networks. Energy-efficient clustering protocols are used to save the energy consumption. Power aware protocols, utilized optimal routes are chosen based on the energy at each node along the route [5]. Distributed Weight-Based Energy-Efficient Hierarchical Clustering Algorithm (DWEHC) is an improvement over HEED was proposed [6]. Every node in the cluster runs the DWEHC algorithm on its own iteratively (seven times) resulting in a distributed network structure. Each cluster has a CH and child nodes which are divided into levels depending on the clusters range and the minimum energy of the CH. TDMA is used for intra-cluster communication. The sensor transmits the data to its CH which forwards it to the next CH and in turn to the base station. Non-probabilistic Clustering Algorithms (NCA) adopts more specific criteria for cluster head election and formation of clusters such as nodes connectivity, residual energy transmission power, mobility etc [7]. Energy Efficient Hierarchical Clustering (EEHC) overcomes the shortcoming of one-hop communication of LEACH by extending the cluster design to multi-hops. It is a

distributed hierarchical algorithm which aims at increasing network life time [8]. Hierarchical Control Clustering (HCC) is a distributed multi-hop hierarchical algorithm. Any node in the network can initiate the formation of cluster. Many more traditional approaches deal with sensor node deployment, residue node energy, distance, time, packet delivery ratio and control overhead etc aren't capable enough for handling the proper functioning of the network and still needs to optimize this [9]. To deal with such issues and challenges advent of optimization algorithms can be used to provide an optimal solution for enhancing individual parameters and overall the performance of WSNs [10]. These optimization algorithms can obtain best results under the given circumstances and finding the optimal solution in terms of desired minimum and maximum value related to the performance parameters. Several issues in WSNs such as network lifetime, energy efficiency, cost, network complexity, average execution time, data transmission etc. can be directly related with the optimization approaches to compute optimal solutions for the problems. Some of the optimization algorithms incorporating evolutionary model are swarm Intelligence are Particle Swarm optimization (PSO), Genetic Algorithm (GA), Firefly Algorithm (FA), Ant colony optimization (ACO), Grey wolf optimization (GWO), BEES optimization Algorithm (BOA), Particle Swarm Frog leaping hybrid optimization algorithm (PSFLHOA), Elephant swarm optimization (ESO), Cuckoo search (CS), and Bat Algorithm (BA) etc. Bacterial Foraging Optimization Algorithm (BFOA) [11] solved problems of clustering and routing based on residue energy and distance. Many other existing optimization algorithms are available for solving problems related to clustering and routing WSNs.

II. Related Work

The key point to develop a clustering algorithm is distribution strategy of nodes, cluster formation method, data dissemination process, communication protection, stability, synchronization etc. The existing literature is reviewed as follows:

A. Ghoshal et al developed a routing aware optimal clustering strategy for optimizing network lifetime among various cluster heads depending upon balance node energy. In addition, the deployment of nodes and selection of CH had done through the Archimedes Spiral for achieving energy balance and longer lifetime of network. The simulated results revealed that performance of network enhanced satisfactory with respect to throughput and end to end delay. The proposed Archimedes spiral considered both cluster head as well as member nodes deployed with some predetermined locations and found that this type of arrangement provided prolonged network life time without disturbing the performance standards of network [12].

Y Zhou et al. invented improved PSO method for CH selection and enhancing network lifetime by considering distance, relay nodes and energy efficiency. The simulated results showed performed better in comparison to existing distributed and balanced clustering in terms of minimizing distance for transmission, increased network lifetime and improved energy consumption. The proposed algorithms improved overall energy consumption of the network by varying network attributes such as positions of base station, area size of network and node density [13].

H. Singh et al. presented CLA (concentric layered architecture) with PSO-C for optimal layer position and quantity of sensors for every layer to perform multi level clustering. The simulated results showed improvement in energy efficiency and lifetime of network. The performance evaluated for PSO-CLA for equal distribution of cluster heads in each layer in the diverse network condition. This proposed PSO-CLA method outperformed in terms of network lifetime and efficient use of energy improvement in comparison to BERA, PSO-C and PSO-ECHS [14].

H. Singh et al. proposed EESCP (energy efficient scalable clustering protocol) for generating balanced clusters of equal size by virtue of the distances of inter cluster and intra cluster for scalability. DA-PSO (Dragonfly algorithm based PSO) utilized the initialization of opposition based population with fast rate of convergence that results in decreasing the clustering latency and transmission of data. The simulated results outperformed in regards to balanced clustering, network lifetime, rotation ability for CH, throughput and energy consumption in comparison to the existing protocols. Also, the performance of the network is checked for different network sizes and density [15].

N. Parkash et al. calculated SA-AOA (Suitable based Antlion group with advanced optimization algorithm) for choosing the cluster head in the cluster and compared with the existing algorithms like ALO (Antlion Algorithm), GOA (grasshopper optimization algorithm), FFOA (Fruit fly Optimization Algorithm) and PSO. The simulated results revealed that the demonstrated method provided higher network lifetime, least validity and alive hubs [16].

N. Jiang et al. provided a joint solution for routing issue in wireless sensor network (WSN) by using slime mold algorithm (SMA) in conjunction with existing mobile sink traditional clustering method. The results proved that life of the network for efficient data transmission was significantly improved by 12% with good energy balancing [17].

N. Mittal presented a threshold sensitive energy efficient clustering protocol (TECP) based on Moth Flame Optimization (MFO) to provide the stable network functioning. The work utilized multihop communication among BS and cluster heads (CHs) by virtue of MFO for achieving less energy consumption and load balancing within far-away CHs. The CH election was done on the bases of MFO depending upon cluster organization and division. Also, the threshold dependent inter cluster data communication method was implemented for enhancing lifetime of WSN. The results discovered that the proposed protocol outperformed in comparison to existing techniques with respect to stability, system lifetime and energy [18].

On the basis of above literature, network lifetime and the energy consumption are the main goals to achieve good quality of a wireless network. Sensors have prefixed energy so need to be managed efficiently to prolong the network lifetime. Most of the research work is done using traditional techniques such as LEACH, HEED and their variants but natured inspired techniques still need to explore for WSN optimization due to their flexibility, low computational complexity, low cost, numerical ease etc. Very few researchers work on optimization of energy algorithms for WSN to provide better throughput, prolonged network lifetime, low packet loss, less execution time etc., so energy conservation is an open challenge to optimize energy constraints using nature inspired optimization techniques. In this paper, problem of energy consumption and improvement in network lifetime is

considered and proposed a hybrid algorithm to deal with these issues by considering health of the node, distance between the nodes and load on the node during transmission for CH selection process of WSN.

In this research paper, execution time, packet loss and energy consumption of WSNs is computed for cluster head selection using ODCHSA and compared with existing GA and ALO. Section 2 gives the related work and Section 3 provides the basic energy model. Section 4 discusses proposed ODCHSA with work flow in detail. Results and discussions are shown in section 5 and conclusion is specified in section 6.

III. ENERGY MODEL FOR NETWORK

The execution radio energy model is shown in the Fig.1 [3]. For an effective energy efficient WSN, a radio model for must have energy efficient radio channel and low energy dissipation. Here, the transmission electronics for radio channel is discussed. The transmitter dissipates energy for running the radio electronics and the power amplifier whereas receiver dissipates the energy for running the radio electronics at recipient side. The amount of consumed energy is proportional to the energy used for data transmission and reception. To transmit k bits of the data over the specific distance d using this energy model requires the amount of energy as provided in eq. (1, 2, 3).

$$E_{Tx}(k,d) = E_{Tx-elect}(k) + E_{Tx-amp^r}(k,d) \tag{1}$$

$$= \begin{cases} (kE_{elect} + k\varepsilon_{fs} \times d^2), d < d_{th} \\ (kE_{elect} + k\varepsilon_{amp^r} \times d_{toBS}^4), d \geq d_{th} \end{cases} \tag{2}$$

$$= \begin{cases} k(E_{elect} + \varepsilon_{fs} \times d^2), d < d_{th} \\ k(E_{elect} + \varepsilon_{amp^r} \times d_{toBS}^4), d \geq d_{th} \end{cases} \tag{3}$$

Here ε_{fs} = power consumption of free space propagation

ε_{amp^r} = power consumption of multipath propagation

E_{elect} = or energy dissipated per bit of the network model

d_{th} = threshold value of distance

ε_{fs} & ε_{amp^r} = transmitter amplifier power characteristics for free space and multipath respectively [8-9].

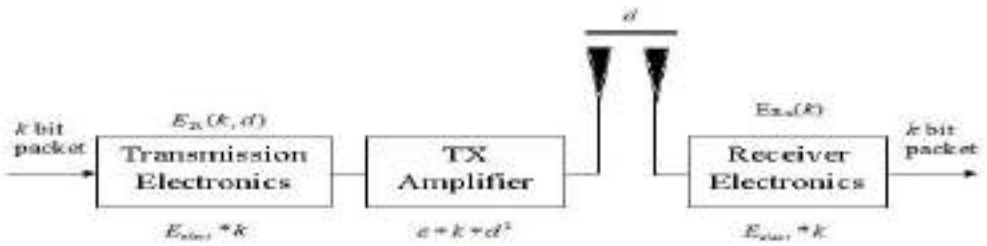

Fig.1 Network Energy Model

These models can be described on the basis of the distance between transmitter and receiver as compared with the threshold distance value d_{th}. If the threshold value d_{th} is less, the free space channel model (d^2 power loss) is used or else (d^4 power loss) multipath fading channel is applied. The power amplifier is utilized appropriately to adjust this power loss [9]. The amount of energy required to receive k bits at receiver is as given by equation 4. Also, the threshold value d_{th} can be represented as the ratio of ε_{fs} and ε_{amp^r} in eq. (4,5).

$$E_{Rx}(k) = E_{elect} * k \tag{4}$$

$$d_{th} = \sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{amp^r}}} \tag{5}$$

Our proposed network architecture is inspired by the nature optimization technique known as optimized dynamic cluster head selection algorithm (ODCHSA). Proposed ODCHSA is used for clustering in the model which depends upon the energy, distance between the nodes and the node health i.e. whether it is alive or not depending on the desired threshold value. In the forthcoming section the discussion is illustrated in details.

IV. Proposed Optimized Dynamic Cluster Head Selection Algorithm

The CH selection is a challenging issue in WSNs. For optimum selection of CH an optimized dynamic cluster head selection algorithm is proposed. Here an hybrid approach is used by integrating artificial bee colony algorithm (ABC) with the goodness of stochastic gradient descent (SGD) algorithm. The proposed approach is used to elect CH dynamically for hierarchal clustering (HC) using random deployment to obtain better performance parameters of the WSNs. The proposed optimized dynamic cluster head selection algorithm (ODCHSA) contributes as follows:

1. An optimized approach named as ODCHSA includes characteristics from ABC and SGD is proposed.
2. The proposed ODCHSA is presented for CH selection based on residue energy, distance between the node and load on the node for performance enhancement of WSNs.
3. It deals with CH selection in different steps such as random deployment for HC, choosing cluster heads using ODCHSA process and SGD priority vector used to build fitness.
4. Data transmission is presented with the shortest path routing
5. Comparative simulation analysis is provided with the existing algorithms named as GA and ALO.

Here the working of ODCHSA is presented for CH selection and packet transmission for efficient working of WSNs.

A. Proposed Network Architecture

The processing architecture of the proposed simulation for various sub-modules that are working together to form a network and will make the transmission of data packets from one location to another. Proposed architecture utilizes dynamic clustering algorithm with hierarchical cluster (HC) formation to achieve the energy efficient routing. CH selection is done on the basis of residue energy on the node and calculated the weight matrix. Another parameter is considered for the CH election is load on the node and it should be minimum for the selection. Lastly the distance matrix is considered among the sensor nodes for efficient selection of head nodes. For proposed network architecture sensor nodes are deployed with the initial parameters for instance number of nodes, network size, number of clusters, initial energy of the node, positions for the nodes transmission radius, simulation time, packet size and round time.

The network coverage is calculated by coverage distance for creation of distance vector. It helps to route packets in efficient manner. The coverage vector used to form routes in the network after selection of source and destination for sensed data transmission. All the calculated routes are processed with the shortest route selection modules with graph theory. It helps to provide low cost routes and intermediate nodes for transmission. The packets transmit from one to another location through selected route and after specific iteration the selection of head performed on the network nodes. It will help to reduce the dead node count and make high rate of network lifetime. This process executed with hybrid optimization technique ODCHSA to calculate best fitness value and priority vectors for the final selection. Once transmission completed, network show all the processed parameters and show comparison of various calculation matrixes. In the beginning, process for deployment of sensor node is completed using the HC approach. Then cluster formation and head selection for the respective cluster is done through ODCHSA where the data is sensed and specified the source and destination nodes for data aggregation. Once the data is aggregated route formation and selection is done by using the shortest path routing approach. As soon as the path selected the transmission of the packets started.

The network parameters have been calculated for the performance evaluation of network in terms of energy consumption, network lifetime, execution time and packet loss. The hybrid approach to find the dynamic cluster heads in the network is shown in Fig. 2. Various steps from clustering to selection of head processed with the proposed hybrid approach. Here, in the initial steps, the flows running with the hierarchical clustering technique to deploy the sensor nodes and bind them with CH. The random deployment processed with the hierarchical clustering to achieve this step in the overall flow.

After this, second phase of the proposed algorithm used to find the optimal cluster heads with optimization process. It optimize the clusters on behave of various parameters and SGD priority analysis to build fitness values. The selection process execute last and final step to find the optimal cluster head on the behalf calculated fitness value. After the selection, network transmits data and optimization process run behind for selection dynamic cluster heads for all the clusters. Initially the sensor deployment is done using the HC approach as shown in Fig. 2. The clusters have been formed and by calculating initial parameters of the network nodes. The selection of cluster heads is considered on the parameters such as energy, distance between the nodes and network load on the node. The coverage weight is calculated directly proportional to the energy and health of the node with distance weight vector and also inversely proportional to the load vector i.e load on the node. After calculating the coverage weight priority to be elected as head is calculated using stochastic gradient descent. The simulations have been done to calculate new solutions with number of iterations for calculating best head location. The process is repeated for all clusters and then the task is terminated.

The proposed ODCHSA approach is formulated for CH selection and the main aim is to maximize the network lifetime and reduce the energy consumption. The details of mathematical characteristics have been discussed by following equations:

Firstly, sensors known as bees in the network are randomly deployed in the search area. The average energy of each sensor is calculated by eq. (6)

$$En_{avg} = \frac{En_{sn1} + En_{sn2} + ...En_{snN}}{N_L} = \frac{\sum_{i=1}^{N} En_{sn(i)}}{N_L} \tag{6}$$

where $En_{sn(i)}$ is the energy of the node and N_L the living node number

Then all the nearby locations of the nodes from the node $sn(i)$ are computed and the distance between these nodes and $sn(i)$ is evaluated as weight (w) of $sn(i)$ parameter by eq. (7).

$$weight(sn(i)) = \frac{En_{sn}}{\sum_{dis=p}^{dis=q} dis(sn(i), sn(p) + .. + dis(sn(i), sn(q)} \quad (7)$$

Where dis is the distance between the node sn(i) and its neighbors, En_{sn} is the node sn(i)'s residual energy.

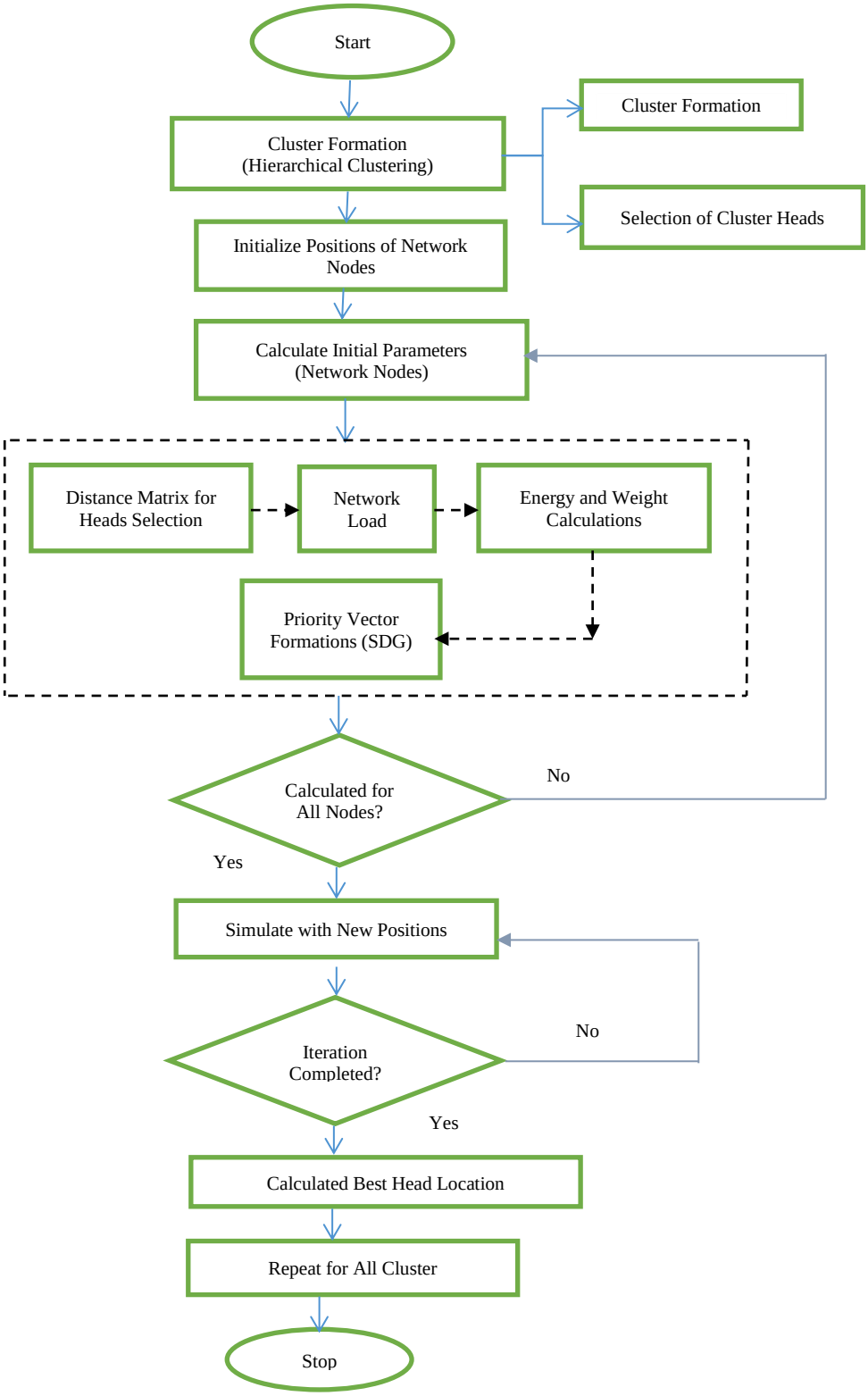

Fig.2 Cluster Head Selection Flowchart

Thereafter $SNL_{sn(i)}$ is computed depending upon living nodes and neighboring nodes. CH is elected on the highest value of $SNL_{sn(i)}$ and is given by eq. (8):

$$SNL_{sn(i)} = \frac{Nebr(sn(i))}{N_L} \tag{8}$$

where $SNL_{sn(i)}$ is the the neighbor life of sn(i) and $Nebr$ is the number of neighbors of nodes sn(i).

Then following eq. (9) is implemented after computing the value of $SNL_{sn(i)}$ to validate the solution.

$$P(sn(i)) = \begin{cases} \dfrac{C_p}{1 - C_p * \{round \bmod (\dfrac{1}{C_p})\}} ....sn(i) \in g \\ 1.....sn(i) \in g \end{cases} \tag{9}$$

Where C_p is CH's probability in every round and is actually the ratio of total CH number and nodes, $round$ is the current round value, g is the group of nodes not being elected for $\frac{1}{C_p}$ rounds.

Now load on the node is calculated as the rate of routed packets in specific time and expressed by eq. (10) as :

$$Load(i) = \sum_{r=0}^{W_{k,i}} \frac{Rp_r}{t} \tag{10}$$

Where Rp_r is the packet on the route and $W_{k,i}$ is the C distance matrix and will be computed by using locations of the nodes x and y and may be expressed with eq. (11) as:

$$C = \sqrt{(Loc\_x2 - Loc\_x1)^2 - (Loc\_y2 - Loc\_y1)^2} \tag{11}$$

Depending on the Load and on the node, health of the node and residue energy the fitness value of the function is calculated by eq. (12) as follows:

$$f(C_{w(i)}) = \sum_{i=1}^{n} \frac{F(1)}{Load(i)} \tag{12}$$

$$\text{Here } F(1) = (E_{k,i} h_{k,i} * \max(\sum_{s=0}^{W_{k,i}} w_{k,s}))$$

Where $E_{k,i}$ is the energy and $h_{k,i}$ is the health of the node whether it is alive or not.

The overall fitness is calculated as per eq. (13):

$$fitness(C_{w(i)}) = Min(Load(i)) + Max(F(1)) \tag{13}$$

The final CH is further optimized using stochastic gradient descent (SGD) on the basis of priority vector by expression given by eq. (14):

$$q_{sn} = q_{sn-}\alpha(\hat{y}^t - y^t)x_{sn}^t \tag{14}$$

Where sn is the range of sensor data

All the sensor data samples need to be operated by the traditional gradient descent optimization for every iteration until the minima is achieved. Here in SGD, this applies only a single sample to be used for every iteration on the bases of random selection (N. Padmapriya et al., 2021). The cost function need to be calculated a single data at every iteration instead of the addition of the gradient among all the samples. Initially the weight for CH is used and error is calculated minima for coverage weight. New predicted weights are used for adjustment till the significant value achieved. The Pseudo code is given here as under:

PSEUDO CODE FOR PROPOSED ODCHSA FOR CH SELECTION

Input: Nodes of clustered network simulation
Output: Optimized cluster-head

// processing phase 1

Start
// Initialization process of network nodes and parameters
N = total number of nodes.
For all-nodes-of-network **do**
Init. Positions=**true**
C_distance_matrix=$\sqrt{(loc\_x2 - loc\_x1)\text{^}2 - (loc\_y2 - loc\_y1)\text{^}2}$
End

// processing phase 2

For all-clusters k **do**

For all-placed-node i **do**

If $node_{k,i}$ not in dead-vector **then**

$w_{k,i}$=C_distance_matrix$_i$. // calculated distance vector weight

$$L_i = \sum_{r=0}^{w_{k,i}} \frac{Rp_r}{t}$$ // calculated load vector

$$\text{Calculate-weight}_i = \sum_{i=1}^{n} \frac{\left(E_{k,i} h_{k,i} * \max\left(\sum_{s=0}^{w_{k,i}} w_{k,s}\right)\right)}{L_i}$$

Find-priority-vector= SDG(Calculate-weight$_i$)

// processing phase 3

If cost.node>Find-priority-vector //then node become head

end

end

end

end

end

V. RESULTS AND DISCUSSIONS

This section provides the result and discussion related to the communication between the nodes inside and outside the cluster, energy consumption, packet loss and average computation time related to the proposed network as described in Table-1. The sensor nodes for proposed network architecture are deployed with the initial parameters shown in Table-1. The coverage is calculated by using distance vector that routes packets in efficient manner. The sensed data by the sensors is transmitted between the source and the destination over the routes formed by coverage vector. All the routes are calculated by the shortest path selection modules with graph theory. The sensor nodes for proposed network architecture are deployed with the initial parameters shown in table. The coverage is calculated by using distance vector that routes packets in efficient manner. The sensed data by the sensors is transmitted between the source and the destination over the routes formed by coverage vector. All the routes are calculated by the shortest path selection modules with graph theory.

TABLE –I PROPOSED ODCHSA NETWORK SIMULATION PARAMETERS

Parameters	Proposed protocol
Network size	100 m x 100 m
Number of nodes	100
Number of clusters	Variable
Initial energy of nodes	5 J
Position of nodes	Between (0,0) and (100,100)
Round time	20 s
Transmission radius	30 m
Simulation time	3600 s
Packet size	2000 bits

The Fig.3 shows the plotting of various nodes and cluster heads. The CH from each cluster can be selected randomly with every iteration and is chosen particularly on runtime. The CH selection is done dynamically and performance is optimized using GA on the basis of residue energy. Fig.4 shows the plotting of various CH and nodes on random basis. The CH selection is done dynamically and performance is optimized using ALO on the basis of available node energy. The Fig. 5 illustrates the plotting of randomly deployed sensor nodes and cluster heads. The cluster head among each cluster can be selected in every iteration on the basis of residual energy and distance between the nodes. The CH selection is done dynamically and performance is optimized using ODCHSA on the basis of energy consumption.

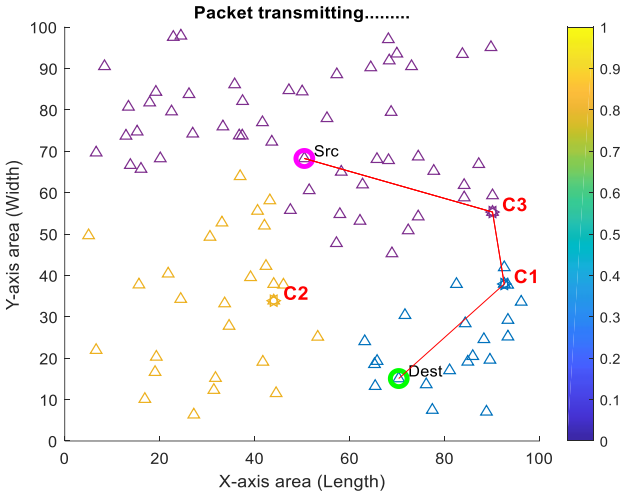

Fig.3 Existing GA communication plot for clustering

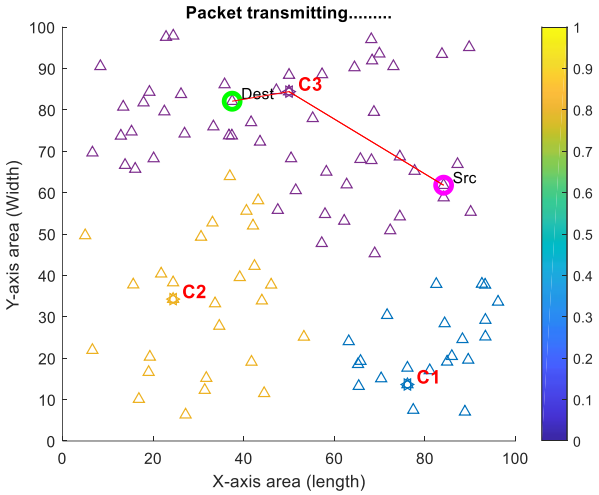

Fig.4Existing ALO communication plot for clustering

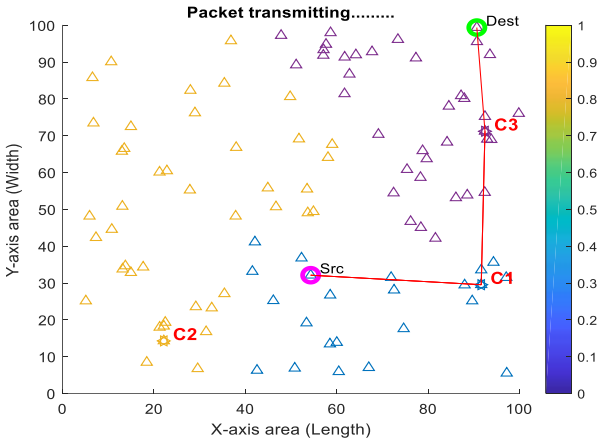

Fig.5 Proposed ODCHSA communication plot for clustering

The Fig.7 depicts that proposed ODCHSA consumes less energy in comparison to GA and ALO. The energy parameter is used to calculate the cost of network. Each node has its initial energy. As soon as the energy of node gets dissipated completely, it dies thereby affecting the network lifetime. Higher energy consumption leads to high network cost and less network lifetime. Therefore, energy consumption should be as less as possible. The better approach for clustering results in lesser energy consumption. The proposed algorithm uses dynamic clustering technique to determine the cluster heads which leads to minimum energy consumption. The graph also depicts that the proposed algorithm consumes less energy as compared to the existing algorithms which leads to better network performance.

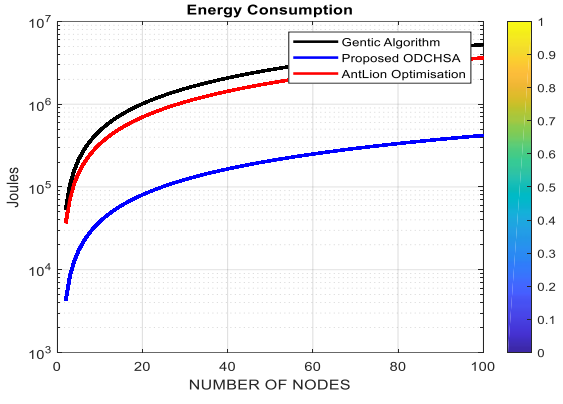

Fig.6 Energy consumption (Joules) plot for GA, ALO and proposed ODCHSA

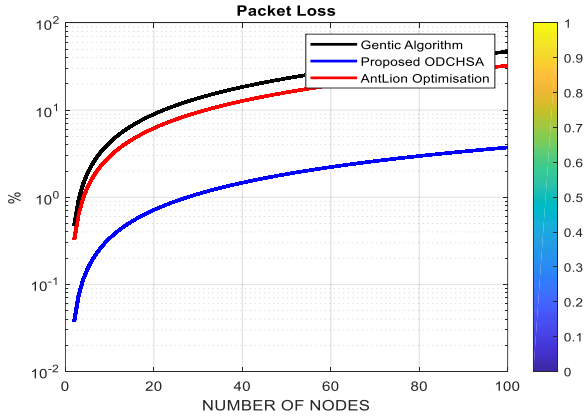

Fig.7 Packet Loss plot for GA, ALO and proposed ODCHSA

The Fig.7 shows the plot for packet loss comparison of GA, ALO and proposed ODCHSA. Packet loss is a condition when the network communication gets lost during transmission and some of the packets don't reach the destination. The increase in the packet loss indicates the degradation of network performance as the destination user receives incomplete data. The proposed ODCHSA algorithm is used to process the network and is responsible for the network communication between nodes. It

provides better cluster heads to meet the communication requirements and provide better network performance. The graph reveals the comparative results of the proposed algorithm with the existing GA and ALO algorithms. It depicts that the proposed algorithm has lower rate of packet loss as compared to the existing ones. It shows that the destination user receives maximum amount of data which leads to better network performance.

The Fig.8 depicts that proposed ODCHSA takes less time for execution for more packets during transmission in comparison to GA and ALO. Average computation time is basically the time span required for selection of dynamic cluster head during the transmission process. Lesser the computation time, better is the network performance. The computation time involves the execution speed and calculation of various network properties. The selection of cluster heads affects the network performance in terms of network speed. Here in the Fig.9, the proposed ODCHSA algorithm consumes less time as compared with other approaches that leads to increase in the network speed which in turn decreases the average computation time. The proposed ODCHSA is compared to GA and ALO for better functioning of WSNs and to provide the enhanced quality of service.

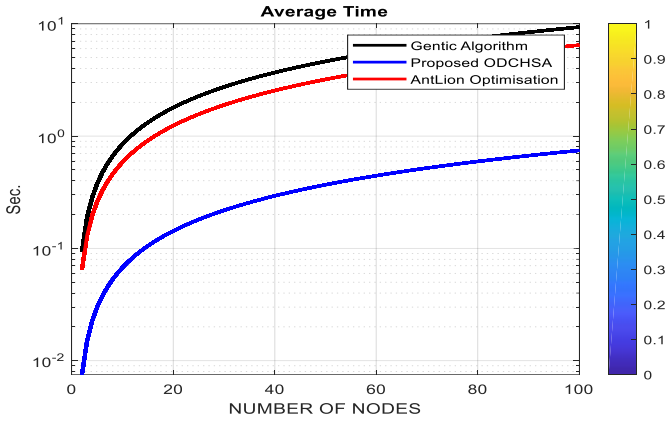

Fig.8 Average Execution time (sec) plot for GA, ALO and proposed ODCHSA

.Here the summary is provided in Table-II related to the proposed network. Table -II provides the simulated results on different number of nodes for various algorithms to calculate the energy consumption, average time, network lifetime and packet loss for CH selection process of the network for checking robustness as per the simulation parameters given by Table-I. As per the table given below the performance in calculated in percentage among various simulated techniques for the given scenario as per table-I.

TABLE –II PROPOSED ODCHSA NETWORK SIMULATION PARAMETERS

Nodes	Algorithms	Execution Time (sec)	Packet loss (%)	Energy Consumption (J)
40	ALO	1.59	7.94	0.89
	GA	1.33	6.67	0.75
	ODCHSA	0.32	1.59	0.17
50	ALO	2.09	10.44	1.18
	GA	2.00	10.01	1.13
	ODCHSA	0.35	1.77	0.19
60	ALO	2.89	14.45	1.63
	GA	3.04	15.18	1.71
	ODCHSA	0.45	2.26	0.26
70	ALO	3.48	17.40	1.96
	GA	4.75	23.74	2.67
	ODCHSA	0.50	2.50	0.28
80	ALO	6.73	33.67	3.79
	GA	9.08	45.38	5.11
	ODCHSA	0.74	3.70	0.42
90	ALO	5.40	26.99	3.04
	GA	7.71	38.53	4.34
	ODCHSA	0.72	3.58	0.43
100	ALO	6.46	32.29	3.64
	GA	9.35	46.74	5.26
	ODCHSA	0.41	3.01	0.32

Fig. 9 (a), (b) & (c) shows the simulated performance evaluation of the proposed algorithm for computing analysis of various parameters. The result revealed that ODCHSA provides only 4% times the packet loss that is appreciable for the

network data aggregation and also the CH is selected with the less execution time only of the order of 2% in comparison to the other existing techniques. The energy consumption for the proposed ODCHSA is very less as compared to the other simulated methods and enhances the longevity of the network by consuming only 3% of the energy as compared to the other existing methods. Fig.10 shows the performance evaluation of GA, ALO and proposed ODCHSA.

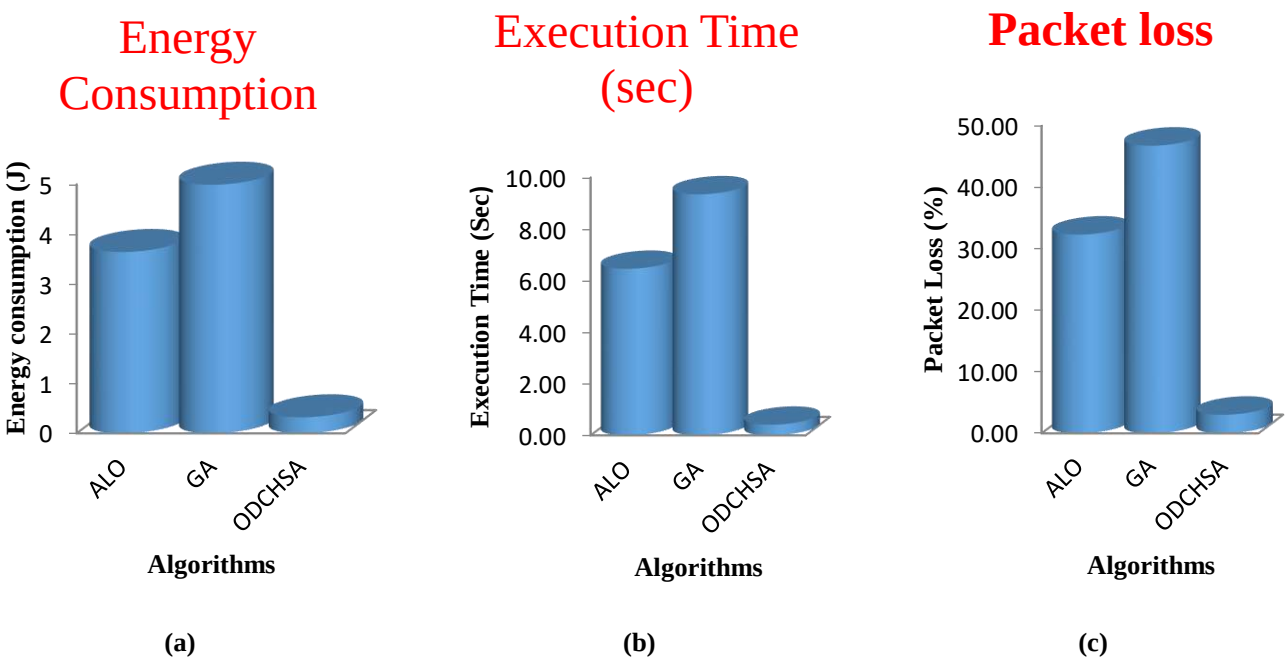

Fig.9 (a) to (c) Performance evaluation of GA, ALO and proposed ODCHSA

VI. CONCLUSIONS

To ensure the proper function of the network, energy and execution time is paying role of the key factor. Data packets should be delivered taking less time of execution for efficient communication process among the network. Also, the lesser energy consumption is required by the network for longer operability. In this paper an optimized dynamic cluster head selection algorithm is proposed to improve the energy consumption and execution time of WSNs for better performance. Here the CH selection is done by applying ODCHSA and heads are changed dynamically on random basis for every round. Every node in the cluster associated to head has its own initial energy. Depending on this available energy on the node CH is elected. Once the head is selected the gathered packets from the clusters is communicated during transmission to the base station keeping in view for less time for execution. The transmission within the cluster is done among the cluster members directly and through CH outside the cluster. The simulation results revealed that ODCHSA takes less time for execution for more packet transmission in lesser energy which in turn results in lengthen network lifetime. GA and ALO take more time in comparison to proposed ODCHSA. The proposed ODCHSA outperforms with only 2% of computation time in comparison to existing GA (58%) and ALO(40%) for CH selection. The simulated results for proposed ODCHSA showed that less energy of the order of 3% is consumed in comparison to GA (57%) and ALO (4%) which provide longer system operability and maximum data speed with low complexity by using the concept of dynamic clustering for selecting the cluster heads which leads to better routing and delivery of more packets within less time span in the network. For good quality transmission the proposed clustering algorithm depicts that it has lower rate of packet loss ODCHSA 4% only in comparison to GA (57%) and ALO (39%) as compared to the existing ones and shows that the destination user receives maximum amount of data which leads to better network performance. The Proposed ODCHSA showed better results in comparison to existing GA and ALO in terms of lesser energy consumption, minimum average execution time and lower rate of packet loss.

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Evaluations of a mode-division multiplexed-free-space optics transmission system under rainy weather and scintillation effects

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Abstract – **We report the modelling and evaluations of a mode-division multiplexed-free-space optics transmission system capable of concomitantly transporting 2-data channels at 10 Gbps over 2-distinct Hermite-Gaussian (HG) modal channels of a single-wavelength laser source. The net data transportation rate achieved is 20 Gbps for single-channel and transmission quality is evaluated for return-to-zero (RZ) and non-return-to-zero (NRZ) encoding schemes. The proposed setup is evaluated under varying rainy weather conditions using bit error rate, quality factor, and eye plots as the metrics of performance evaluation. The results demonstrate better signal transmission employing NRZ scheme. Also, impact of varying scintillation on the proposed setup is evaluated and results demonstrate significant performance degradation in terms of received signal's quality.**

Keywords – FSO; rainy-weather; MDM; range; scintillation effects

1. Introduction

The application of laser beams to transport data signals over free-space as the medium of propagation, also referred to as free-space optics (FSO) technology has garnered enormous attraction of the telecommunication engineers and scientists due to its abundant merits. FSO technology exploits the visible to far infrared portion of electromagnetic spectrum for carrier signals, which are abundantly available and do not require any permissions and expensive licensing as in the case of conventional radio-frequency wireless communication systems [1-3]. They have a small footprint as the components and devices used in the deployment of FSO system have low mass, are light-weight, and are very power-efficient [4, 5]. FSO systems have very large channel bandwidth capacity and can support very high data transportation rates and therefore are witnessed as a promising candidate for next-generation wireless transmission networks which can readily support the ever-rising network capacity and data transmission speed demands as a result of rising usage of variety of multimedia applications like social-networking, web-streaming, and teleconferencing, etc. [6-9]. Further, due to the deployment of very narrow optical beam signals as the information carrier, they are very secure since it is very difficult to tap laser beam signals and any attempt to tap the signal will results in line-of-sight obstruction and ultimately link failure [10, 11]. Moreover, the laser signals are immune to interference from electromagnetic waves and radio-frequency carrier signals employed for other applications and result in low-latency, readily availability, and high-throughput transmission systems [12, 13]. All these mentioned merits of FSO systems make them a crucial and promising candidate for 5^{th} generation mobile communication services [14, 15]. Although, there are a number of benefits of deploying FSO systems for data transportation, but the signal degradation as a result of attenuation caused by external atmospheric conditions and scintillation effects are a reason of major concern while practically deploying FSO links [16]. In tropical countries like Malaysia and India, the major concern is signal attenuation offered by rainy weather conditions which may result in 6.27 dB/km to 19.28 dB/km signal attenuation depending on the type of rain [17].

In conventional works reported on high data transportation rate FSO system, most of the researchers have employed wavelength-division multiplexed (WDM) signals to carry multiple data signals concomitantly and enhance the data capacity of the system. In the year 2017, M. Grover et al. [18] have reported the implementation of a WDM-FSO system transporting high data rate information over clear sky climate using multi-beam transmission technology. The authors have reported favourable transportation along 53 km for clear and 8.5 km for hazy climate using 32 laser diodes. In the year 2017, P. Krishnan et al. [19] reported the implementation of a WDM-FSO system and evaluated its performance for Vellore, Tamil Nadu, India conditions by employing spectrum-slicing technique. The authors reported favourable transportation along 140 km for clear and 2.7 km for heavy-foggy weather by employing 4, 8, and16 laser diodes. In the year 2018, J. Jeyaseelan et al. [20] reported the implementation of a WDM-FSO system by employing amplitude-shift keying and polarisation-shift keying scheme. The authors reported favourable 10 Gbps transportation along 5.8 km for heavy-foggy weather by employing 4 laser diodes. In the year 2018, M. Singh [21] reported the implementation of 32-laser channel WDM-FSO system along 1.07 km range for snowy-weather conditions. In the works discussed in [18-21], multiple laser diodes have been employed which result in augmenting the cost of system implementation [22, 23]. An emerging cost-efficient high data transportation rate technology is mode-division multiplexing (MDM), which transports independent multiple data signals by utilizing different spatial modal sets of a single-wavelength laser diode [24-27]. In this work, we report the implementation of a MDM-FSO data transportation system and evaluate its performance for different rainy weather and scintillation effects.

2. Implementation of MDM-FSO transmission system

Fig. 1 explicate the implementation of proposed MDM-FSO system, where 2-independent 10 Gbps return-to-zero (RZ)/non-return-to-zero (NRZ) signals (Fig. 2) are transported by simultaneous modulation over 2-distinct Hermite-Gaussian (HG) modal channels i.e. HG00 and HG01 (Fig. 3).

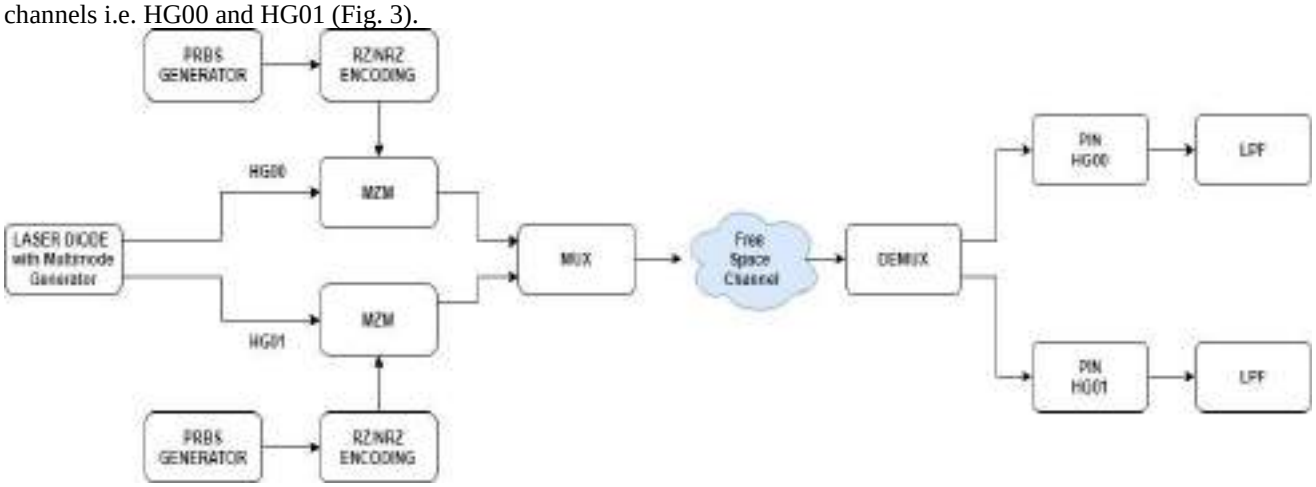
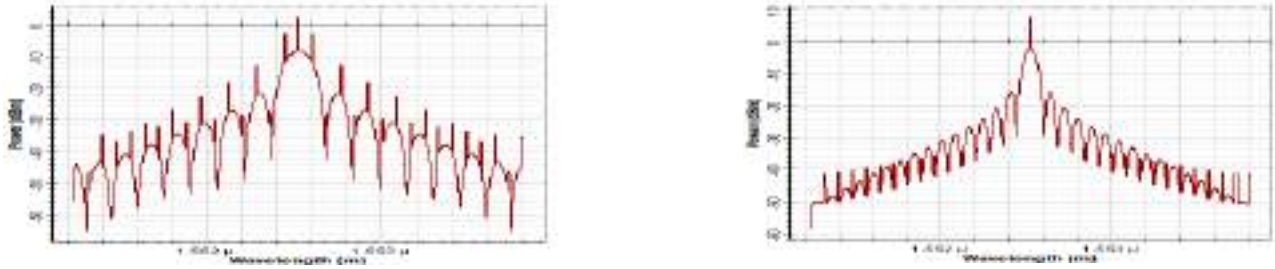
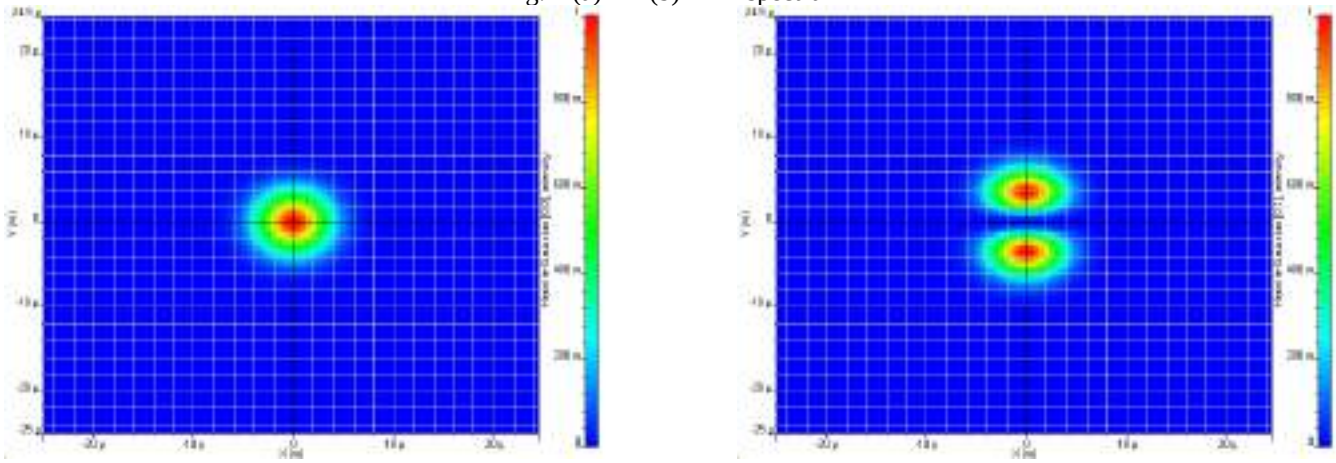


Fig. 1 MDM-FSO implementation



(a) (b)

Fig. 2 (a) RZ (b) NRZ spectrum



(a) (b)

Fig. 3 (a) HG00 modal channel (b) HG01 modal channel

For both the data channels, information at 10 Gbps rate is produced by PRBS component. Binary-to-electrical conversion of information bits is achieved using RZ/NRZ encoding. Each electrical signal is modulated at optical frequency using distinct HG spatial modal channels from a multimode laser and an independent MZM. Both spatially modulated signals are multiplexed and transmitted over free-space channel. At demodulator section, independent channels are de-multiplexed and each information signal is retrieved using PIN-photodiode and a low-pass filter (LPF). The FSO link is modelled as [28]:

$$S_r = S_t \times \left[\frac{d_r^2}{(d_t + \theta Z)^2}\right] \times 10^{-\sigma Z/10} \quad (1)$$

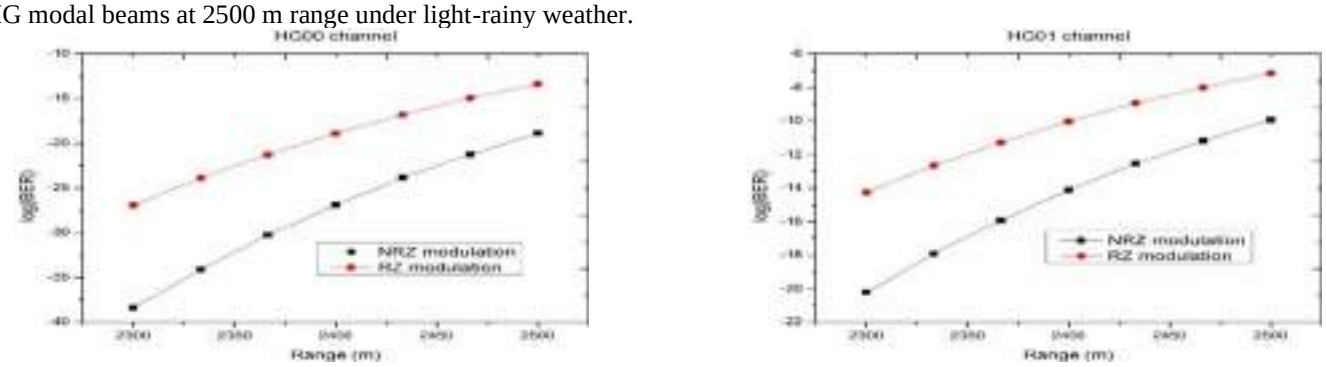
where,

S_r – power captured by receiver lens
S_t – power of the laser diode
θ – beam width
Z – range of FSO transmission
d_r – receiver lens diameter
d_t – transmitter lens diameter
σ – atmospheric attenuation coefficient

The link and system simulation parameters, which have been considered while evaluating the proposed systems' performance have been taken as per practically available FSO solutions as reported by the authors in [29, 30].

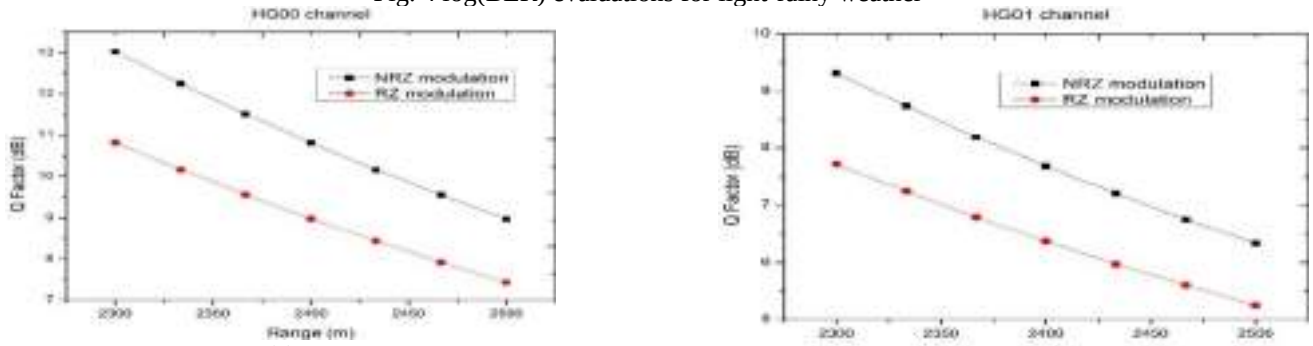
3. Results

Fig. 4 and 5 reveal the performance curves of the proposed system in terms of log(BER) and Q Factor plots respectively under light-rainy conditions. Fig. 4 shows that for light-rainy weather, for HG00 channel, log(BER) is -38.38, -26.86, and -18.84 for NRZ modulation and -26.88, -18.87, and -13.30 for RZ modulation at 2300, 2400, and 2500 m respectively. Alternatively for HG01 channel, log(BER) is -20.20, -14.11, and -9.92 for NRZ modulation and -14.25, -10.03, and -7.12 for RZ modulation at 2300, 2400, and 2500 m respectively. Fig. 5 shows that for light-rainy weather, for HG00 channel, Q Factor is 13.02, 10.81, and 8.97 dB for NRZ modulation and 10.82, 8.97, and 7.44 dB for RZ modulation at 2300, 2400, and 2500 m respectively. Alternatively, for HG01 channel, Q Factor is 9.31, 7.68, and 6.33 dB for NRZ modulation and 7.72, 6.36, and 5.25 dB for RZ modulation at 2300, 2400, and 2500 m respectively. Fig. 6 shows the eye plots for different modulation schemes using different HG modal beams at 2500 m range under light-rainy weather.



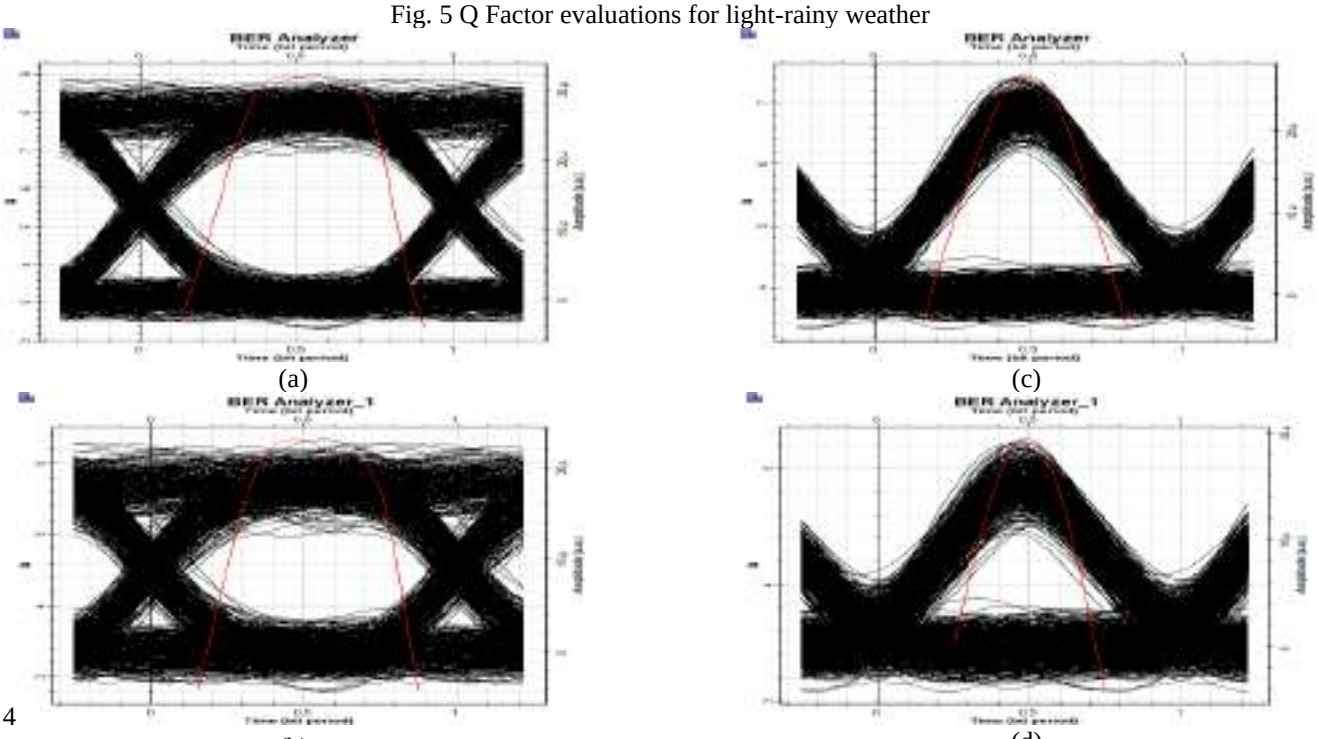
(a) (b)

Fig. 4 log(BER) evaluations for light-rainy weather



(a) (b)

Fig. 5 Q Factor evaluations for light-rainy weather

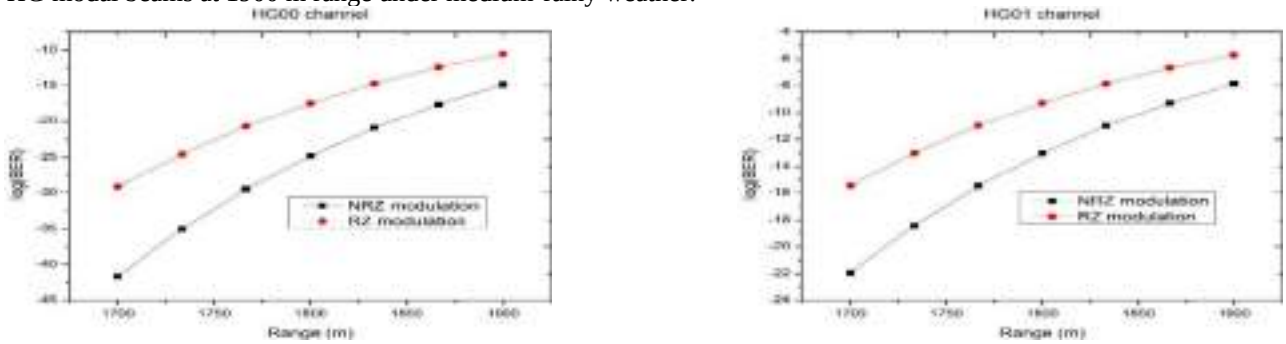


(a) (c)

(b) (d)

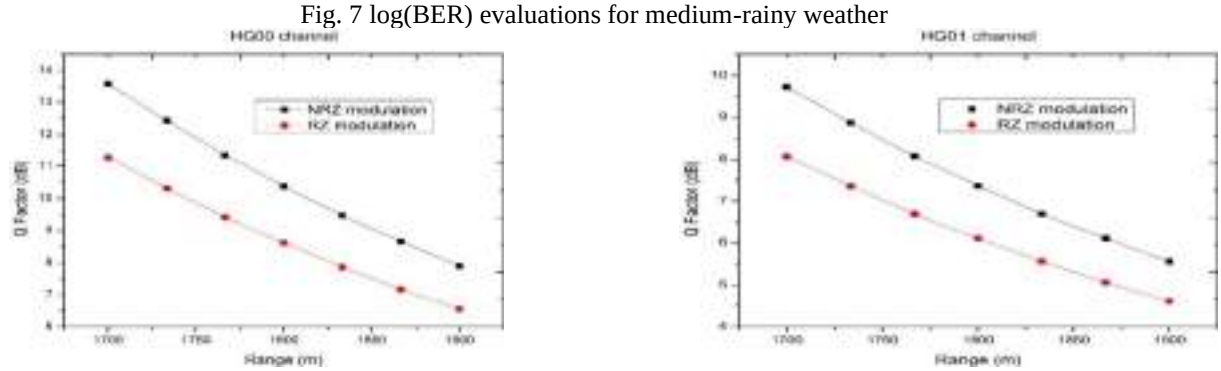
Fig. 6 Eye plots at 2500 m for light-rainy weather for (a) NRZ-HG00 channel (b) NRZ-HG01 channel (c) RZ-HG00 channel (d) RZ-HG01 channel

Fig. 7 and 8 reveal the performance curves of the proposed system in terms of log(BER) and Q Factor plots respectively under medium-rainy conditions. Fig. 7 shows that for medium-rainy weather, for HG00 channel, log(BER) is -41.63, -24.80, and -14.83 for NRZ modulation and -29.14, -17.44, and -10.53 for RZ modulation at 1700, 1800, and 1900 m respectively. Alternatively for HG01 channel, log(BER) is -21.93, -13.03, and -7.85 for NRZ modulation and -15.45, -9.28, and -5.69 for RZ modulation at 1700, 1800, and 1900 m respectively. Fig. 8 shows that for medium-rainy weather, for HG00 channel, Q Factor is 13.58, 10.37, and 7.89 dB for NRZ modulation and 11.29, 8.61, and 6.54 dB for RZ modulation at 1700, 1800, and 1900 m respectively. Alternatively, for HG01 channel, Q Factor is 9.72, 7.35, and 5.55 dB for NRZ modulation and 8.06, 6.10, and 4.60 dB for RZ modulation at 1700, 1800, and 1900 m respectively. Fig. 9 shows the eye plots for different modulation schemes using different HG modal beams at 1900 m range under medium-rainy weather.



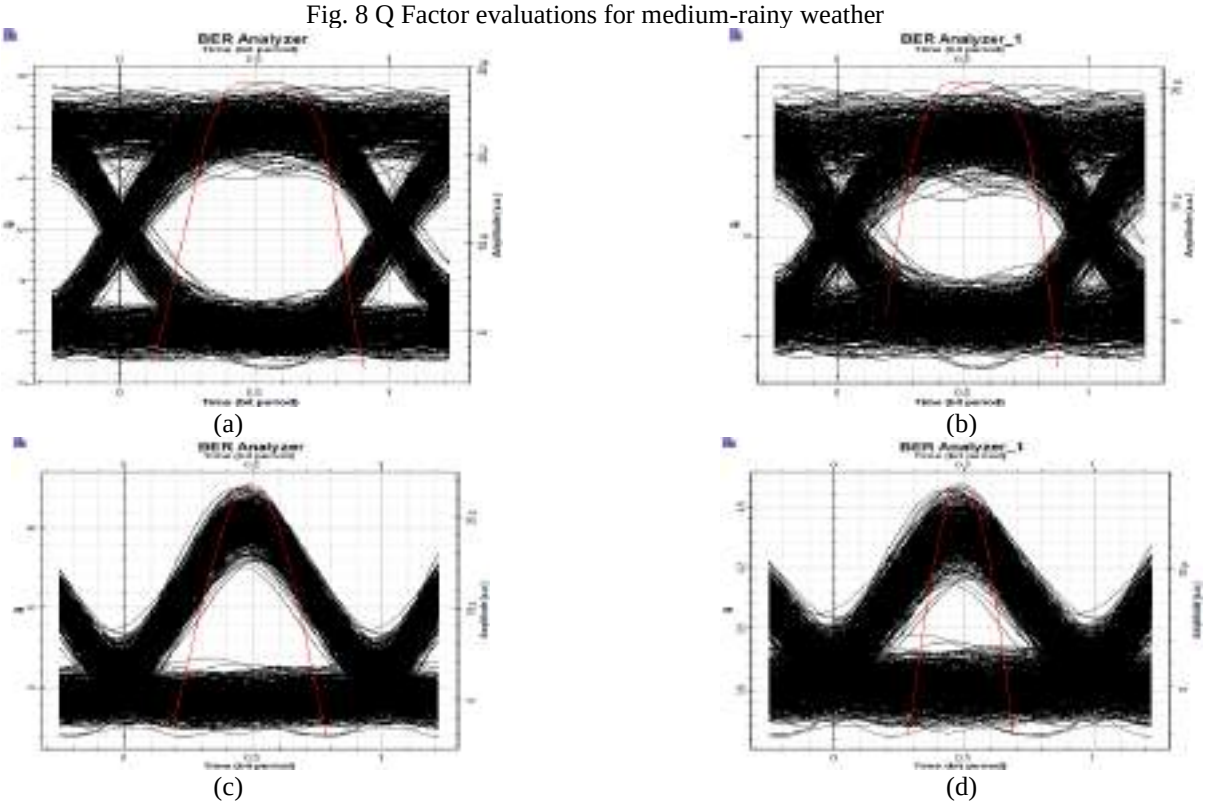
(a) (b)

Fig. 7 log(BER) evaluations for medium-rainy weather



(a) (b)

Fig. 8 Q Factor evaluations for medium-rainy weather

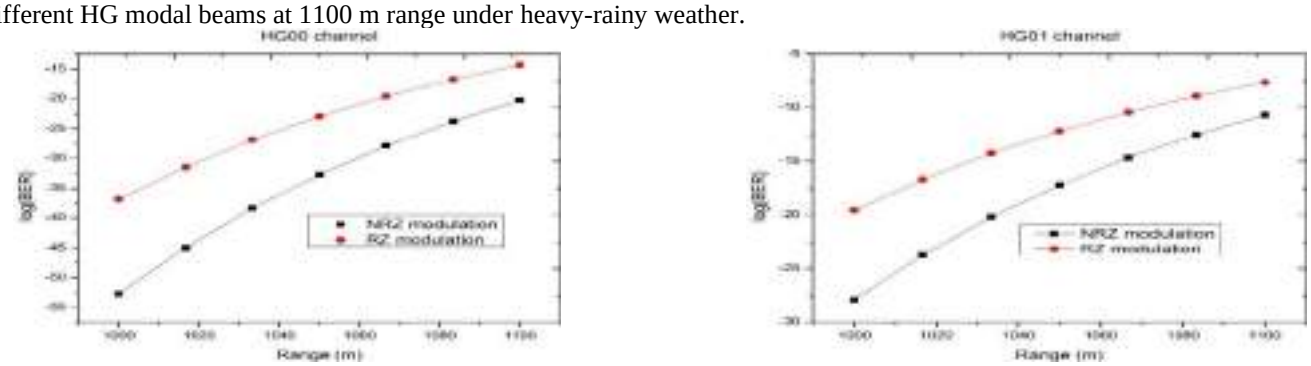


(a) (b)

(c) (d)

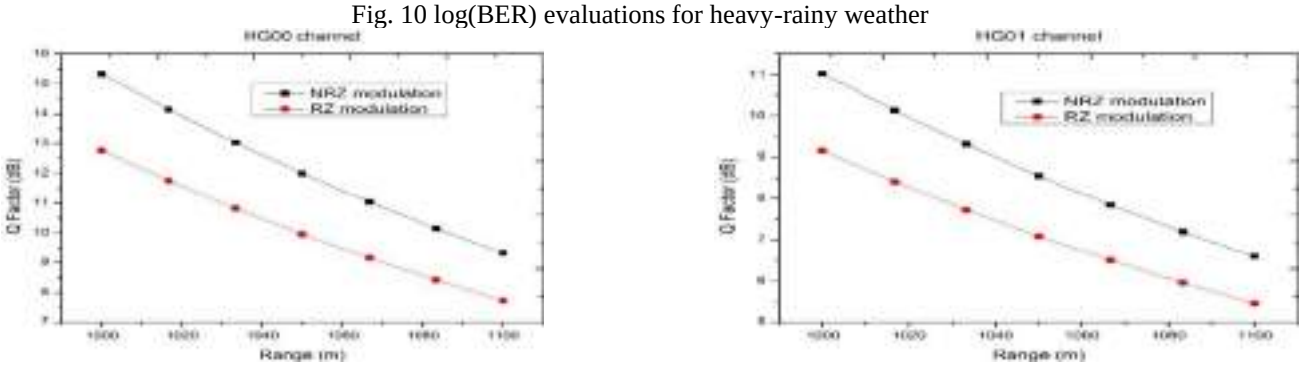
Fig. 9 Eye plots at 1900 m for medium-rainy weather for (a) NRZ-HG00 channel (b) NRZ-HG01 channel (c) RZ-HG00 channel (d) RZ-HG01 channel

Fig. 10 and 11 reveal the performance curves of the proposed system in terms of log(BER) and Q Factor plots respectively under heavy-rainy conditions. Fig. 10 shows that for heavy-rainy weather, for HG00 channel, log(BER) is -52.70, -32.71, and -20.28 for NRZ modulation and -36.85, -22.94, and –14.30 for RZ modulation at 1000, 1050, and 1100 m respectively. Alternatively for HG01 channel, log(BER) is -27.87, -17.19, and -10.67 for NRZ modulation and -19.57, -12.16, and -7.64 for RZ modulation at 1000, 1050, and 1100 m respectively. Fig. 11 shows that for heavy-rainy weather, for HG00 channel, Q Factor is 15.34, 11.99, and 9.32 dB for NRZ modulation and 12.75, 9.95, and 7.73 dB for RZ modulation at 1000, 1050, and 1100 m respectively. Alternatively, for HG01 channel, Q Factor is 11.03, 8.54, and 6.59 dB for NRZ modulation and 9.15, 7.08, and 5.46 dB for RZ modulation at 1000, 1050, and 1100 m respectively. Fig. 12 shows the eye plots for different modulation schemes using different HG modal beams at 1100 m range under heavy-rainy weather.



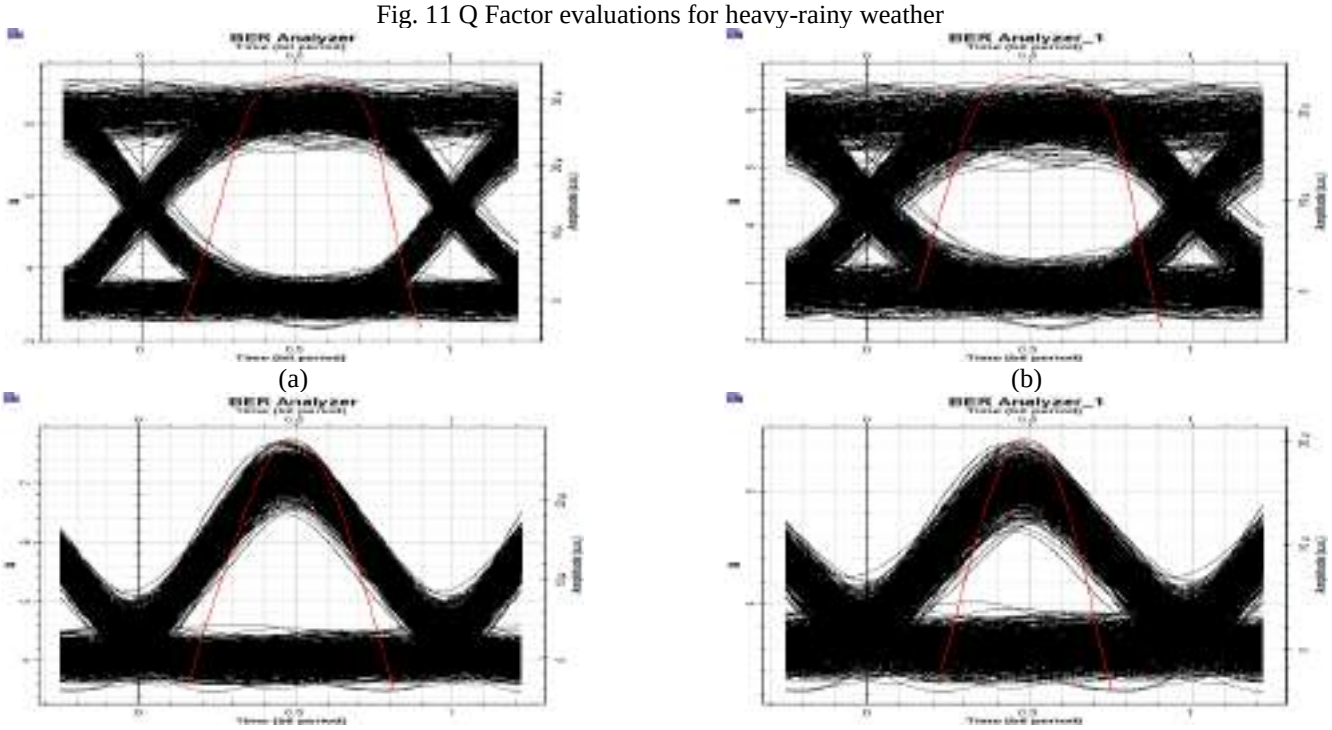
(a) (b)

Fig. 10 log(BER) evaluations for heavy-rainy weather



(a) (b)

Fig. 11 Q Factor evaluations for heavy-rainy weather



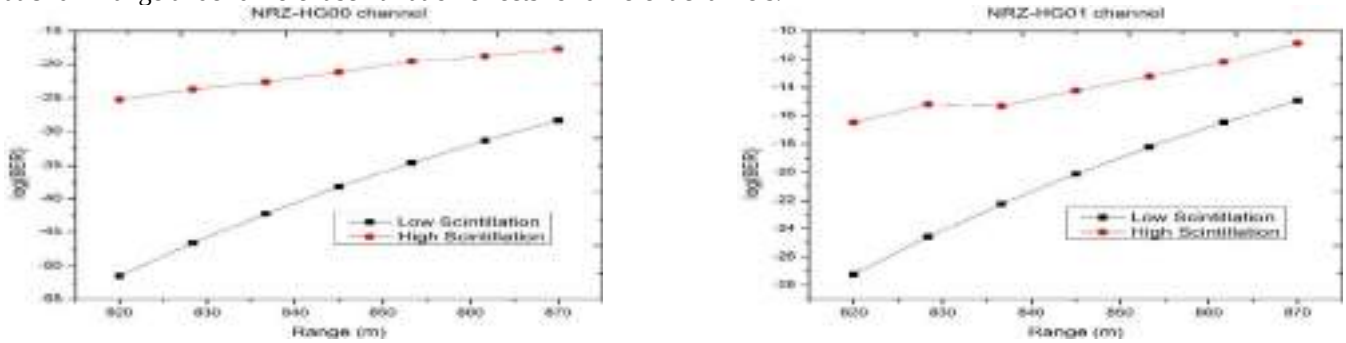
(a) (b)

(c) (d)

Fig. 12 Eye plots at 1100 m for heavy-rainy weather for (a) NRZ-HG00 channel (b) NRZ-HG01 channel (c) RZ-HG00 channel (d) RZ-HG01 channel

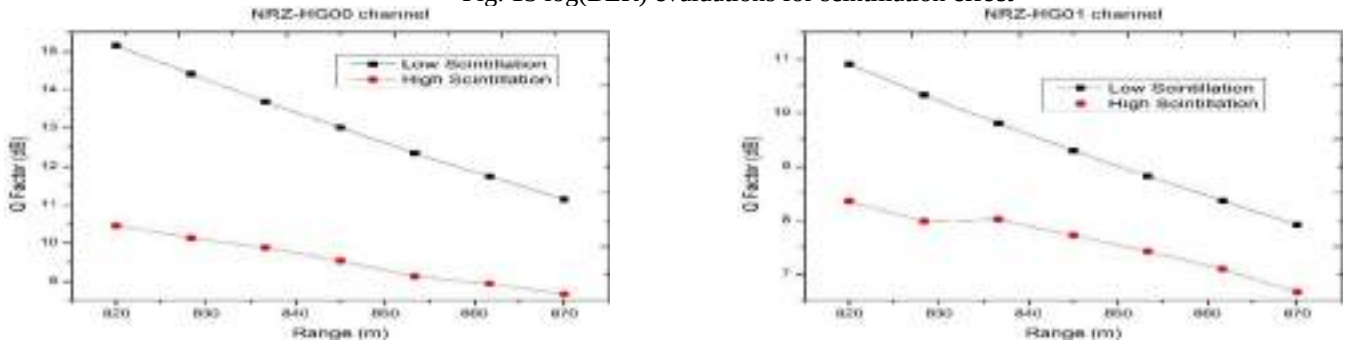
Fig. 13 and 14 reveal the performance curves of the proposed system in terms of log(BER) and Q Factor plots respectively under varying scintillation conditions. Here, evaluation for only NRZ-modulation is reported. Fig. 13 shows that for

NRZ-HG00 channel, log(BER) is -51.45, -38.23, and -28.35 for low scintillation and -25.20, -21.16, and -17.63 for high scintillation at 820, 845, and 870 m respectively. Alternatively for NRZ-HG01 channel, log(BER) is -27.21, -20.12, and -14.90 for low scintillation and -16.49, -14.21, and -10.84 for high scintillation at 820, 845, and 870 m respectively. Fig. 14 shows that for NRZ-HG00 channel, Q Factor is 15.15, 13.00, and 11.12 dB for low scintillation and 10.45, 9.53, and 8.65 dB for high scintillation at 820, 845, and 870 m respectively. Alternatively, for NRZ-HG01 channel, Q Factor is 10.89, 9.29, and 7.91 dB for low scintillation and 8.34, 7.70, and 6.64 dB for high scintillation at 820, 845, and 870 m respectively. Fig. 15 shows the eye plots at 870 m range under different scintillation effects for different channels.



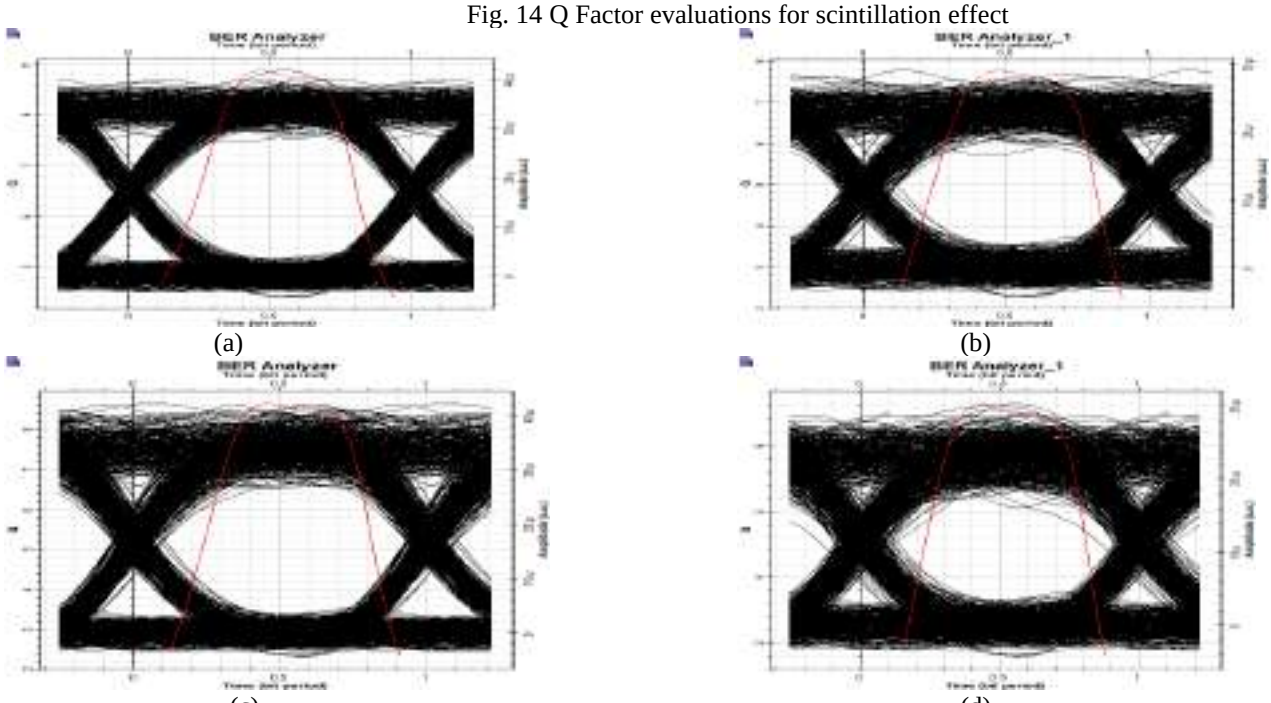
(a) (b)

Fig. 13 log(BER) evaluations for scintillation effect



(c) (d)

Fig. 14 Q Factor evaluations for scintillation effect



(a) (b)

(c) (d)

Fig. 15 Eye plots at 870 m under low scintillation for (a) NRZ-HG00 channel (b) NRZ-HG01 channel; under high scintillation for (c) NRZ-HG00 channel (d) NRZ-HG01 channel

4. Conclusion

A 20 Gbps MDM-FSO transmission system is reported and evaluated for different rainy weather conditions and the performance of RZ and NRZ encoding schemes is compared. Results reported demonstrate that NRZ encoding scheme has a superior performance. Further, as the rain attenuation and range increases, the signal quality degrades. The maximum range with favourable performance for proposed NRZ-MDM-FSO system is reported as 2500, 1900, and 1100 m under light-rainy, medium-rainy, and heavy-rainy weather conditions respectively. Moreover, the impact of increasing scintillation is evaluated and the results report that as the scintillation increases from low to high, the signal performance degrades.

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Optimization of Raman Gain in Multiband optical transmission

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Abstract— In optical communication, optical amplifiers plays a very important role, which allows the signal to be transmitted to long distance by amplifying the optical signal. Currently the focus of research is in studying the effect of Raman Amplifiers and its applications in optical amplification. Designed an optimization tool to make design of Raman Amplifiers more suitable and efficient. In this paper, methodologies and algorithms adopted in designing optimization tool are described. Results shows that proposed framework can design Raman Amplifiers with good performance.

Keywords—Raman Amplifier, optimization, Raman Pump, Multi-Band, WDM

Introduction

The light wave systems that employ optical fiber for transmission are called Fiber-optic communication systems. Since 1980 such systems have been deployed worldwide and have changed the underlying technology in telecommunications. Indeed, the light wave technology, together with microelectronics, is believed to be a major factor in the advent of the information age. Every year number of internet users is increasing sharply and so the bandwidth, speed requirement also increases. Fiber optic communication plays a very important role in meeting the increasing speed requirements of end consumer. Now there is need to improve performance of the existing network and exploit it's capacity. The 4th generation of optical fiber systems use optical amplification for increasing the repeater spacing and wavelength-division multiplexing (WDM) for better bit rate. In most WDM systems, fiber losses are compensated periodically using erbium-doped fiber amplifiers spaced 60–80 km apart [10].

A. Raman Amplifier

The physical mechanism is identified with the association between a photonic beam and the particles of the material wherein it is propagating. At the point when a photon impacts with an atom, this one gains energy and can arrive at a higher energy level.

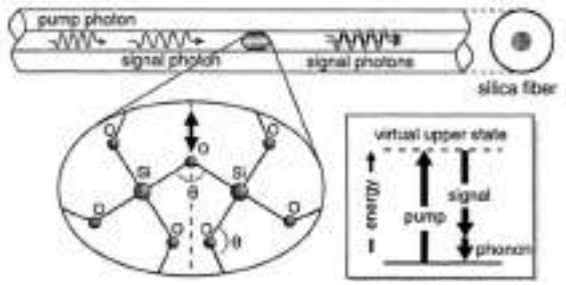

Figure 1: Portrayal of optical enhancement due to St Raman scattering along a silica fiber

After the vivacious change, the communication has as items a dispersed photon at lower frequency which relies upon the medium and a photon with qualities identified with the difference in frequency among the occurrence photon and the dissipated one. These optical parts moved at lower frequency concerning the underlying photon recurrence are called Stokes waves. A specific sort of Raman scattering happens when the recurrence difference of two photon radiates is inside a specific range: Stimulated Raman Scattering (SRS).

For this situation, it is feasible to see a reasonable optical amplification effect through a power move from signals at higher frequencies to signals at lower frequency and extra vibrational energy identified with arrival of photons. The purpose of this work is centered around two fundamental results of the Raman effect in optical communication applications:

- Raman cross-talk;
- Raman amplification.

The first one is a downside found in WDM frameworks, because of the way that input spectrum loaded on the optical fiber has signals at various frequencies. During propagation, higher frequency signals have pumping impact on lower frequency signals, having as final result a shifting impact. On the other side, Raman amplification has the advantage of providing distributed amplification along the optical fiber.

In figure 2 general representation of Raman amplifier has been presented. A few number of high-power signals at higher frequency are presented inside the optical fiber. Those are called pumps and they are utilized to move power to the modulated signals and to get the needed amplification

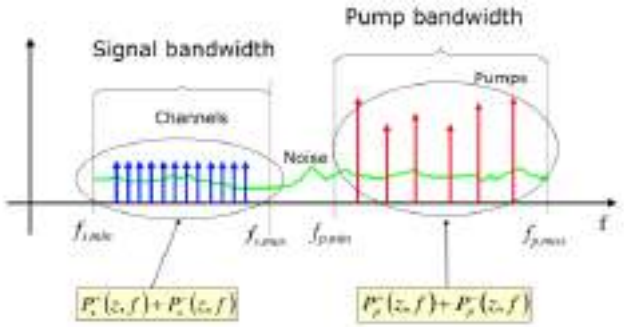

Figure 2: Mechanism of Raman crosstalk

In general, Raman amplifiers are adopted in optical communication systems because it is a phenomenon that occurs in every kind of optical fiber. It is also a wide-band amplification, so it is extremely useful in scenarios where multi-band transmission is needed. Moreover, the noise accumulation along fiber spans is lower than systems which adopt only EDFAs and this allows to propagate information
along longer spans. [2], [8], [9].

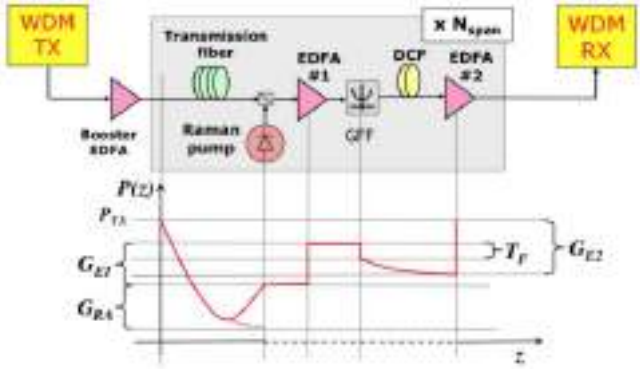

Figure 3: Scheme and operation of hybrid Raman/Erbium-Doped Fiber amplifiers [3].

As of late, some complex hybrid amplifiers are designed to optimize gain performances and to keep noise accumulation under control, to overcome fiber nonlinearities.

The main purpose is to expand the transmission band, moving to Dense Wavelength Division Multiplexing systems, and to maximize single range length of the entire optical link path

Methodology and setup

Methodology

There are two types of algorithms that are being implemented and on which whole framework is based.

- Algorithms for optimization;
- Algorithms for the analysis of the optimum solution.

Given a certain preliminary physical description of the scenario under analysis, all developed codes and functions have as primary engine an emulator that allows to evaluate the consequences of Raman effect: the Raman Solver.

This examination brings to clarify the structure of the work so that every result that will be seen afterwards could be easily analyzed and evaluated knowing the methodology behind its derivation. Given the physical description of scenario under investigation, all developed codes and functions work with an emulator, with the help of which impact of raman effect can be evaluted: The Raman Solver. This evaluation clarifies the structure of the scenario, so that results obtained after words can be easily analysed and compared.

Scenario under analysis

Emulated scenario constitutes of three main elements:

- The input WDM power spectrum
- The fiber link span
- The Raman pumps.

In the examination completed, the format of different sources of input and characteristics is as per following:

- The input spectrum is selected choosing between two different patterns

  - C band: it is composed of 96 channels in the range [191 : 196] THz
  - C+L band: it is composed of 192 channels in the range [186 : 196] THz, with a frequency distance among L and C band of around 200 GHz.

  Each channel is spaced at 50 GHz and is assumed to be modulated with a 32 GBaud PM-16QAM signal with a 10% roll-out root raised cosine range. The entire spectrum is always loaded with some input power per channel.
- The connection is a single mode-fiber range of fixed length of around 120 km and attenuation is modelled as a piece-wise function

- Spectrum loss coefficient (in the reach [186, 197] THz):
  α_s = 0.21 dB/km;
- Raman pumps loss coefficient (in the reach [197, 207] THz):
  α_p = 0.25 dB/km.

- Raman amplification is made utilizing two different sets of counter-spreading Raman pumps put toward the end of the line that, as per the case, can be composed of 4 or 5 pumps

Raman Solver

The center of this investigation is Raman solver. It is an open source system and it is available in the GitHub archive of the Telecom Infra Project [9] (TIP).

Given a specific scenario, the Raman solver is a tool that can emulate the behaviour of the Raman effect as indicated by the standard differential equations that describe the amplification [1]

$$\frac{dP_s}{dz} = -\alpha_s P_S + C_R(\lambda_S, \lambda_P)[P_P^+ + P_P^-]$$

$$\pm\frac{dP_P^{\pm}}{dz} = -\alpha_P P_P^{\pm} - (\frac{\lambda_S}{\lambda_P})C_R(\lambda_S, \lambda_P)P_S + P_P^{\pm}] \qquad (1)$$

where α_s and α_p are the loss coefficients, C_R is the Raman gain efficiency of the fiber, that quantfies the strength of the coupling among pumps and signal, and ± shows if the Raman pump is co-propagating (+) or counter-propagating (-).The main program is Raman Engine that executes the emulation. The user has to insert as input parameters in the form of following information.

- Fiber parameters:

- Loss coefficient function α
- Raman efficiency curve C_R
- Temperature T

- Spectrum parameters: Channels which compose the input spectrum, described through:

- Central frequency of each channel f_s
- Symbol rate
- Roll-off
- Input power per channel P_S

- Raman pumps parameters:

- Set of Raman pumps, described through
- List of Raman pumps input powers P_P
- List of Raman pumps wavelengths λ_S
- List of Raman pumps propagation direction (co-propagating or counter-propagating)

- ODE solver settings:

- Resolution along z axis
- Convergence tolerance
- Verbose

With these inputs Raman Engine gives following output

- Accuracy numerical parameters: arrays that contain the discretization of the solution in frequency and along the fiber link (z axis);
- Stimulated Raman Scattering solution: matrix of values containing the evolution of the power per each channel along the z axis;
- Spontaneous Raman Scattering solution: matrix of values containing the evolution of the ASE power per each channel along the z axis;

Results and discussion

Given a fiber length of 100 km and an input spectrum of 90 channels in C band, the impact of a counter-propagating pump at 205 THz with 0.5 W of input power is copied.

In fig 4, the propagation of pump power and channel power along the fiber link is represented graphically. For this situation, the standardized power ρ(f,z) has been considered.

The fiber transfer function is stated as follows

$$\rho(f, z)_s = \sqrt{\frac{P_s(f,z)}{P_s(f,0)}}$$

where $P_s(f, 0)$ is input power of spectrum. For Raman pump power similar feature has been defined as follows

$$\rho(f, z)_p = \sqrt{\frac{P_p(f,z)}{P_p(f,L_{span})}}$$

where $P_p(f, L_{span})$ is the input counter-propagating Raman pump power. At first look, we can notice the impact of distributed amplification provided by Raman pump, on the signal spectrum. Two different power setups were used for emulation, - 3 dBm and 3 dBm, in the second

case, pump power is not decreasing linearly, while for the first one it is decreasing exponentially. This effect is the called pump depletion. If we keep signal power high, the transfer of power from pumps to spectrum is high and pump power decay's sharply. At times, pump depletion is negligible due to low signal power, this effect can be seen along z axis of the pump. For this scenario spectrum profiles are shown in fig 5. From this spectrum we can analyze the impact of Raman amplifiers
In the situation with turned-off pump and thus without Raman amplification, the spectrum profile is shifted and its slope relies upon the measure of input power per channel (higher slope for higher power level). This is called inter channel Raman effect and it is a result of the presence of nearby channel at different frequencies that trade power moving it from channels at higher frequencies to channels at lower frequencies. It is additionally called Raman cross-talk due to the way that neighboring channels are not totally isolated, however they exchange some amount of energy.

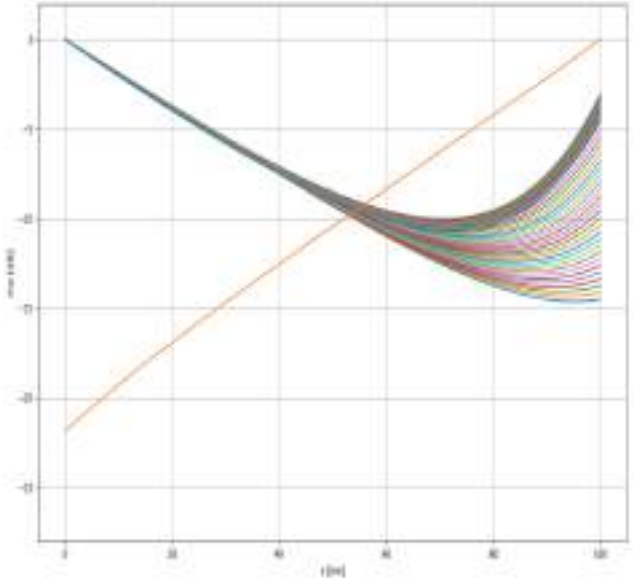

Fig 4a Propagation of pump power along z with power(-3dBm)

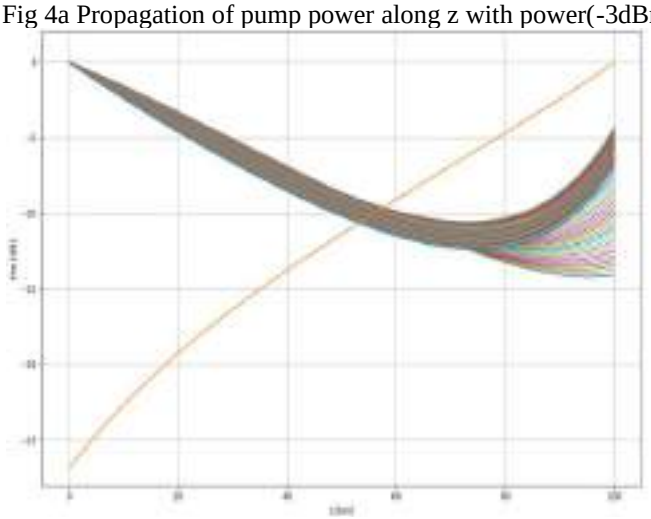

Fig 4b Propagation of pump power along z with power(3dBm)

Besides, the overlapping of spectrum profiles with turned on and off pump towards the end of the line gives the definition of on-off gain, which is actually the difference between the two curves in logarithmic units.
Now, the pumps depletion is being examined on a situation with 4 Raman pumps by changing per channel input power level.

In figures 6, 7 and 8 propagation of Raman Pump's power along the fiber link and relative gradient examination are presented.
With gradient evaluation, we can see depletion is more clear, that increases with input power level per channel. In the first case (Ps(f) = 10 dBm), towards the finish of the pump power propagation all patterns settle at the Pump's fiber loss coefficient of .25dB/km. If we increase the power spectrum level, slope of pump power also increases and makes pump depletion more becomes considerably more sensible. Then again, at the start of the propagation of pump's power, the pumping effect that pumps at higher frequencies have on pumps at lower frequencies is more evident. Indeed, lower frequency pump's power level, becomes most significant, getting power from higher frequency pumps.

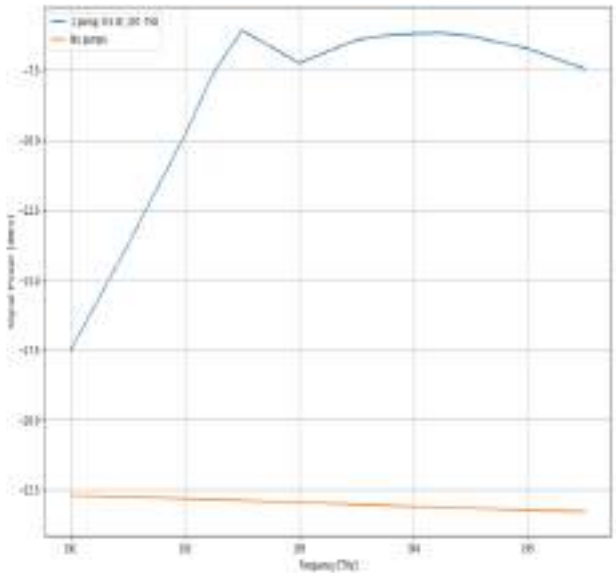

Figure 5 a Power profile of the signal at the end of the fiber length(-3dBm)

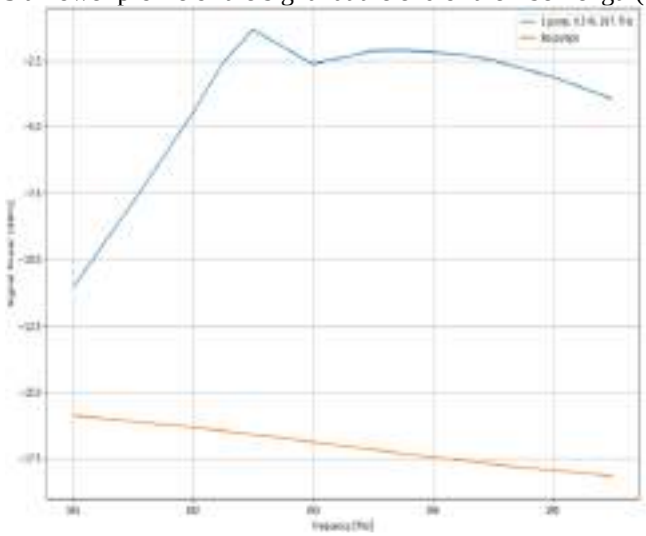

Figure 5 b Power profile of the signal at the end of the fiber length(3dBm)

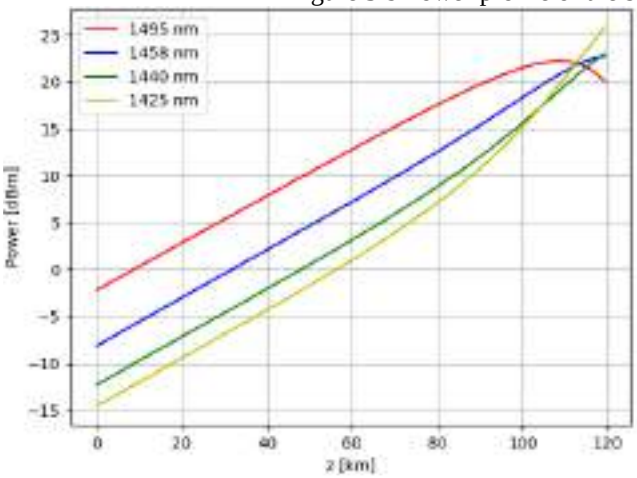

Figure 6a : Pump's power Propagation along z axis with input power per channel of -10 dBm

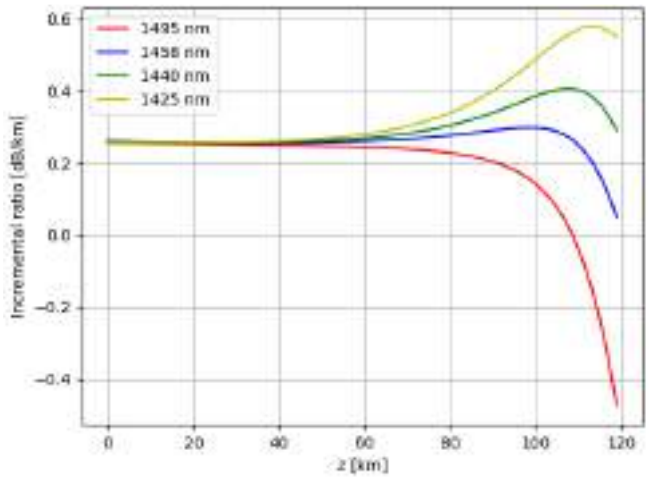

Figure 6b: Incremental ratio evaluation with input power per channel of -10 dBm

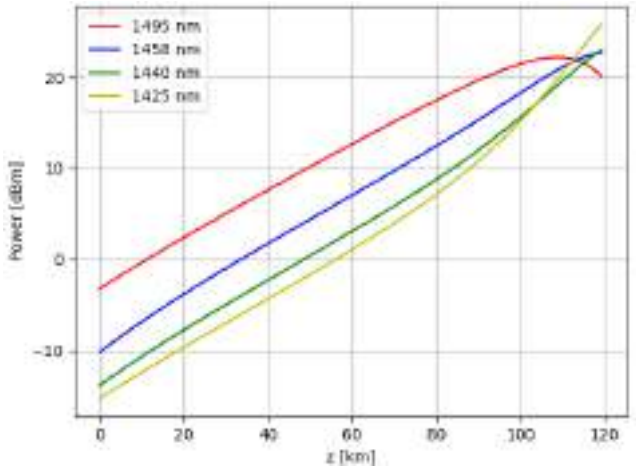

Figure 7a: Pump's power Propagation along z axis with input power per channel of 0 dBm

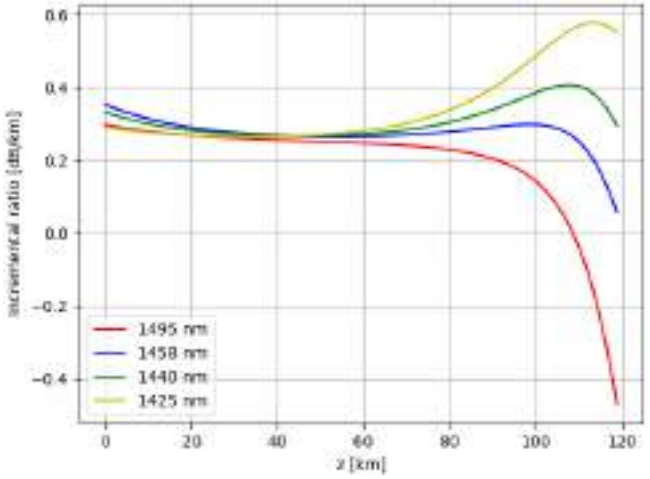

Figure 7b: Incremental ratio evaluation with input power per channel of 0 dBm

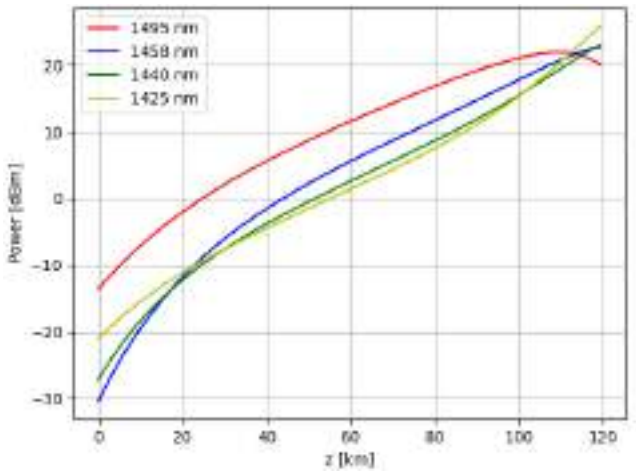

Figure 8a Pump's power Propagation along z axis with input power per channel of 10dBm

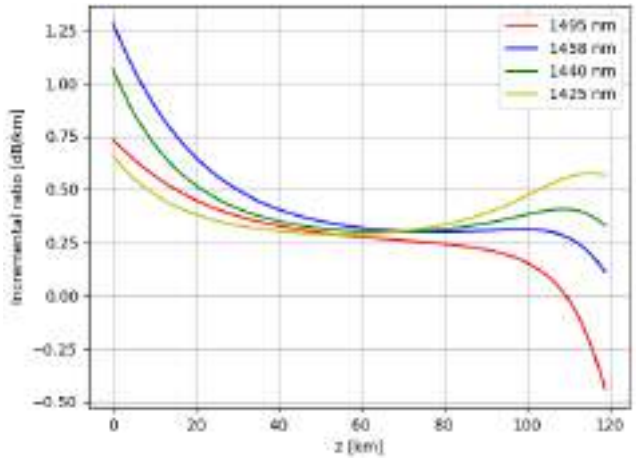

Figure 8b Incremental ratio evaluation with input power per channel of 10dBm

A. Brute Force Strategy

Taking advantage of the Raman solver, a brute force strategy has been executed to optimize Raman pump's parameters. This is only one of the optimization approach that, given a few constraints and minimization criteria, permits to pick an ideal solution from the set of solutions created by ranges in which parameters can vary.

Thus, the brute force strategy is based on creation of set of solutions, in which optimum solution has to be found. Given the list of parameters with the values that can be taken by each parameter, the related iterator with all potential combinations of input values is created

A.a Brute forces strategy - 4 Raman pumps

Toward the start of the examination on Raman amplification, the first approach that was taken on to understand attributes of input Raman Pump's configuration was brute force strategy.

Producing the solution space and examining metrics, it was feasible to have a general cognizance of the phenomenon in multi-pump situation and a more prompt view of how modifications of the inputs affect the output on-off gain and noise.

Following values of parameters have been taken in the scenario under evaluation

- Fiber link length: 120 km;
- 4 counter-propagating Raman pumps;
- Set of Raman pump wavelengths:

  - 1425 nm
  - 1440 nm
  - 1458 nm
  - 1495 nm

The solution set of this scenario is created by possible combination of following parameters:-

- Input power per channel level Ps:

-10 dBm
- 0 dBm

- Spectrum grid (spacing of 50 GHz among adjacent channels):

- C band: 96 channels
- C+L band: 192 channels (96 + 96)

▪ Input power of each Raman pump P_p:

- 0 mW
- 125 mW
- 250 mW
- 375 mW
- 500 mW

Once the solution set is generated, relative metrics are evaluated to understand the quality of amplification
Putting constraints on metrics, the cases presented in figure 9 match the required features

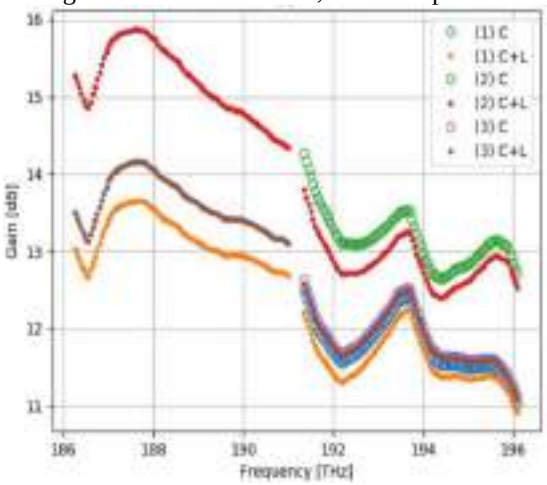

Figure 9a Brute force strategy - gain profiles of selected scenarios

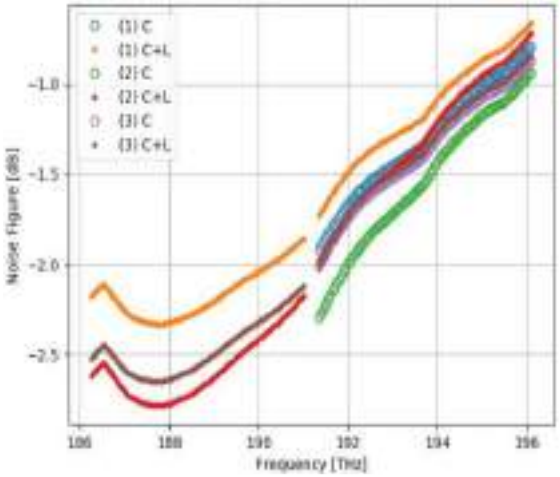

Figure 9b Brute force strategy - noise profiles of selected scenarios

In table 1 are accounted for input configurations that produce the double scenarios C/C+L that match constraints.
Seeing on-off gain profiles and relative measurements, we can see that turning on and off L band in the C+L scenario, performance doesn't change much.
Some variation is more clear for cases when higher input power per channel level (0 dBm) is presented. This is effect of pump depletion and inter channel Raman effect, because turning off of the L band restricts power transfer over C band frequencies. Thus, in C band situations, the relative on-off gain profile is marginally higher than the C+L situation

Table1: Configurations of the selected scenarios considering metrics constraints

N Scenaio	Power per channel[dBm]	Power Pump1[mW]	Power Pump2[mW]	Power Pump3[mW]	Power Pump4[mW]
1	0	125	250	125	250
2	0	250	250	125	250
3	-10	125	250	125	250

Conclusion

The optimization framework is able to determine values for Raman pumps for input power and wavelength. The examination has been done before on C band situations, analyzing the shape of the solution space, thus assessing the stability of the framework, through the utilization of little irritations around the ideal arrangement. To work on the acquired outcome as far as execution, the enhancement issue has been broadened rening the total arrangement of Raman pump input powers and wavelengths.

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A Review of Design of PID And FOPID Controller for AVR System

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Abstract: Control engineering is a dynamic field of research and practice in recent years, development of better and simple control algorithms has been undertaken as an active area of research to get better performance of plants to be controlled, under consideration. Significant development in many control techniques including fuzzy control, neural networks, predictive control, optimal control have already boosted the research for better products. The objective of this study is to study various techniques to design a controller that behaves well with respect to robustness analysis. This paper brings out the discussion of various techniques applied to optimize the controllers for optimum response from Automatic Voltage Regulator (AVR) system.
Key Words: *PID, FOPID, AVR, Optimization*.

1. INTRODUCTION

Control deals with the modification of dynamic systems to obtain desired response given in terms of a set of specifications. To achieve this, a controller senses the operation of a system, compares it to the desired behaviour, takes corrective action based on specifications and actuates the system to obtain the desired change.

Proportional-Integral-Derivative (PID) control is the most common control algorithm used in industry and its importance has been universally accepted in industrial control. The popularity of PID controllers can be attributed partly to their robust performance in a wide range of operating conditions and partly to their functional simplicity, which allow engineers to operate them in a simple, straightforward manner. As the name suggests, PID algorithm consists of three basic coefficients- Proportional, Integral and Derivative which are varied to get optimal response [1]. PID controllers is one of the most used controllers for different application areas such as, in petrochemical, paper and pulp, food, iron and steel, refining, chemical and fibre industries. Apart from this, the optical memories of CD and DVD contain three PID loops for control and rotation of speed, focus and track following. PID controllers are also used in large numbers for motor drives and positioning systems. They are structurally simple and exhibit robust performance over a wide range of operating conditions. This simple controller has in fact become a benchmark for many new ideas and innovations. An ideal way of enhancing PID controller performance is to use Fractional Order PID controllers (FOPID) where the I and D actions have, in general, non-integer orders [2].

Keeping in mind the end goal to evaluate the pattern and level of exploration work done till date in the region of PID and FOPID optimization of AVR system, a broad literature has been audited.

2. A PERSPECTIVE ON CONTROL DESIGN

Development of new design methods has been a goal for control theory for a long time. The classical frequency domain methods were developed in the nineteen thirties and forties starting with the breakthrough in stability theory made by Nyquist [3] and continuing with the work on feedback amplifiers by Black and Bode. In classical approach the main concern was to design feedback compensators so that a certain stability margin was achieved [4]. Then emphasis was given on model uncertainties and feedback was used to decrease sensitivity to disturbances and modelling errors. The compensator design was developed mainly by graphical methods which evolved from Nyquist stability criterion.

Newton et al [5], [6] in 1957 developed the analytical methods, which made it possible to give specifications on the transient performance by giving a process model together with closed loop specification. At that time, less attention was paid to research on robustness and sensitivity issues. From 1990 onwards, analytical methods have been developed in which robustness has regained its importance.

In the nineteen sixties, the development of optimization techniques-based control design methods garnered importance as they could consider many different aspects of the design problem. During this time efficient computer methods were developed to solve these optimal control problems. A general discussion of the use of optimization for control design is found in Boyd and Baratt (1991) [7] and Mayne and Polak (1993) [8], [9].

2.1 Need of PID Controller Design

Despite the development in control theory, the PID controllers are the most used controllers in industry as can be found in Yamamoto and Hashimoto (1991) [10]. Various reasons for their popularity include better understanding by industrial, technical and maintenance individuals and well-established theory and long history of proven operation. This makes these controllers suitable to meet or exceed the design objectives for which these are well tuned. Finally, there are many extensions of PID controllers which make them practical for controlling an industrial process. For example, these have manual and automatic switching modes, set point tracking and emergency manual modes.

In spite of the well spread use of PID controllers, there is a lack of universally acceptable tuning method. Many design methods of PID controllers have been proposed in literature [11]. Finding design methods which lead to optimal operation of PID controllers is therefore very significant. The tuning rules involving computational simplicity and moderate process knowledge enjoy considerable success at the expense of narrow application area. Take the case of Zeigler Nichols method, which is simple and widely used yet not applicable to a wide range of systems, where it requires more information. Consequently, more elaborate

methods based on process modeling, formulation of specifications and control design gives better performance for a wide range of systems. In these cases, optimization is a powerful tool.

Need of FOPID Controller Design

The use of Fractional Calculus in modelling and control of dynamic systems was introduced in 1999 by **Podlubny.** A generalized $PI^{\lambda}D^{\mu}$ controller, involving a λ order integrator and a μ order differentiator was proposed [12]– [14]. He proved the superiority of FOPID controller over classical PID controller for the control of fractional order systems. In principle, FOPID controller have five tuning parameters as compared to three of PID controllers that provide it greater flexibility in the design process but at the same time increasing the tuning complexity. Higher number of the integrators leads to better set point tracking but the stability of the closed system in the process gets worsened. On the other hand, higher the number of differentiators, higher the stability margin but worse the noise rejection performance of the closed-loop system is not up to the mark. FO-PID is a trade-off between higher precision provided by higher order of integrator and stability provided by higher order of differentiator [15]. Hence, depending on performance requirement, FO-PID controllers can perform better than Integral order (IO)-PID controllers.

The desired specifications for the controllers are usually robustness against load disturbances, high-frequency noise and uncertainties of the plant model. Taking into account all of the constraints, the optimal set of controller parameters can be found by a tuning method. The aim of the tuning method is to find the optimum parameters of the PID and FOPID controllers under given constraints. A number of tuning methods have been used in the literature for optimizing the parameters of the PID and FOPID controllers. Out of the existing tuning methods, recently, Swarm Intelligent Algorithms have gained increasing popularity among researchers on account of their outstanding performance on many practical problems.

2.3 Robustness Analysis

Robustness is an important criterion in controller design because most of the real systems are vulnerable to external disturbance, measurement noise and model uncertainty [18]. The design objective is to determine the controller parameters so that the system behaves well under such conditions. Along with error in system parameters, three external signals act on any control loop, namely set point *r(t)*, load disturbance *l* and measurement noise *n* as shown in Figure 1 and discussed briefly below.

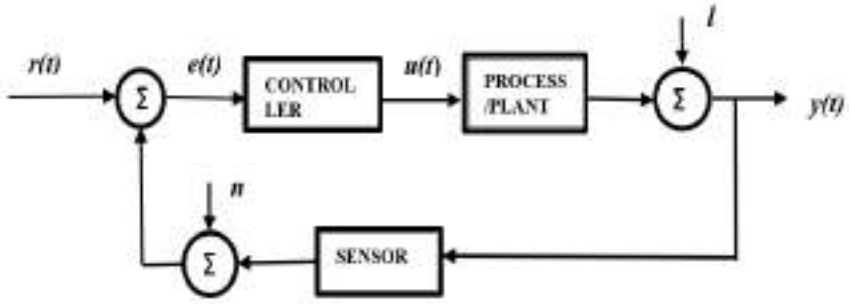

Figure 0 Control System with Load Disturbance and Noise

2.3.1 Modelling Errors: The system parameters change or vary with use and it is desirable that the tuned controller works satisfactorily under such conditions. To illustrate the effect of the variation in system parameter on the obtained optimal solution, the gain and time constant of the system with $\pm$ 25% and $\pm$ 50% variations. If the optimized controller values are giving satisfactory output, then the controller is considered to be robust.

2.3.2 Set Point Tracking: Set Point is the reference input that is given to any control system. A designed controller should be such as follows the variations in set points and must keep the process outputs as close as possible to set point and within its range.

2.3.3 Load Disturbance Rejection Capability (*l*): Load disturbances are often the most common disturbances in control systems. The load disturbance drives the process output away from desired values. So, most controller design methods should focus on load disturbance rejection capability of the controller. The controller then has to put an effort in opposite direction to bring the process output back to nominal value.

2.3.4 Noise Suppression Capability (*n*): Noise entering the system in the feedback path corrupts the information obtained from the sensors while if it enters the forward path adds to the magnitude of process output and affects the feedback.

So, the designed system should be such as it follows the set point, suppresses the noise and rejects the load disturbance without making the system unstable. In some applications like in a power station, the electrical oscillations may occur for a long time and might result in system instability. One such application is that of an Automatic Voltage Regulator system discussed below.

3. DESIGN AND OPTIMIZATION OF AVR SYSTEM

In a power station there is usually more than one generator connected to the same busbar and each has an individual Automatic Voltage Regulator (AVR) [16]. The objective of the design for an AVR is to control the voltage at the terminals of the generator, i.e. to achieve primary voltage control [17]. With the advancement in the design of fast acting AVRs as well as the increasing complexity of large interconnected power systems, oscillations may continue for an extended period and even instability may occur following some system disturbances. The control algorithms to overcome these problems are generally

implemented using analogue components [18].

The transfer function model of an AVR system after ignoring the nonlinearity and saturation with gain and time constant in its components namely- an exciter (Ke, Te), an amplifier (Ka, Ta), a generator (Kg, Tg) and a sensor (Ks, Ts) is shown in Figure 2.

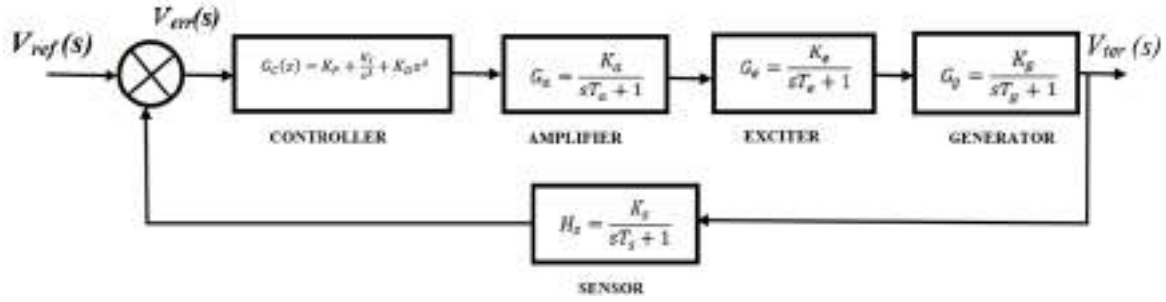

Figure 2 Transfer Function Model of FOPID-AVR system [18],[40],[43].

Where $G_C(s)$is the controller effort, V_{ter} *(s)* is the terminal voltage of the generation unit being continuously compared against reference voltage, V_{ref}*(s)* and the error between the two given as V_{err}*(s)* is applied to the controller. $G_C(s)$ works upon this error voltage signal, V_{err}*(s)* according to equation (9). This output is amplified and further provided to the exciter which controls the current of the field windings of the generator. This process continues till V_{err}*(s)* is minimized. The parameter limits and the applied values for optimization of FOPID controller for AVR system using ECSA has been tabulated in Table 1.

TABLE 1 Parameter Limits and Used Parameters of PID-FOPID-AVR System [16], [17],[18], [40], [42], [43]

Block	Parameter limits	Used Parameters
PID Controller	0.2≤ K_P, K_I, K_D ≤ 2	K_P, K_I, K_D= *fmin* values
FOPID Controller	0.2≤ K_P, K_I, K_D, λ, μ ≤ 2	K_P, K_I, K_D, λ, μ = *fmin* values
Amplifier	10≤Ka≤40, 0.02s≤Ta≤0.1s	Ka=10, Ta = 0.1s
Exciter	1≤Ke≤10, 0.4s≤Te≤1.0s	Ke = 1, Te = 0.4s
Generator	0.7≤Kg≤1, 1s≤Tg≤2s	Kg = 1, Tg = 1s
Sensor	0.9≤Ks≤1.1, 0.001s≤Ts≤0.06s	Ks = 1, Ts = 0.01s

Replacing the gain and time constant in Figure 2 by used parameters of the corresponding components as given by third column of Table 1, the closed loop transfer function along with the designed PID and FOPID controller $G_{AVR\text{-}PID}$ given by equation (1) and $G_{AVR\text{-}FOPID}$ given by equation (2) becomes:

$$G_{AVR-PID} = \frac{0.1s+10}{0.0004s^4+0.045s^3+0.555s^2+1.51s+11} \quad (1)$$

$$G_{AVR-FOPID} = \frac{1.0536s^{2.0999}+3.3199s^{0.9986}+1.9309}{s^{3.9986}+2.727s^{2.9986}+5.94s^{1.9986}+4.228s^{0.9986}} \quad (2)$$

Gaing [19] suggested a novel design method based on self-tuning PID controller for the AVR system using the PSO algorithm in 2004. In this study, the method used was more efficient and robust in improving the step response of the AVR system as compared to that of Genetic Algorithm (GA). Two years after, **Kim et al**.[20] developed the hybrid method which contained genetic algorithm and bacterial foraging optimization technique, in order to improve the performance of the self-tuning PID controller in the AVR system. In 2007, **Mukherjee** and **Ghoshal** [21] reported the Sugeno fuzzy logic self-tuning algorithm based on Crazy-PSO for PID controller and proposed a novel cost function in this optimization method. They also compared their results with those of GA based controller. Later on, **Zhu et al**. [22] suggested a Chaotic Ant Swarm Algorithm in order to optimize the gains of PID controller in the AVR system in the year 2009. In the same year, **Zamani et al**.[23] designed the Particle Swarm Optimization based FOPID controller for the AVR system. They analysed the basic performance and robustness of their controller and compared them with those of the classical PID controller.

Coelho [24] proposed the chaotic optimization approach for tuning of the PID gains in 2009. **Chatterjee et al.** [25] also made a comparison between the optimization performance of velocity relaxed and craziness-based particle swarm optimization

methods on AVR system in 2009. Later in 2011, **Gozde et al** [26] applied Artificial Bee Colony Algorithm to optimize AVR system with PID controller gains. The comparison of optimized AVR output was done with Particle Swarm Optimization and Differential Evolution Algorithm for robustness and set point Tracking. The simulation results showed that the ABC algorithm could be applied to the AVR system successfully and allowed to control the system optimally and robustly. The core outcome of this study was the successful application of ABC algorithm to the PID controller for enhancing the performance of AVR system. It further showed a better tuning capability compared to that of the other optimization algorithms for optimizing the controller parameters.

Panda et al. [27] dealt with the design and performance analysis of the PID controller for the AVR system using simplified PSO, which is also called the many optimizing liaisons algorithm. The superiority of the used approach was shown by comparing the results with those of PSO, ABC, and DE algorithms. The analysis results demonstrated that the approach adopted for the AVR system performed better compared to the similar population-based optimization algorithm. **Zhang et al** [28] proposed an improved ABC algorithm which was based on the Cyclic Exchange Neighbourhood and Chaos ABC to optimize the parameters of the FOPID controller for an AVR system. To examine its performance, the proposed method was compared with the results of PSO and GA algorithms. Simulation experiments showed better performance of Cyclic Exchange Neighbourhood and Chaos ABC-FOPID controller than those of ABC-FOPID controller, PSO-PID and GA-PID. **Sahib et al.** [29] presented a new time domain performance criterion based on the multiobjective Pareto Front Solutions. The objective function was tested in the PID controller design for an AVR application using PSO Algorithm. Simulation results showed that the performance criterion can highly improve the PID tuning optimization as compared to with traditional objective functions. **Kansit et al.** [30]used hybrid of PSO and Gravitational Space algorithm (GSA) for the design of optimized PID AVR system. Both transient and Bode analysis were considered to show the effectiveness of the designed technique and comparison was done with those of PSO, ZN and Many Optimizing Liaisons (MOL) tuning methods.

Teaching Learning Based Optimization (TLBO) algorithm was applied by **Chatterjee et al.** [31] to optimize PID-AVR with an aim to find out the optimum value of PID controller gains with first order low pass filter. The voltage response was compared to GA, PSO, DEA and ABC technique. Robustness analysis was also carried out to check the performance of the designed TLBO based PID controller. **Elumalai** [32] presented a novel fitness function for determining the parameters of PID controller for an automatic voltage regulator system using Particle Swarm Optimization Algorithm approach and compared the results with outcomes of GA-PID. It was found that PSO-PID has higher computational efficiency resulting in more stability of controlled AVR system. In 2018, **Hekimoglu et al.** [33] compared Grass Hopper Optimization Algorithm (GOA) with the other PID controllers based on Ziegler-Nichols (ZN), differential evolution (DE) and artificial bee colony (ABC) tuning methods. The used method was found to be highly effective and robust to improve AVR system's transient response.

The Fractional Calculus was also applied in the field of PID controller to enhance its capabilities. Research on optimization of FOPID was also being carried out simultaneously. The validity of an optimum FOPID controller tuned by PSO to control the AVR system of a power system was demonstrated by **Karimi *et al.*** [34] in 2007. It was concluded from simulations that FOPID controller has more robust stability and performance characteristics than those of the PID controller applied to the AVR. In 2012, Artificial Bee Colony Algorithm was improved for optimum design of FOPID by **Tang *et al.*** [35]. Robustness of the system with respect to modelling errors was found to be better for FOPID-AVR system as compared those of other techniques. **Zeng *et al.*** [36] presented a real-coded extremal optimization method with multi-non-uniform mutation (MOEO) for the design of FOPID controller. MOEO has been found to be simpler than NSGA-II, GA, CAS and PSO due to fewer control parameters. **Verma *et al.*** [37] also optimized FOPID controller using ZN initially and then Grey wolf optimizer (GWO) and compared the results with those of GWO-PID, ZN-PID, GA-FOPID, PSO-FOPID, CAS-FOPID, NSGA-II-FOPID and MOEO-FOPID. GWO showed improved optimization in T_R, T_P and M_P but it failed to optimize Ts as compared to those found through other techniques. **Suri Babu *et al.*** [38] implemented FOPID optimization using GA and ACO techniques and also found FOPID to have more robust stability and performance characteristics than PID controller. **Lahcene *et al.*** [39] implemented Simulated Annealing (SA) for optimizing AVR system by tuning the parameters of FOPID controller. The step responses of the AVR system controlled by SA-FOPID had better performance than that of PSO-PID controller, MOL-PID controller and MOEO-PID controller.

Based on the above work already implemented, application of AVR system had been chosen, to test the performance of the CSA, ECSA, DLCSA, NNA and MNNA [18], [40-45] based optimization algorithms designed by the author and then compared the results with the state-of-the-art techniques as tried in the studies listed above.

4. CONCLUSIONS

The designed controller should behave well with respect to changes in three input signals i.e. setpoint, noise and load disturbance as well as in the process model. Keeping in mind these requirements the formulated controllers must be good enough to handle these problems efficiently and have a good load disturbance rejection capability, Noise suppression capability, Set point response, and Robustness with respect to model uncertainties. As, AVR system is the most important control loop in power generation unit and many researchers have tried to optimize AVR system.

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Reconfigurable Antenna Methodologies and Techniques: A Review

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***Abstract*— The recent advancements in wireless communications require the integration of multiple standards on a single platform to provide connectivity according to availability of a particular band. In this chapter, the various design processes commonly used for reconfigurable antenna design are discussed. Reconfigurable antennas are supposed to be compatible with different wireless services operating over a wide frequency range. Reconfigurable antennas have the ability to address new system requirements. Their ability to modify the geometries and behaviour to adapt to changes in surrounding conditions are their prime strengths. Reconfigurable antennas can deliver the same results as of a multi antenna system. As more space is required to accommodate multiple antennas but the use dynamically variable and adaptable single-antenna geometry provides the solution without increasing the space requirements. Controlling antenna reconfiguration with the help of software is also discussed. In the end, applications of reconfigurable antennas are highlighted.**

***Keywords*— Reconfigurable antennas, filters, micro-electromechanical systems (MEMS), p-i-n diodes.**

I. INTRODUCTION

Future fifth generation (5G) wireless platforms of wireless communication industry continue to drive the requirements for small, light-weight, and cost-effective reconfigurable antennas and antenna arrays. Antennas are one of the key components which play a very critical role in determining overall performance of a wireless system. Now days, wireless systems are growing towards multi-functionality to achieve fast, secure, and reliable communications. Reconfigurable multiband antennas are attractive for a large number of civilian and military applications with a single antenna that can be dynamically reconfigured to transmit and receive on multiple frequency bands, providing high data-rate wireless access in congested environments along with highly secure data transmissions [1]-[8]. These types of antennas find applications in communication satellites, space-based radar, electronic intelligence aircraft, unmanned aerial vehicles and many other sensing and communications applications.

Reconfigurable Radio Frequency Micro Electromechanical System (RF MEMS) antenna systems were first introduced in 1998 by E. R. Brown. RF MEMS switches are developed in various shapes and geometries like Planar Inverted F-shape Antenna (PIFA), E-shape, S-shape, spiral, fractal and many more to achieve different applications [9].

II. NECESSITY OF RECONFIGURABILITY

Consider two general antenna application areas, single-element implementation and array implementation, while single-element implementation of antenna is used in portable wireless devices, such as a cellular telephone, a personal digital assistant, or a laptop computer. Typically, single monopole or microstrip antenna having multiple-frequency capabilities are used in these devices. The weakest part of the bidirectional communication link is the transmission from the portable device to a base station or other access point is the because of the power, size, and cost restrictions imposed by portability [9]-[12]. Moreover, the portable device is often used in unpredictable and/or harsh electromagnetic conditions, resulting in antenna performance that is certainly less than optimal. Antenna re-configurability in such a situation could provide numerous advantages. For instance, the ability to tune the antenna's operating frequency could be utilized to change operating bands, filter out interfering signals, or tune the antenna to account for a new environment. If the antenna's radiation pattern could be changed, it could be redirected toward the access point and use less power for transmission, resulting in a significant savings in battery power. The antennas are mostly used in array configuration, feed structures with power dividers/combiners and phase shifters. For instance, current planar phased array radar technology is typically limited in both scan angle and frequency bandwidth as a result of the limitations of the individual array elements and the restrictions on antenna element spacing [13]. This restriction comes from mutual coupling effect on one hand, appearance on grating lobe on other hand. Many of these established applications assume that the antenna element pattern is fixed, all of the elements are identical, and the elements lie on a periodic grid. The addition of re-configurability to antenna arrays can provide additional degrees of freedom that may result in wider instantaneous frequency bandwidths, more extensive scan volumes, and radiation patterns with control on side lobe distributions. There are several antenna structures that are suitable for implementation of reconfigurable antennas, among them microstrip patch antennas are very attractive structures for various types of reconfigurable antennas, all such antennas are usually equipped with switches that are controlled by DC bias signals [14]. Upon toggling the switch between on and off states, the antenna can be reconfigured. The following section describes the design procedure of microstrip patch antenna types presented and different feed types used in this dissertation.

III. BACKGROUND OF CONVENTIONAL MICROSTRIP ANTENNA

The basic factors that are considered for designing of any microstrip patch antenna are the frequency on which antenna will operate. Another factor is dielectric constant and last parameter is dielectric substrate having suitable thickness. All these parameters are responsible to design a microstrip antenna having suitable geometry.

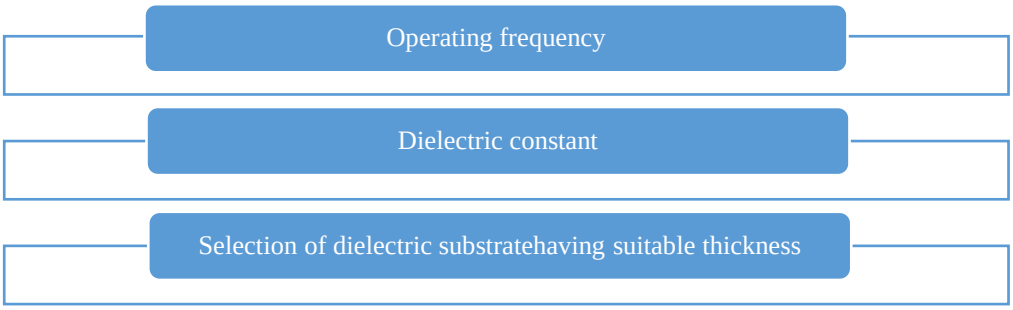

Fig. 17 Factors for Selecting Micro-strip Antenna.

While design of any microstrip antenna, various models of antenna design come to mind. But the one that is efficient and simple is selected for design of antenna. Now, to design conventional antenna transmission line model is commonly used. This method of antenna design is simplest method. Munson and Carver had proposed the design process of microstrip patch antenna. The structure of microstrip antenna is such that dielectric substrate is sandwich among radiating patch on upper and lower plane on other side as shown in Fig. 2. If we considered the patch shape, there is no restriction or constraint on the shape of patch. It can be of any shape and made of materials that are good conductors like gold or copper. The radiating patch and feed lines are generally photo etched on dielectric substrate.

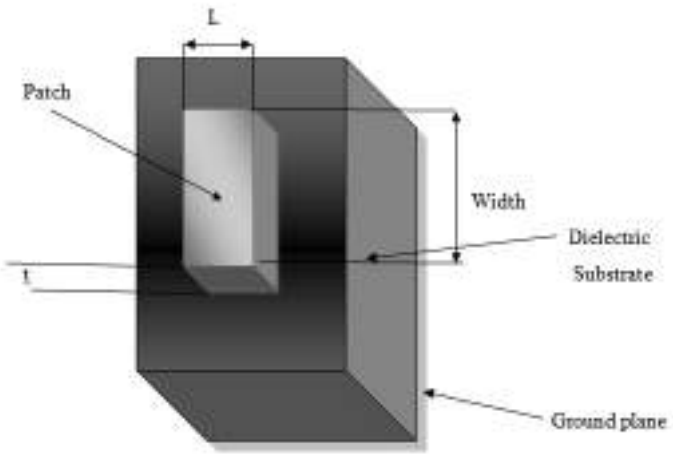

Fig. 2 Factors for Selecting Micro-strip Antenna.

IV. RECONFIGURABLE ANTENNA METHODOLOGIES

To design the reconfigurable or programmable antenna some of techniques have been found. This part elaborates each method in brief and its advantages and disadvantages as well. Each method has been explained with example. Three design methods have been identified as shown in Fig. 3.

Total geometry morphing method as name indicates it is the geometrically complex method among all other methods. This method provides design by combination of switchable elements in an array form to achieve the required radiating pattern. Matching network morphing is simple method among all other methods. As the name indicates that this method related to impedance matching network. It only changes the impedance matching network of antenna and radiating pattern remains same [15-17]. The smart geometry methods complexity lies between other two methods. This method only alters some important characteristics of antenna radiating pattern to fulfill the required range of reconfigurable control.

A. Total Geometry Morphing Method

The reconfigurable operation in this method is fulfilled by providing sub elements of large array a switching process. RF switches are utilized to provide connection between elements and size is usually not more than λ/20. When these elements are joined to form an array than this array results into efficient radiating pattern. Now, depend upon the application the radiating structures can be differing with respective to geometry [18]. The antenna implemented using this method is also known as distributed radiator. Fig. 4 is demonstrating the total geometry morphing method.

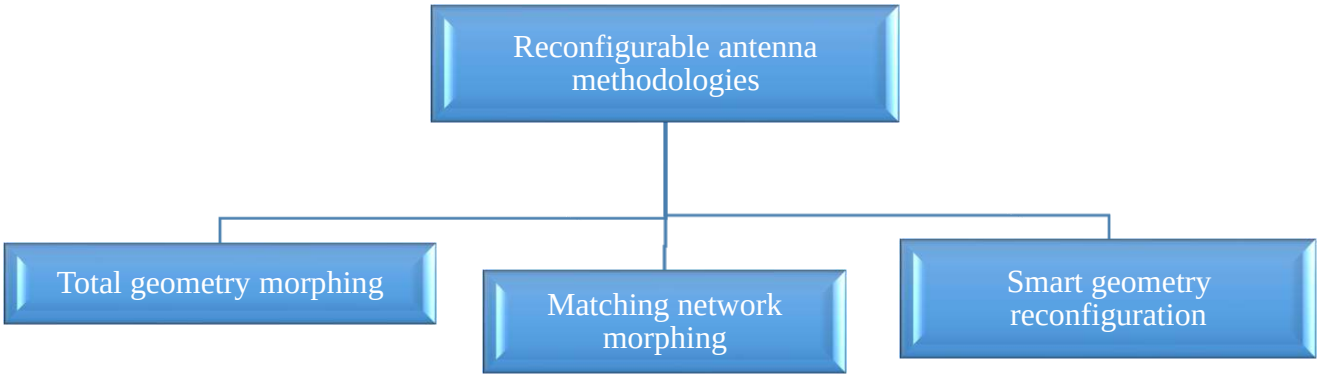

Fig. 3 Reconfiguration Methodologies

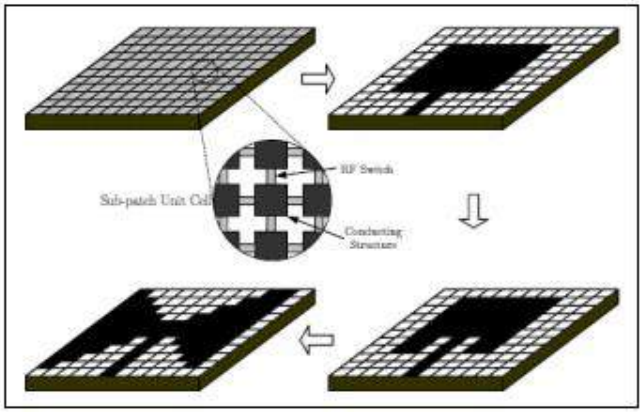

Fig 4 Total geometry morphing method of reconfigurable antenna design

The main strength of this method is that it provides wide range of antenna reconfigurability. The various antenna parameters can be controlled due to flexibility of this method. So many applications in number can be supported by this single platform. Thus, antenna can support different frequency bands while operating on a single platform. In this method design is also possible with three dimensional and surface conformal [19]-[21]. As a result, leads to complex structure design.

Now, to design antenna using this method needs an array of may number of sub-elements, many switches and control lines. These will result into complex geometrical structure design. Also, as number of active elements are more in number which also leads to more points that are not functioning. RF MEMS as micro electrical mechanical switches having reliability issues because of mechanical fatigue. So, any design which is based on RFMEMS can results into degradation performance.

B. Matching Network Morphing Method

The matching network morphing method is easy and simplest method among all other three methods for getting reconfigurability of antenna. In this method there will no change in radiating structure of antenna, only the part of antenna that provides impedance matching is reconfigured. As same in previous method, this method is also using the geometries having microstrip structure [22]. Now, to control the antenna parameters in a suitable way these sub elements are arranged in transverse alignment along with width of microstrip line. These elements are arranged in such a way so that distance between individual elements not more than $\lambda/20$ in longitudinal alignment.

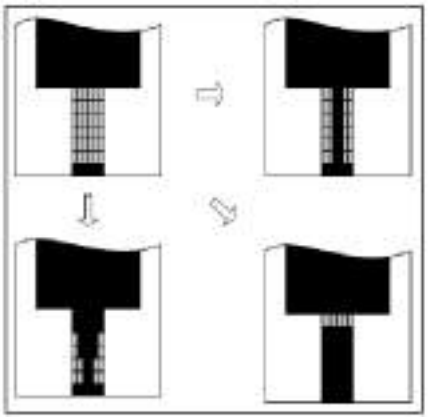

Fig 5 Microstrip feed configurations for impedance matching

Fig. 5 demonstrates the design using matching network morphing method. A reconfigurable microstrip line is used to edge fed the microstrip patch antenna. The structure of reconfigurable microstrip line contains an array of elements that exhibit switching property [23]-[24]. Now these sub-elements can be active or inactive through on/off the RF switches which make the connections among the sub-elements and hence represent the overall structure. The impedance of microstrip can be change through alter the length and width of feed line. In above figure, black box indicates that the sub-elements are active and gray box indicates that the elements are inactive elements.

Now let discuss the arrangement of Fig. 5. The arrangements can be seen of two parts one is upper part and second is bottom part. In upper part, it represents two sections one is upper left and second is upper right. Now, upper left part represents the microstrip patch antenna along with microstrip feed lattice. The upper right part represents the arrangement of sub elements in a way that feed line having configuration as narrow microstrip line. This feed configuration shows the mode of patch antenna that it works in radiation mode. Now, the bottom both parts left and right represents that microstrip feed line have been configured in two appropriate formations. Microstrip patch antenna shows the many radiation modes that are excited by the variations in feed impedance. The advantage of this technique is that this is easy and simple method to implement practically. The reason behind is that only feed network section is changed and rest design remains same. hence results into minimum complexity. So, RF switch components are used very less in number. So, there is not an issue of switching reliability as in case of Total geometry morphing method. But this method face disadvantage of being limited antenna reconfigurability because antenna operations are only work by change in impedance. Also, electrical characteristics also led to alter because the main radiation mode is changed by impedance

C. Smart Geometry Configuration Method

The third technique that have found for antenna reconfigurability is smart geometry reconfiguration. In comparison with other two methods geometry morphing method and matching network morphing method, this method only alters critical or important parameters to achieve required antenna reconfigurability [25]. The microstrip antenna reconfigurability can be designed using this method requires very fewer elements that leads to simple structure advantage over other method. Thus a good amount of reconfigurability can be achieved through this method by having complete knowledge of antenna design and carefully consideration of all parameters. The shortcoming of this method is that one should have deep knowledge of internal physics of specified antenna so that little change in geometrical structure leads to higher reconfigurability. Another factor that affects the reconfigurability of antenna is electrical characteristics of antenna.

V. SWITCHING TECHNOLOGIES USED IN ANTENNA

This section will introduce you to the current technologies used for switching in reconfigurable antenna. PIN diodes and MEMS are the two most commonly used switching techniques for antenna reconfiguration. The basic concept of switching is to connect and disconnect an electric connection by some means. In routine application of Electronics/Electrical systems, a switch provides either conducting path or non-conducting part. But in RF systems, electric properties of switch affect the system parameters and its state of operation. Therefore, in RF systems we must consider the electric properties of switches like resistance, capacitance, inductance, etc along with the RF system. In reconfigurable antenna systems, the role of switching is to control and redirect the flow of RF energy to meet desired response from the system. The criterion for selection of switching technology depends upon the application where the antenna is to be deployed [26]-[28]. The common crucial factors are signal power level, switching speed required, impedance characteristics, switch biasing, activations conditions, package and form factor, switch cost, etc.

D. TYPES OF SWITCHES

RF switches may be mechanical or semiconductor. A switch is an open circuit when no actuation voltage is applied and a low-impedance path for the RF signal when an actuation voltage is applied. The switch can be implemented in a series or Shunt configuration. The Table. 1 summarizes the performance comparison of mechanical switches with the solid-state switches.

TABLE XIII
PERFORMANCE COMPARISON OF MECHANICAL AND SOLID STATE SWITCHES

Parameter	**Mechanical switch**	**Solid state switch**
Frequency range	from [DC]	from kHz
Insertion loss	Low	High
Return loss	Good	Good
Isolation	Good	excellent
Switching speed	In ms	In ns
Settling time	< 15 ms	< 1 us
Power handling	High	Low
Operating life	5 million cycles	Infinite
ESD immunity	High	Low
Sensitive to	Vibration	RF power overstress

Several reconfiguration techniques have been proposed by the researchers for reconfigurable antennas. These reconfiguration techniques can be divided into four major streams as shown in Fig 6.

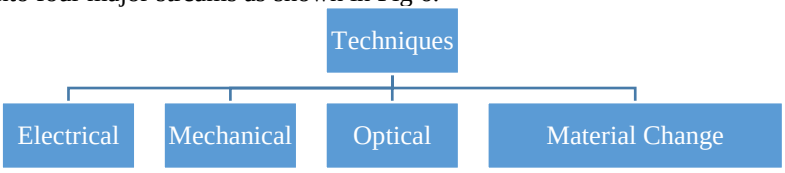

Fig 6 Reconfiguration Techniques

10) *PIN Diode*: Pin diodes became very popular for reconfigurable antenna design as they provide fast switching speed and relatively large current handling capability. Comparatively conventional RF switches has less switching speed. PIN diodes can be easily placed in packaging, consuming very less space as compared to the conventional RF switches. In PIN diodes, the semiconductor junction acts as a control element to control the RF energy.

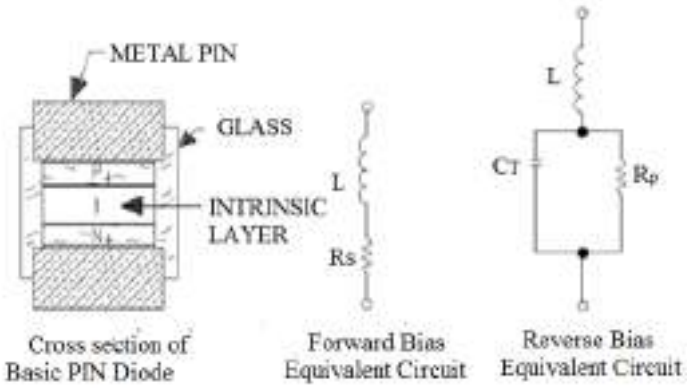

Fig 7 PIN diode cross section and its circuit equivalents

It's one special quality in RF microwave applications is that, it behaves as almost resistance only in Microwave range of frequencies. With the help of controlled biasing its resistance can be varied from few ohms to several kilo ohms. The biasing current required for operation of PIN diode is approximately 10mA.P-I-N diode is made up of two semiconductor regions, p-type and n-type separated by a resistive intrinsic region. This resistive intrinsic layer differentiates it from regular PN diode and same is the region for its unique properties.

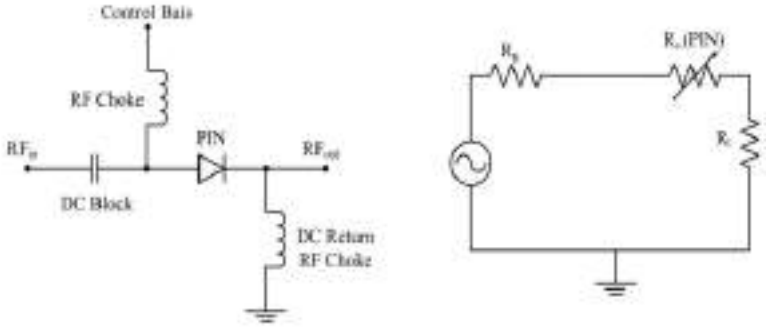

Fig 8 Series PIN diode RF switch model

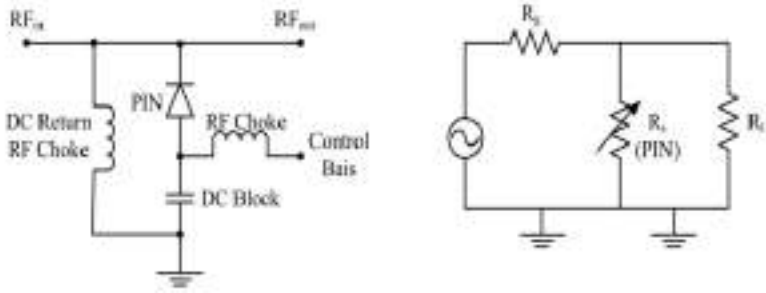

Fig 9 Shunt PIN diode RF switch model

11) *MEMS Switches:* PIN diodes have disadvantages too, they are not suitable for reconfigurable antennas where large number of switches are required. The individual device losses may impact the overall performance of antenna cumulatively. The results

may be narrow bandwidth, high insertion loss and more power consumption. This makes the PIN diode as less preferable choice. So, the advancements in RF MEMS technology made it more preferable for reconfigurable antenna design as compared to PIN diodes as RF MEMS switches has the capability to overcome the shortcomings of conventional RF switches. Additional they have shown excellent and consistent switching characteristics over very wide range of frequencies. Also, they exhibit low insertion loss and large isolation, which makes them well suitable for RF microwave applications. The MEMS device can also act as variable capacitor, Inductor, filter, etc. which provides more flexibility to designers for designing reconfigurable design.

The advantages provided by RF MEMS over PIN diodes are listed below:

- Wide Bandwidth
- High Isolation
- Low Insertion Loss
- Low Power Consumption
- Linearity

Providing numerous advantages over PIN diodes, RF MEMS also have few short comings as listed below:

- Slow Switching Speed
- Low Power Handling
- High Actuation Voltage

Requirement of high actuation voltage is major challenge which restricts the use of RF MEMS in portable devices. Typical value of required actuation voltage lies between 20-80 V. This is also a challenge for researcher in the field, they are continuously working on reducing actuation voltage to make them suitable for portable devices.

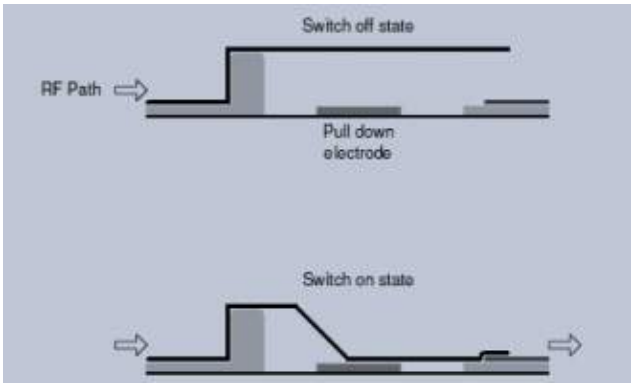

Fig 10 RF MEMS

12) The Optical Reconfiguration: Researcher also tried to make use of optical switches to achieve reconfigurable antennas. These photoconductive switches are deployed in antenna layout, these get active when laser light falls on them. But due to Integration difficulty and higher power requirements, they did not find much application in reconfigurable design.

VI. FABRICATION PROCESS

Fabrication process is very critical in case of antenna design. To design reconfigurable microstrip antenna very careful steps have to be taken to avoid any type of errors. The bandwidth of antenna can be affected even a minimal error in dimension [29]-[30]. So, throughout the fabrication process high dimensional tolerance is kept and maintained. To design the antenna certain steps, have to be followed which are given in Fig 10.

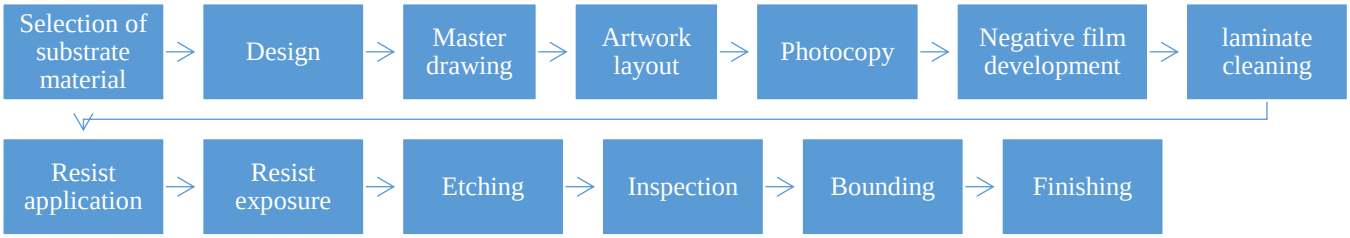

Fig 11 Fabrication steps of reconfigurable Microstrip antenna

VII. CONCLUSION

In this paper detailed study on reconfigurable methodologies and switching technologies using microstrip antennas have been discussed. Also, the design procedures of different microstrip antenna geometries which form the basis for the reconfigurable antenna have been discussed. The detailed description of reconfigurable antenna technology including various methodologies for achieving frequency, pattern and polarization reconfiguration along with the principle behind reconfiguration and mechanisms to

achieve them. Brief overview of the RF switches available for use in reconfigurable antenna systems and fabrication process of antenna design has been discussed.

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The Electronics and Communication Engineering was established in the year 2003, at Punjabi University, Patiala. The courses of Bachelor and Master of Technology course in Electronics and Communication Engineering and Bachelor of Electronics and Computer engineering are run by the department succefully. Presently, there are 32 faculty members who are actively involved in research work in his/her respective fields of specialization along with well-trained technical and non-technical staff to assist them. All ECE concerned Labs are well equipped with latest equipment and software. To assist the students of M.Tech. and Ph.D. in the field of research, a Research Lab with number of software's and hardware equipment. More details are provided on webpage of the department: http://punjabiuniversity.ac.in/pbiuniweb/pages/departments/newece.html , http://ecedpup.ac.in hosted on the university website. The department is associated with other professional technical associations and societies namely IETE and IEEE with an aim for 100% employability and campus placement for all eligible candidates. As per the past placement record, the department candidates had a good contribution/share in each year of campus placement drive.Our vision is to become the best Teaching and Research department of the region in the field of Electronics and Communication Engineering. Our mission is to establish the department as the Centre of Excellence in its domain.

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