



Don Bosco Institute of Technology
Department of Electronics and Telecommunication



PubTech

volume 4.0

Research Papers based on Final Year Projects
Academic Year 2021 - 2022

HOD's Message



The final year projects of academic year 2021 –2022, compelled the faculty and students to be at their best of creativity. Uncertain circumstances lingered all through the year and called for good execution plans especially in case of hardware projects. Despite all odds, the projects were very well implemented and tested. The zeal and commitment of the students and their project guide is definitely praiseworthy.

I am very proud that the quality of the projects was very well appreciated by the industry professionals and external individuals who visited the project during INNOVEX 2022. Among the 19 projects, 2 have resulted in publications in conferences and refereed journals which is commendable. PUBTECH 4.0 showcases a compilation of all the papers written based on their projects. It demonstrates the diligence and ardour of the students and their guides.

Special appreciations for the efforts put in by Ms. Freda Carvalho, Department Project Coordinator in ensuring smooth conduct of all project related activities including PUBTECH. Last but not the least, I wish to congratulate the students and the guides for the endearing efforts which will go a long way.

Dr. Ashwini Kotrashetti
HOD, Dept. EXTC

Department Project Mentor's Message



It gives me great pleasure to introduce the latest edition of PubTech, which features technical papers written by students in their final year of study based on their work on capstone projects. PubTech 4.0 is more than simply a compendium of technical papers; it also serves as an example of how students think creatively and how hard faculty members work to make those ideas a reality.

Over the years, the Department of Electronics & Telecommunication Engineering has put in place robust procedures, which has raised the quality of project work. These steps led to the creation of the present edition of PubTech. I hope that every issue of PubTech will serve as a landmark for faculty and other students.

Finally, I would want to use this opportunity to thank the faculty and students for their work and contributions.

Dr. Sudhakar Mande
Project Mentor, Dept. EXTC

CONTENTS

1. Single/Dual–Axis Solar Tracker for Domestic Use.....	1
2. Vibration Analysis for Condition Monitoring & Predictive Maintenance using Embedded tinyML	5
3. Low–Cost Portable Digital Storage Oscilloscope with Function Generator	8
4. Energy Monitoring System For Electric Vehicle Supply Equipment (EVSE).....	16
5. Low Power CMOS VLSI Design MAC Unit.....	20
6. Design & Development of Wireless Charger for EV	24
7. Multipurpose Stair Climbing Robot.....	33
8. Medical Report Generation using Chest X– Ray.....	37
9. Design and Implementation of Intravenous Fluid Monitoring and Alerting System.....	43
10. Implementation of Smart Electronic Voting Machine.....	47
11. MRI based Classification and Segmentation of Brain Tumour using Deep Learning.....	52
12. Home Automation System.....	59
13. Age Progression and Regression using cycleGAN.....	63
14. Liver Tumor Detection and Segmentation.....	68
15. Capacitive level sensor for water level detection.....	72
16. Renal Cell Carcinoma Segmentation.....	76

PAPERS ACCEPTED FOR PUBLICATION

1. Design of a Dual Band Monolayer Metasurface Based Bandpass Filter.
2. Design and Analysis of a Compact Metasurface Based Filter for Broadband Performance.

SINGLE/DUAL-AXIS SOLAR TRACKER FOR DOMESTIC USE

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Abstract—Of all the renewable energies, solar power is the only energy that gained popularity and importance quickly. Through the solar tracking system, producing an abundant amount of energy makes the solar panel's work ability much more efficient[1]. The perpendicular proportionality of the solar array with the sun rays is the reason behind its efficiency. Pecuniary, its installation charge is high provided cheaper options also are available. The project discusses the design and construction mechanism of the miniature model for the solar tracking system having a dual axis of freedom. This project's goal is to create an autonomous tracking system that can track the location of the sun. In recent years, solar panels have grown in popularity to convert solar energy to electricity. The panel can be used as to generate output or an out-sized solar system connected to the electricity grids. The motive is to consume more energy from the sun using solar panels. Solar panels must be positioned perpendicular to the sun to maximize solar power conversion. As a result, tracking the sun's position and situating the solar array is critical. The tracking system will move the solar array so that it's positioned perpendicular to the sun for max energy conversion at all times. Light Dependent resistors would be used as sensors in this system. The system will contain a lightweight sensing system, various integrated circuits, a gear motor system, and a solar panel. The system will output up to 30 percentile more energy than solar panels without tracking systems.

Index Terms—solar energy, solar tracker, dual axis tracking

I. INTRODUCTION

In this project, the idea was to implement a prototype/minature model of a solar tracker system that could generate more energy[2]. People use nonrenewable energy sources at an alarming rate, and they are rapidly decreasing. With rising global temperatures, people will eventually need to switch to sustainable energy sources, and solar energy is one of the most abundant. Solar panels are getting increasingly popular. The research was conducted using various platforms and readings that helped us to understand the various solar tracker systems and the growing demand for the use of solar energy being considered. A solar panel takes the sun's energy and transforms it into electric energy, and stores that energy in a battery. Solar energy can be utilized when required or is often used as an immediate alternative to relying on the grid for power. It is feasible to utilize the energy stored in batteries. The solar panel gets the most energy from the Sun when sun-rays hit the panel orthogonally. As the earth rotates for the static solar panel, the solar radiation is not hitting the panel orthogonally for the time of the day, and the solar panel

generates less energy. For efficient solar energy usage, the Solar panels should absorb energy to a maximum extent. The requirement can be fulfilled only if the panels are continuously placed in the direction of the Sun. So, the solar panel should continuously rotate in the direction of the Sun. That will mean that the solar panel is always parallel to the Sun, and it is always receiving maximum solar radiation and, in turn, generating the maximum energy. The idea describes a circuit that rotates solar panels to remain perpendicular to the Sun to maximize energy generation[3].

A. Literary work

During the research analysis, studies of various articles and research paper was done through which the following details and observations were made. It was discovered in a Jordanian climate experiment on the basis of using two-axis sun-tracking systems. The analysis found that when compared to a static system for a given day, the power outcome improved by 30-45 percentile [4]. The static system does not get maximum solar radiation for the majority of the day, resulting in lower power generation; however, the dual-axis solar tracking system tracks the sun in the sky and moves the solar panel so that it is parallel to the sun and receives maximum solar radiation. Research into single-axis horizontal tracker solar panels was made. As per the findings, east-west axis tracking was inefficient in increasing energy efficiency, however, following the sun about south-north was the most effective. The east-west axis efficiency increased by less than 8 percentile, whereas the south-north axis efficiency increased by 10-24 percentile [6][7]. In Sanliurfa, Turkey, the reason of dual-axis solar tracking with the development of electricity energy was overlooked when compared to a fixed PV panel [8]. For a specific day in July, the daily power gain was found to be 29.3 percentile in solar radiation and 34.6 percentile in power generation. The devised technique boosted the energy gain up to 28.31 percentile for a partially overcast day in the Experiment findings [9]. The research proposed a dual-axis tracking system to implement developed a simple and efficient control scheme. The outcome of this experiment was that the project successfully designed, built, and examined a dual-axis sun tracking system in tracking, and inexpensive [5].

B. Analysis

In this project, prototype system will be designed and developed to implement a single/dual-axis solar tracker to enable the solar panels always to face the sun orthogonally. Multiple sensors will be deployed, which will feed the Comparator circuit for measuring certain parameters and make appropriate decisions for controlling the servo motor-based actuators. The Motor Driver, as well as the comparator circuits, both act as the brain of the system, which is responsible for scanning each sensor continuously on a time-shared basis and, after measuring these parameters analyzing the values, obtained and finally assessing as per the conditions to send commands to the servo motors. These servo motors are responsible for the movement of the solar platform attached to them.

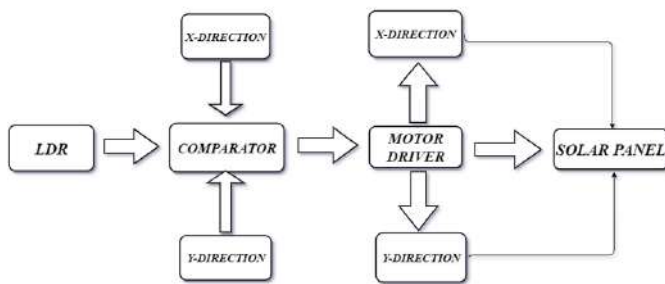


Fig. 1. Block diagram of the model.

1) **Design details:** The system developed comprises of the various material stated as the solar panel, Light Dependent Resistor [LDR], Motor Driver [L293D], Servo motor, and the frame on which the whole setup will be resting. Initially, the working of the Integrated circuits was checked. Then the interfacing of the components was then done on a breadboard using wires and the stated circuits and then connected to the servo motor. The whole procedure was done using the simulation Proteus 8 Professional to test and eliminate the troubleshooting if any occurred. Once the software part was done, the whole system was developed virtually and tested with the use of simulation software, which gave the required results. The frame that is to be made would have a design that would provide the ease of movement of the system and fulfill the requirements of the system that is to be designed.

2) **Implementation Plan:** The project started initially with the research work on the existing system and any changes or developments that had been made to date. Once information was gathered about the system, then started testing the simulation part to check the workability of the circuit and troubleshoot if any errors were present. Then, after a successful or positive result from the simulation was achieved, approach towards the structuring of the system where the circuit and the panel would rest. The use of wood was made to help the base of the structure so that it could sustain the whole load. Finally, the combination of both the circuit system and the necessary connection to the solar panels was made and the whole system was rested onto the made frame.



Fig. 2. Block diagram of the model.

1) **LM358:** It has 2 low pass filters and will work as a comparator in our system. It can operate at supply voltages as low as 3.0 V or as high as 32 V, with quiescent currents about one-fifth of these related to the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the need for external biasing components in many applications.

2) **L293D MOTOR DRIVER:** It can drive 2 motors simultaneously. It allows to move servo motors in any direction. This IC consists of 16-pins which are used to control a set of two DC motors instantaneously in any direction.

3) **Solar Panel:** Solar panel converts the solar energy to electrical energy and stores it for later use. It is made up of solar cells.

4) **Light Dependent Resistor:** Four LDR are being used. It works on photo conductivity principle. As the light intensity on them increases, their resistance decreases and vice versa.

5) **Servo Motor:** Servo motors are being used to move the solar panel in required direction. Servo motors are reliable and can carry different amount of load comfortably. Stepper motor can also be used for this system but it could lose synchronism due to overload[10].

II. OVERVIEW OF THE MODEL

There are four Light-Dependent Resistor sensors connected to the solar panel. Each one is connected to a low pass filter. Four low pass filters are there in the system. Two LM358 integrated circuit's are being used. One integrated circuit has two low pass filters. One integrated circuit is for the movement of solar panel in x direction and other for the movement of solar panel in y direction. They will send output to L293D motor driver and then it will process that and send output to two servo motors.

In the project, the use of 555 timer integrated circuit to send PWM pulse to the motor driver. The motor driver will

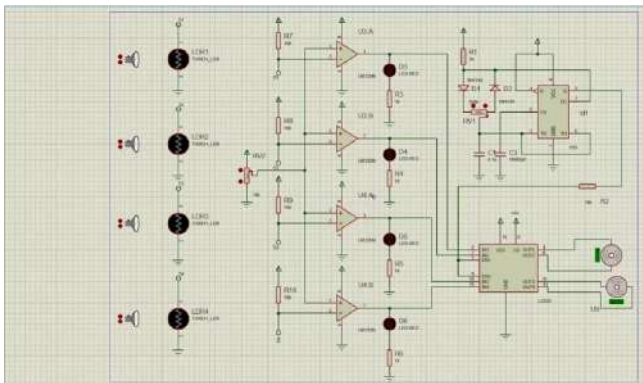


Fig. 3. Proteus simulation of the model.

send a command to one motor about how to move the solar panel in the horizontal direction and the other motor about how to move the solar panel in a circular motion. Combining these two motions, the end model gets our dual-axis tracking system. The Light-Dependent Resistor sensors on the solar panel collect data. Light-Dependent Resistor sensors work on the photo-conductivity principle. The conductivity of

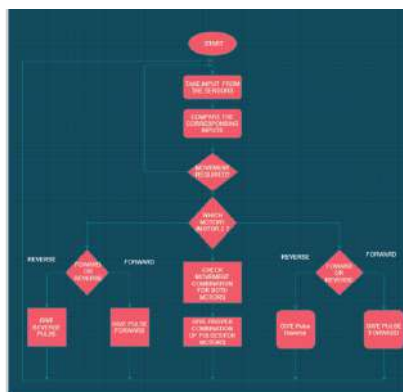


Fig. 4. Flow chart of the model.

the resistance changes depending on the light falling on the Light-Dependent Resistor sensor. When light intensity on the Light-Dependent Resistor sensor increases, the resistance decreases, and vice versa. This data is sent to the LM358 integrated circuit. Two Light-Dependent Resistor are for the north-south direction and the other two for the east-west direction. There are four LEDs to indicate if all Light-Dependent Resistors are receiving an equal amount of light or not. When the light intensity on all Light-Dependent Resistor sensors is equal, the solar panel is parallel to the sun[11]. The motors stop moving, and the solar panel is fixed in that position getting the maximum solar radiation. The Light-Dependent Resistor sensors are continuously collecting data and sending it to the system, so it is an automatic tracking system and not a predefined motion or adaptive system. There are other systems and types of solar tracking that came across in our literature review but the method used comprises going with automatic tracking system.[12][13]

III. RESULT

In the project, four series of solar panels were used. The specifications of the panels were 6 volts and 100 milliamperes each. The system was placed in an open-space environment to demonstrate solar energy absorption during the model testing. The output of the solar panels gave a constant output of 24 volts at the output generation from 7 a.m. to 4 p.m. From the testing, it was found that from 11 a.m. to 4 p.m., the output of the system could achieve or yield 100 percentile of the intensity that the panel could generate..

IV. CONCLUSION

Compared to their traditional fixed-position counterparts, solar systems which track the changes in the sun's trajectory over the course of the day collect a far greater amount of solar energy, and therefore generate a significantly higher output power. According to the given implementation plan and the idea about the design of the system, the implementation was open environment from morning to evening to get 12-hour data on the amount of energy done using the various integrated circuits and the panel structure on which the system rested. In the testing, the system could achieve up to 70 percentile intensity and had a good response to changing the intensity of light. Also, the circuit being self-efficient made it a better model. In the project, four series of solar panels were used. The specifications of panels were 6 volts and 100 milli-amperes each. During the model testing, the system was placed in an open environment from morning to evening to get 12-hour data on the amount of energy generated. As a result of the system work-ability a constant output of 24 volts from 7 am to 4 pm at the output generation. Also conclusion was made that from 11 am to 4 pm, the project's output could achieve or yield 100 percentile of the intensity that the panel could generate.

ACKNOWLEDGMENT

A project is a teamwork which involves the contribution of many people. We would like to thank everyone who has contributed by taking interest in our work and motivating us all the way through. Sincere thanks to our project guide Prof. Poonam Chakraborty, for motivating, co-operating and guiding us throughout the project work, with her effective skills and huge knowledge base. We would like to thank Dr. Ashwini Kotrashetti, Head of Department, Ms. Freda Carvalho, Project Coordinator and Dr. S.S Mande our Project Mentor for their continuous valuable guidance, support, suggestions and their precious time in every possible way throughout the project activity.

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“Vibration Analysis for Condition Monitoring & Predictive Maintenance using Embedded tinyML”

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Abstract—The purpose of our project stems from the inherently unquenching requirement of increasing operational efficiency of an industrial installation. In the face of ever-increasing challenges of building resilient supply chains that are getting more complex by the day, making sure that the downtime of critical industrial equipment is at its minimum is one of the highest priorities of any operator. Keeping these challenges in mind, we aim to develop a generalised, end-to-end plug and play system to predict an outage before it happens and alert the operator of any potential equipment malfunction using machine learning algorithms deployed at edge.

Key Words: Vibration analysis, Embedded TinyML, Condition monitoring, Maintenance, Arduino nano 33 BLE sense, Android app.

I. INTRODUCTION

Vibration analysis is a procedure that involves detecting the vibration levels and frequencies of machinery and then analysing how healthy the machines and their components are. While the inner workings and formulae used to calculate various types of vibration might become intricate, it all begins with the usage of an accelerometer to measure vibration. By adopting the method of Predictive Maintenance (PdM), a process which involves continuously monitoring the state of machinery to predict which parts will fail and when. Maintenance can be planned in this way, and only the parts that are showing signs of degradation or damage can be replaced. Predictive maintenance is based on taking measurements that allow for the prediction of which parts will fail and when they will fail. Machine vibration and plant operational data such as flow, temperature, and pressure are examples of these metrics. The main benefits of PdM are:

- 1) Improved machine reliability through the effective prediction of equipment failures
- 2) Reduced maintenance costs by minimising downtime through the scheduling of repairs
- 3) Increased production through greater machine availability
- 4) Lower energy consumption
- 5) Improved product quality

When a piece of machinery is in operation, it produces vibrations. An accelerometer attached to the machine produces a voltage signal that correlates to the quantity of vibration

and the frequency of vibration the machine produces, which is usually the number of times per second or minute the vibration happens. The data from the accelerometer is immediately fed into a data collector (software), which captures the signal as amplitude vs. time (time waveform). All of this data is processed by computer programme algorithms, which are then reviewed by engineers or skilled vibration analysts to determine the machine's health and identify potential faults such as looseness, imbalance, misalignment, lubrication issues, and other issues. While accelerometers are still the most commonly used instrument for collecting vibration data, advances in sensor technology have allowed for the development of non-contact, high-speed laser sensors capable of detecting faults that accelerometers cannot. This allows for a more precise and targeted examination, as well as a greater variety of vibration analysis methodologies. Vibration analyzers may now gather, analyse, and communicate data much more easily thanks to developments in technology, notably wireless technology. Vibration analyzers are now incredibly portable, can connect in real time with smartphones and tablets, Many vibration instrument manufacturers create their own applications in order to connect with one another. As with most advanced technologies, the majority of vibration analysis data is immediately sent to the cloud and is available on your mobile device, PC, or directly from your browser. This is extremely useful if you're performing vibration analysis as a third-party consultant because you can freely share spectra with your clients.

A. Motivation

Both IoT and Machine Learning are bringing about a paradigm shift in the landscape. Getting hands on experience with these technologies and deploying them will enhance academic and career prospects. Increasing amounts are being spent on improving operational efficiency of industrial set-ups. Providing cutting edge predictive maintenance solutions may help us position this as a product.

B. objective and outcome

Objective:

- 1) Build an Anomaly Detection Model using sklearn on Google Colab
- 2) Export sklearn model and run inference for prototyping and debugging onboard the microcontroller-Arduino nano 33 ble sense
- 3) Mobile Desktop Interface for condition monitoring environment setting for users

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India This paper is a research contribution of students of Batch (2021-2022) .

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- 4) Implementing CI/CD pipeline for periodic data collection and training for improving model accuracy

Outcome: an end-to-end condition monitoring and predictive maintenance system using machine learning for industrial equipment with a mobile desktop application for user interface giving access of condition monitoring for numerous equipment at once where system performance increases with time as more and more data is collected

II. METHODOLOGY

The test bench is used to guide the project's operations. Two scenarios are used to obtain data from the test bench. The servo motor is turned off at first, and this is the typical working state of the DC motor. When the servo motor is turned on, it begins to shake the board, causing unnatural vibrations.

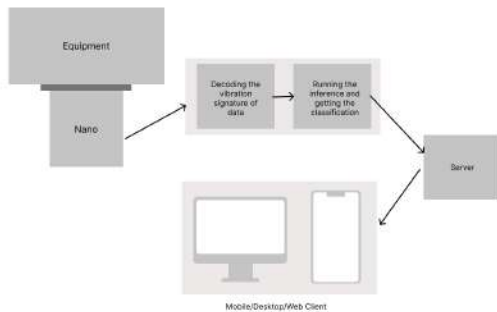


Fig. 1. Block diagram

The accelerometer captures this vibration data using the Arduino nano 33 BLE sense. The data is then saved and converted to a csv file in order to train the ML model. The CSV file is read after it has been loaded into the Python function. The data is then utilized to train a machine learning model using Python's sklearn module and the random forest classifier. Once the model has been trained the Micromlgen's Python library is used to transform the ML model into an Arduino header file after it has been developed. The Arduino code then uses this header file to compare the data from the live sensor (accelerometer). Based on the output, it forecasts either an anomaly 1 or no anomaly 0.

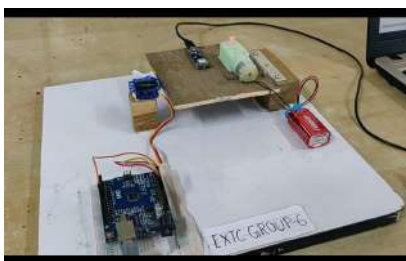


Fig. 2. Test Bench Setup

The live sensor information and the predictions are then changed into JSON string and sent to the serial monitor. Whenever Node Red is working on the local host port 1880, information from the sensor is gathered on the sequential port. Since the information is in a string format, a node is utilized to change it over completely to a JSON string and transform it into a JSON record. This data is used to refresh the site with ongoing information that clients might see alongside expectations and accelerometer information on three axes. This data is likewise given to the Firebase ongoing information administration.

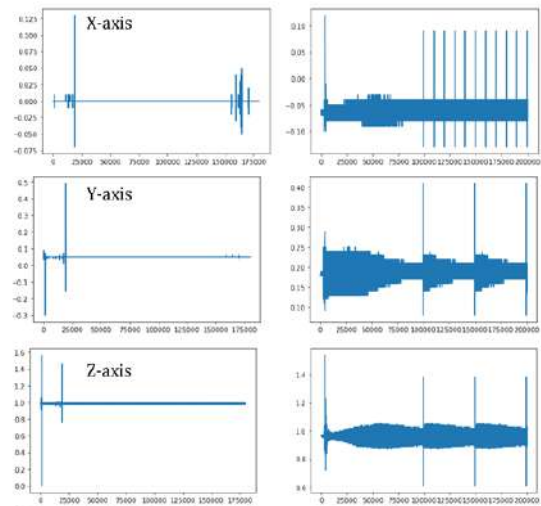


Chart -1: X, Y, Z-axis accelerometer reading with normal state and servo on.

The firebase stores this data in two variants. First for future reference, a JSON report with randomly generated labels is first put away in the information base, making a new single record with live sensor information and expectations for each reading. Second This sensor is additionally refreshed on a solitary JSON record which is expected to show the live sensor readings and comparing forecasts on the android application. The android application is created with the assistance of the flutter app development tool and the dart programming language.

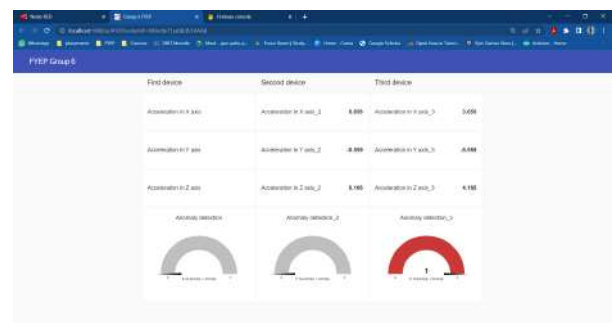


Fig. 3. node red website interface

The Android app displays real-time sensor data as well as anomaly forecasts. Because the sensors are assigned to

separate stages, the user can now check for discrepancies in sensor data in the Node Red interface. To view the sensor's live data, simply enter the proper tag. This can be accomplished with any number of sensors.

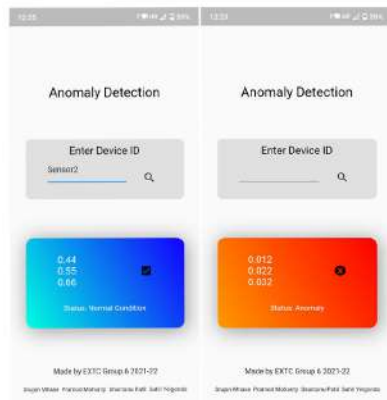


Fig. 4. Android application interface

III. CONCLUSION

We have briefly touched upon the need for preventive maintenance and our project followed by our extensive review into existing implementations and research papers in related fields. We then looked at possible solutions and have proposed a structure to implement our project from the perspective of building a product.

. Our detailed examination of existing implementations and research publications in relevant disciplines has briefly touched on the need of preventive maintenance. We investigated potential alternatives and developed our project with the goal of creating a system that can collect vibration data from industrial installations and anticipate machine status.

ACKNOWLEDGMENT

In this project, the vibration are obtained with the help of Arduino Nano BLE-33 sense and the wifi module ESO-01 which was mounted on a surface of machine to get the desired reading for the vibration which were generated with the help of DC and Servo motor . the reading were then send to the mobile/ desktop application with the help of Node-red and firebase. by this the user will be notified regarding the status of the equipment. A project is a collaboration which incorporates the responsibility of numerous people. We need to thank each person who have contributed by looking at our work and prodding us the entire way through. Our actual appreciation to our project guide Prof. Jithin Saji Isaac, for pushing, collaborating and coordinating all of us through the errand work, with his fruitful capacities and enormous data base. We additionally need to express our gratitude to Dr. Ashwini Kotrashetti, Head of Department, and Ms.Freda Carvalho, project Coordinator for their consistent critical bearing, sponsorship, thoughts and their significant time all over all through the errand activity

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APPENDIX A

The Arduino Nano 33 BLE Sense only supports 3.3V I/Os and is NOT 5V tolerant, so please do not connect 5V signals directly to this board or it will be damaged. In addition, unlike Arduino Nano boards that support 5V operation, the 5V pin does NOT supply voltage but is instead connected to the USB power input via a jumper. A NINA B306 module controls the Blue- tooth. The IMU is an LSM9DS1 that is controlled via I2C. The LPS22HB measures both barometric pressure and ambient temperature. The HTS221 is a relative humidity sensor. The ADPS-9960 is a sensor that detects digital proximity, ambient light, RGB, and gestures. The digital microphone is the MP34DT05. The ATECC608A crypto chip manages crypto keys. The

Low-Cost Portable Digital Storage Oscilloscope with Function Generator

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Abstract—A digital storage oscilloscope and signal generator are essential for every electronics lab. These devices have a vast application spectrum measuring signal voltages, current, and frequency, observing the V-I characteristics of diodes and transistors, and generating various signals to test a circuit. They are being used by many professionals in the industry, academia, and hobbyists. However to have a basic DSO and signal generator, they need to pay a considerable amount, and the size is very bulky. So, to remove this limitation, we have made a low-cost portable DSO cum signal generator. Our project uses a Microcontroller (STM32F401CC) instead of FPGA. STM-32F401CE is affordable and has ADC with a 2.4 MSPS acquisition rate and very efficient processing power which help in processing signal up to 200KHz. We have used ADC along with DMA. Along with these, the waveform can be zoomed and Freezed, the trigger value can be changed as per the users requirement through buttons. It's totally open source so that user's can modify it as per his/her requirement.

Index Terms—IEEEtran, journal, L^AT_EX, paper, template.

I. INTRODUCTION

An Oscilloscope is a basic need at engineering laboratory which is used in telecommunication, electrical, electronic analog, or digital fields. An Oscilloscope can show visualization from the electrical signal form which it can make user could analysis further and get information. A Digital oscilloscope is better than analog oscilloscope (CRT) seen from the shape, efficiency capability, and storage capability. There are various kinds of standalone oscilloscope product from any brand which has a high price. For example, the price of a Fluke digital oscilloscope is around 25k to 30k. These products have excessive features and very high capability, which are not very as such used by students which, makes these products not very cost effective.

A. Problem Statement

This project is focused on the design and the construction of a portable oscilloscope which has a small size and can be grabbed with hand. This oscilloscope has many advantages such as practical, easy to use, easy to carry anywhere, and it is using low power than other oscilloscopes, most importantly

optimum for student level. The oscilloscope is designed by using an embedded system. An open-source electronics platform is based on easy-to-use hardware and software.

B. Design Methodology

1) *Block Diagram:* Block diagram of our project.

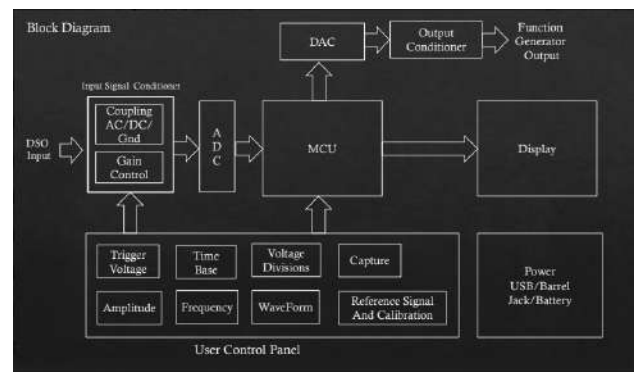


Fig. 1. Block Diagram of DSO

2) *Waveform Plotting:* This is the most essential part of the project that allows us to plot the present waveform at the input. The rate at which we take samples from the internal ADC depends on the ADC clock and the conversion and sampling time. The maximum we can go to is 2.4 Msps when the core clock is 72MHz, and the ADC clock is 36 MHz. however we need a wide range of time bases, to change the number of samples we take or change the method by which we sample. There are two ways we have implemented the sampling for a variable sampling method. ADC works at 36MHz and each sample need 15 clocks to get sampled at the least. For slower Time-bases (0.1s etc), too many samples if sampled at max rate thus, memory consumption is too high. So for time bases we need a very high sampling rate we use DMA at full speed and for slower time bases we poll the ADC at timed intervals to get enough samples and reduce memory consumption.[1] Why not just reduce ADC speed? ADC is disabled for few ms when changing ADC clock speed, thus hampering performance. Our display is of 480x320 resolution for now, a minimum of 480 samples are needed to make one Frame on display.

3) *Function generator AD9833*: AD9833 is a programmable digital synthesizer which means it has all the waveforms according to the phase stored in a memory of 28-bit ROM. It uses three pin SPI protocol to receive the bytes for the waveform, frequency and phase, and produce the output up to 1MHz frequency and a signal of 0.65v max. It has a 16-bit control register that must be filled with specific bytes to get the desired output waveform.[5]

The main task of this module is programming, as there is no hardware required for the module itself to perform.

For programming, AD9833.h library is used, which has software-based SPI protocols using HAL drivers. It assigns wave type and frequency to the module. Using switches and buttons, we can control wave-type and frequency parameters.

C. Implementation

1) *DSO on the Blackpill*: The DSO part has been implemented on the blackpill along with the required hardware to test and implement necessary functions properly. We start with taking samples over DMA, we take around 24k samples at 2.4MSPS, The time difference between each sample is 0.416us. Depending on the time base, the samples needed for plotting the waveform will have different time differences.[6]

TimeBase	FrameTime	PerSampTime
01us	8us	1/4us
02us	16us	1/2us
05us	40us	5/4us
10us	80us	5/2us
20us	160us	5us
50us	400us	25/2us
100us	800us	25us
200us	1.6ms	6.666us
500us	4ms	16.667us
1000us	8ms	33.33us

Fig. 2. Sample time differences

We have eight units for the time base on the screen. Above, we can see what time difference is needed between samples to change the time base, if SamplePlot() is the array needed to plot the waveform, and if Buffer() is the array containing the raw samples then. $\text{SamplePlot}(i) = \text{Buffer}(i * T_d)$, where T_d is the time difference needed between samples as per time-base.

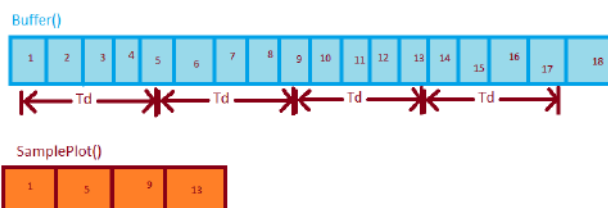


Fig. 3. Select SamplePlot elements from buffer

For larger Time-bases (0.1ms etc) , too many samples if

sampled at max rate thus, memory consumption is too high, depending on the time difference we pick up samples such that the time difference between consecutive selected samples approximates the time difference needed as per the time base. Our display is of 320x240 resolution for now, thus a minimum of 320 samples are needed to make one Frame on display.[7]

2) *Input Circuit*: The AMS-1117 Adj is a variable linear voltage regulator in our project, the above circuit is used as reference for the input signal as well as use to calibrate the DSO, the 1.65v it produces will act as a ground for the input signal, thus shifting them by 1.65v above wrt to the system ground. The potentiometer is there to vary the output voltage, so for calibration, we short the input port and then vary the pot till the DSO reads 0v.

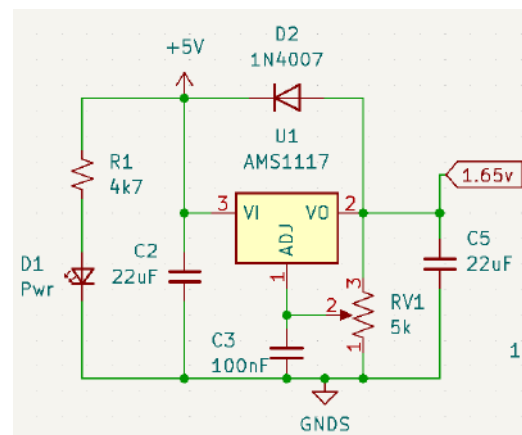


Fig. 4. Input Circuit Protection

This is our input circuit, where we control both couplings and divide the signal so that it does not damage the controller. In the divider part, R2 is connected to 3v3 and R3 to GND, this keeps the signal between 0-3.3v, the capacitor that is present parallel to the series R2 R3 to remove supply line noise. The relay is switching coupling to AC/DC the GND coupling is virtual. For AC coupling we have a 100nf cap in series with the input for DC, this cap is bypassed. Then for the coil part, we are using a BC547 as a switch and a 1n4007 diode to protect from the back EMF of coil.[8]

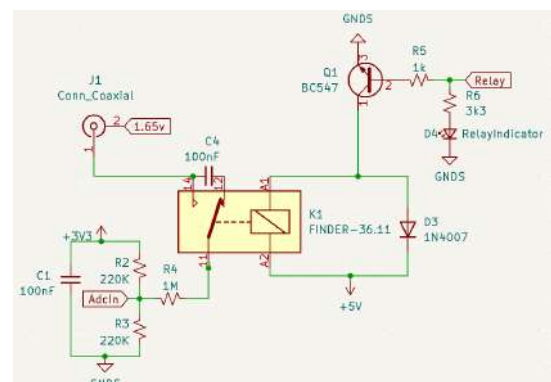


Fig. 5. AC - DC Coupling

3) *Sample Scaling*: Since we have a 12bit ADC, the value of samples ranges from 0 to 4096. since this range is entirely positive, it is difficult to scale them directly on the display while also taking care of voltage per division(zoom). To get a linear scaling across all voltage per division we first shift the sample by 2048 ($4096/2$), which is half our max value, $NewSample = Sample - 2048$. So now our new samples scale from -2048 to 2048 instead of 0 to 4096, so if we plot lines for both, we can see that the -2048 to 2048 is symmetric across the origin while the 0 to 4096 is not symmetric, so when you multiply or instead change the scale to fit the needed voltage per division it will replicate faithfully, However if we did it on the original sample it will also change its amplitude (zoom) but will also shift the wave in Y direction by a certain amount which will depend on the Voltage/Div. As you can see

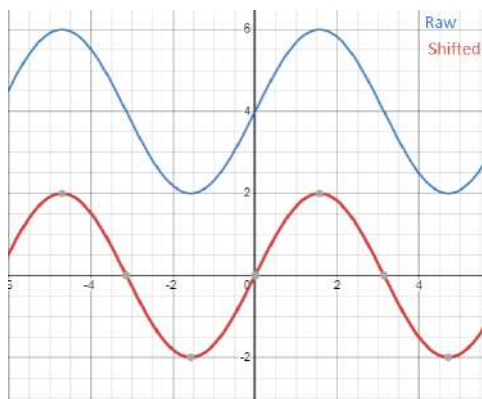


Fig. 6. Raw vs with Shift

above, both are $y=\sin(x)$, in our samples, all values were initially positive, so when we zoom it, we can see that it causes a Y shift along with the zoom, which is not desired but is solved by first shifting the raw sample by half it's max value, then zooming.

4) *X shift and Y shift*: As seen before in 4.1.1 as how samples are selected for a respective time base. X shift, or rather the waveform, is scrolled in the X direction by moving the index of the array by some quantity to see the change. Since all indexes are shifted by the same amount, the time difference between consecutive samples remains the same, and only the position of the buffer from where they were extracted are changed.

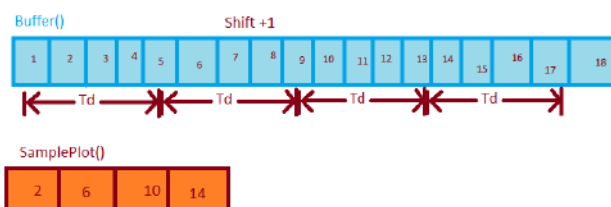


Fig. 7. Shift index by +1 for above example

When the samples from the buffer is converted to create the waveform on display, they are first scaled to fit the display according to the time base. Y shift is added by either

increasing or decreasing the y coordinate of the pixel that results from the scaling.

Suppose we have a sample 'S' from SamplePlot(). It is processed to a pixel 'S'=(x1,y1), now there will be many samples undergoing the process now, this waveform will be shifted by adding a shift to y1. 'S'=(x1,y1)=(x1,y1+Yshift).

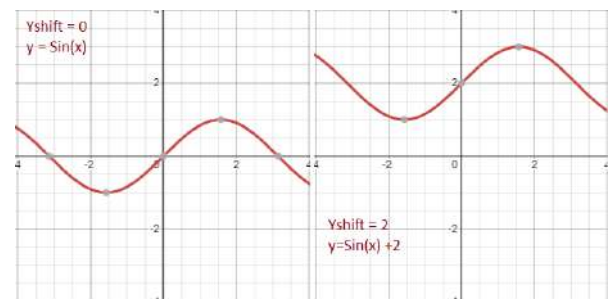


Fig. 8. With and Without Yshift

5) *Amplifier*: As the output is voltage is very small in amplitude i.e, 0.65Vp-p we designed an opamp-based amplifier with variable amplification. We simulated it using Proteus Software, from which we concluded that the required Gain is 6.7. We want that our signals to should contain both negative and positive swings but the AD9833 module outputs signals from 0 to 0.65v, which is entirely positive in amplitude. So before going into the amplifier, the signal is first shifted by -0.325V down i.e, the signal which ranged from 0v to 0.65v now spans from -0.325v to +0.325v this is done by adding a -0.325V dc bias from (8k and 560 ohms) voltage divider to the signal, in this way opamp is acting as an adder and an amplifier at the same time. Here Vin will be our signal from either the duty cycle circuit for a square wave or from the ad9833 module for sine and triangular waves.

6) *Duty Cycle*: The Duty Cycle circuit is used to change the ON/OFF time of the square wave. That is, the frequency of the signal remains the same, but is High Time(Time for which voltage high) and Low Time(Time for which voltage changes). The Squarewave generated by the AD9833 module cannot change it's duty cycle directly via software, so we generate a variable duty cycle square wave by first creating a triangle wave from the AD9833 then passing it through a comparator circuit with 0 to 0.65V dc biasing for comparison using a POT and voltage divider circuit (4.7k and 680 ohms). The voltage present at the POT will be compared with the triangular wave at each instance, This is pot voltage is what determines the

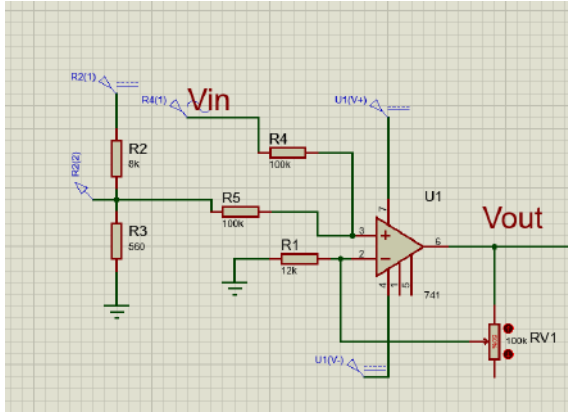


Fig. 9. Circuit diagram of Amplifier

duty cycle. As the pot voltage is present on the inverting input of the opamp, for the period of time for which the voltage of the pot is more than the triangular wave, we will have a $-V_{sat}(-5v)$, and for the other period where the pot voltage is less than the triangular wave, we will have $+V_{sat}(+v)$ thus creating a variable duty cycle wave. As we change the POT value we can change the duty cycle of the square wave. We are using a DPDT switch for user to select the square wave, as the user selects a square wave simultaneously, our output line from the amplifier circuit switches to duty cycle circuit through the DPDT switch. This switching will be replaced by a relay in future versions.

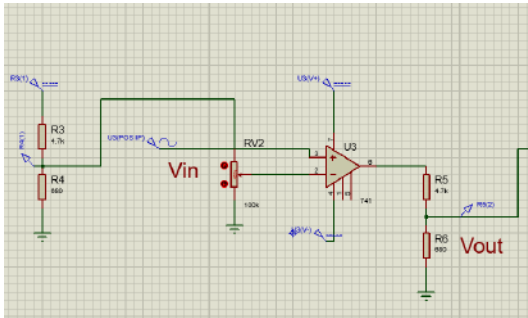


Fig. 10. Circuit diagram of Duty Cycle

The above figure represents the working of the duty cycle circuit, since this output voltage swings from $-5v$ to $+5v$. It is first divided through a voltage divider and then fed to an amp so that its amplitude can be controlled.

D. PCB design

Testing can be done on breadboard but as we know that it has many downsides to avoid hassles while making connections and blowing something up in the process, we designed a PCB to take care of all connections. The components for which the modules are already available we kept them as it is instead of using their basic components in the design. It is done since the modules (AD9833, Blackpill, Bluepill and the display) are

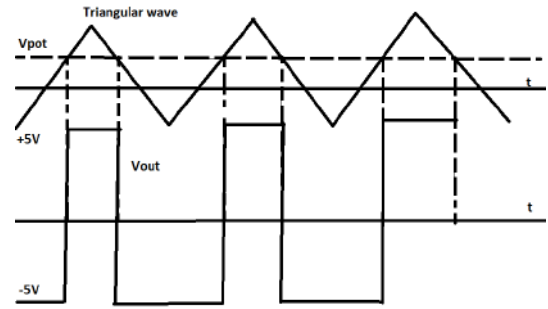


Fig. 11. Duty Cycle Representation

relatively expensive when compared to the other components needed for the system. To connect the modules, female pin headers are used so we can put, and remove them from the rest of the system very easily, including all other components like capacitors, resistors, relay etc, are on the PCB to keep the connecting lines as small as possible while minimizing noise and other parasitic capacitances.

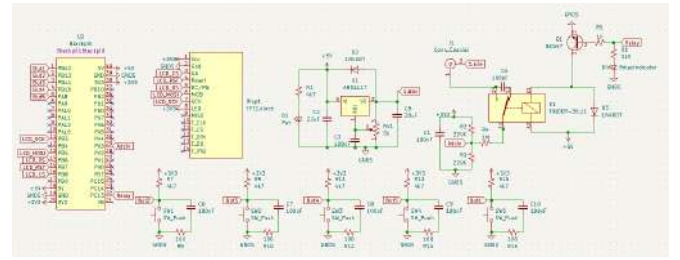


Fig. 12. Schematic of DSO

Presently we are not integrating DSO with the signal generator, but individually output is coming as time permits, we will try to integrate it in the future. Button is used to change time, voltage division, x and y shifts, run, and hold waveform. AC-DC coupling is done via 5V relay. Input circuit protection enables us to give input of $\pm 15V$.

To integrate DSO with the Function Generator circuit, we have added female connectors on our schematic to get signals like SPI pins, 5V, Gnd and GPIO pins from the controller of the DSO PCB. We have included our Amplifier circuit and Duty Cycle circuit in our schematic. A DPDT switch is used for a square wave selection. As the user selects square wave the GPIO pin will be Low and simultaneously, the AD9833 output will be switched from amplifier circuit to duty cycle circuit. Two buttons to increase and decrease the signal are used with their debouncing circuit. We use IC7660 to get negative supply voltage ($-5V$) from our $+5v$ signal from the controller pin.

II. RESULTS

A. DSO Using STM32

This is our current Low-cost Portable Digital Storage Oscilloscope prototype, with a BNC connector and AC-DC coupling with an input range of 30Vpp.

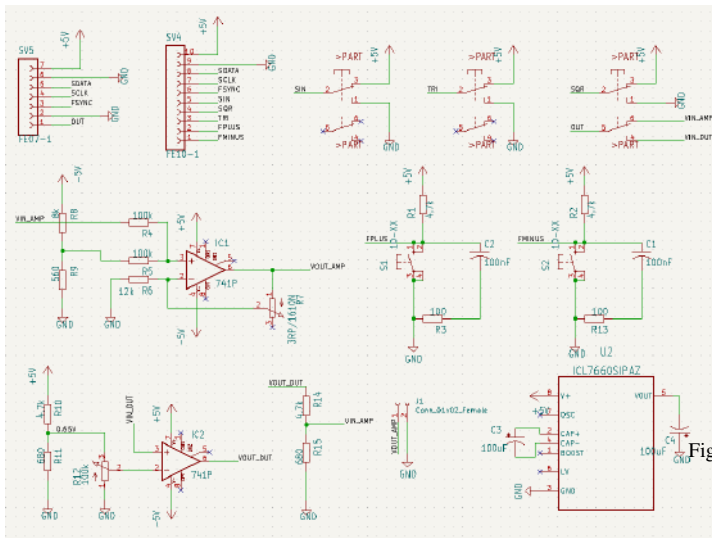


Fig. 13. Schematic of Signal Generator



Fig. 14. DSO using stm32

In the above picture, we can see that there are various buttons for control of which the black buttons supports the Run or Hold the button, its job is as the name suggests, to stop taking a new sample and keep the sample buffer as it is so that the waveform that appears on the screen remains unchanged.

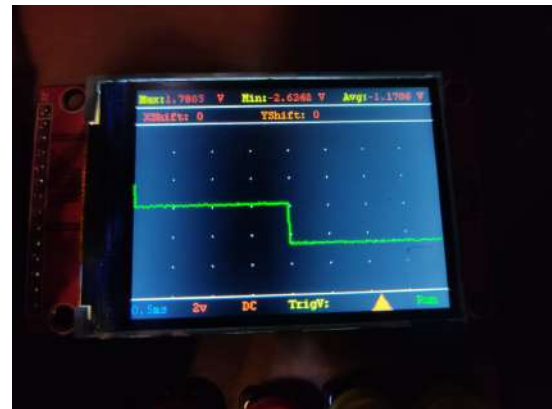
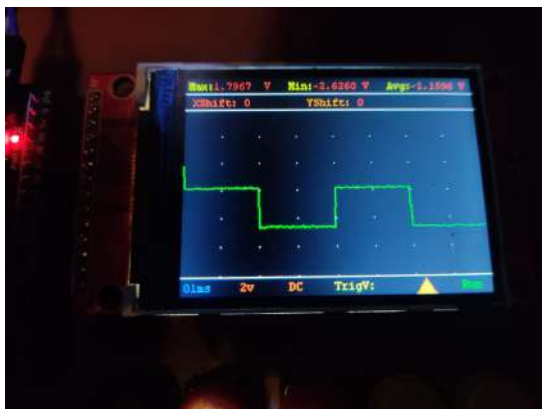


Fig. 15. Time-division

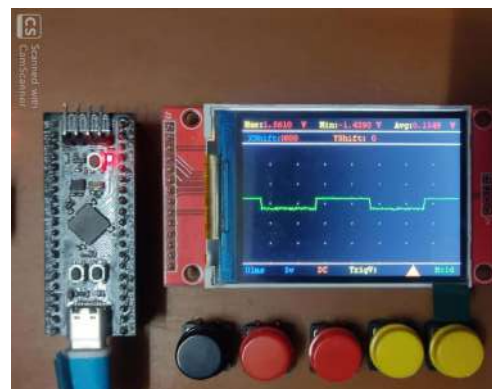


Fig. 16. Voltage-division

B. Function Generator using Stm32

This is the final output of our Function Generator on DSO and PCB of function generator. We can see that all three waveforms are successfully plotted and amplification is also working. For square wave, the duty cycle has some bugs but in the future we will rectify it. As we can see below function generator is plotting all three waveforms i.e. Sine, triangle and Square.

C. PCB

Our final PCB design for our project, DSO and Function Generator. We can see it has a very minimalist and symmetrical look. It has SMD components with good track width.

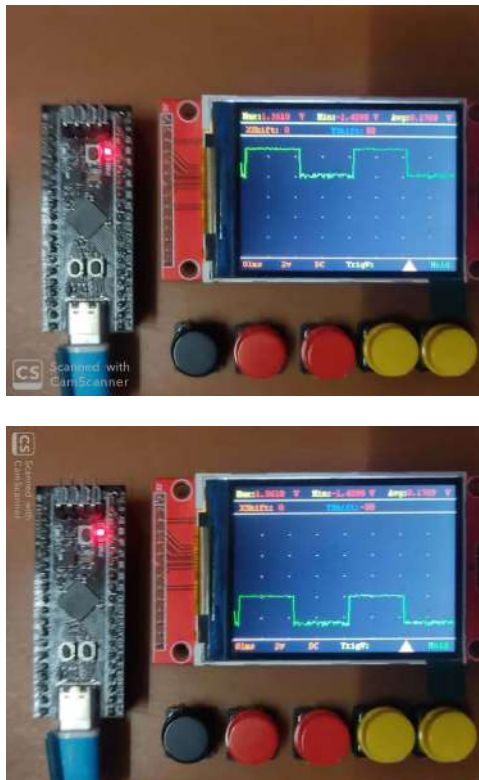


Fig. 17. Y shift



Fig. 18. X shift

so that current requirement is met. It's a one-layer PCB hence a user can home etch it, and can have PCB with minimum investment.[9]



Fig. 19. Falling and Rising Trigger

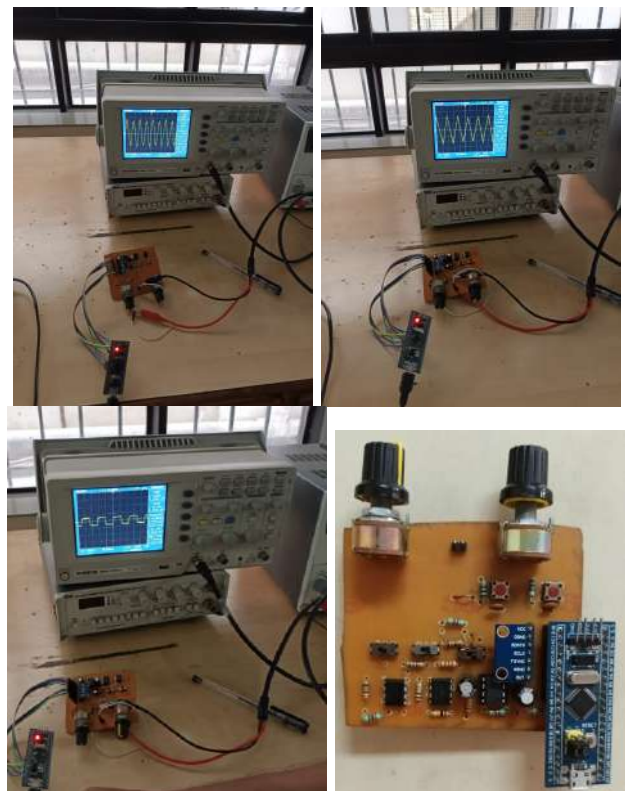


Fig. 20. Output of Function Generator with all three waveform

III. CONCLUSION

Digital Storage Oscilloscope and function generator are essential equipment to analyze various waveforms and to generate various signals respectively, We also completed studying

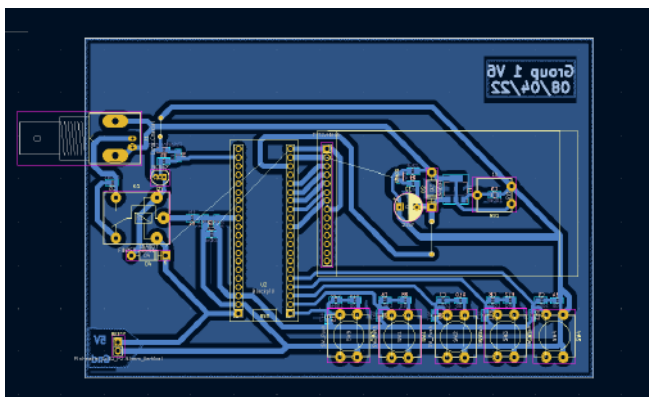


Fig. 21. PCB layout of DSO

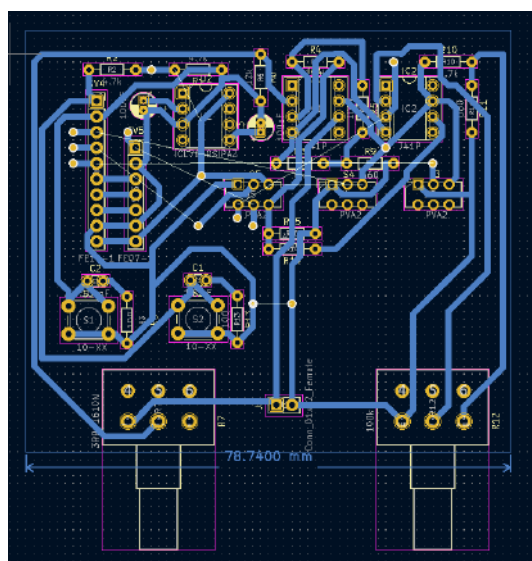


Fig. 22. PCB layout of Function Generator

various literature and papers from trusty resources to understand the different problems and solutions which will help us in the development of our project in the future. Integration of DSO with the signal generator will be our future work. Hence, we successfully create a low cost portable DSO and a signal generator individually. Which plots various signals, generates signals and has basic functions. which is a industry level equipment so that user can use it for his benefits.

APPENDIX A DATASHEETS

A. STM32F401CC

Arm® Cortex® -M4 32-bit RISC core.
Frequency of up to 84 MHz.
High-speed embedded memories (up to 256 Kbytes of Flash memory, up to 64 Kbytes of SRAM),
12-bit ADC,
3.6 V power supply.
16-Channels using Internal 12 bit ADC max speed of 2.4MSPS @36Mhz ADC clock.



Fig. 23. STM32F401CC

B. AD9833

Digitally programmable frequency and phase.
12.65 mW power consumption at 3V.
0 MHz to 12.5 MHz output frequency range.
28-bit resolution: 0.1 Hz at 25 MHz reference clock.
Sinusoidal, triangular, and square wave outputs.
2.3V to 5.5V power supply No external components required.
3-wire SPI interface.
Extended temperature range: -40°C to +105°C.
Power-down option .10-lead MSOP package Qualified for automotive applications.



Fig. 24. AD9833

ACKNOWLEDGMENT

A project is a teamwork that involves the contribution of many people. We want to thank everyone who has contributed by taking an interest in our work and motivating us all the way through. Our sincere thanks to our project guide Prof. Yogesh Gholap, for motivating, cooperating and guiding us throughout the project work, with his effective skills and massive base of knowledge base. We want to thank Dr. Ashwini Kotrashetti , Head of Department and Ms.Freda Carvalho, Project Coordinator, for their continuous valuable guidance, support, suggestions, and their precious time in every possible way throughout the project activity. Also,we are very grateful to the ST Electronics Community Forums.

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Energy Monitoring System For Electric Vehicle Supply Equipment (EVSE)

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Abstract—Energy monitoring is an operation for controlling, monitoring, and managing energy consumption. An accurate and daily analysis of energy consumption is crucial for executing any energy saving strategy. The main goal of this project is to build an energy monitoring system for electric vehicle charging stations (EV supply equipment), for providing users with data about their battery charging status, so they can make an informed energy management decision and maximize savings. We seek to design develop a slow charging station for residential small commercial establishments with energy monitoring capabilities. This station will be a portable unit that can be used to get accurate readings of the energy being drawn during charging of an EV. The system uses a microcontroller and energy monitoring IC module to measure electrical parameters. The execution has been done using Arduino IDE software and parameters such as voltage, current, power etc. are measured. A RFID card system will be interfaced to the system as to validate an EV user. Based on the credit balance in the RFID card, a user will be able to charge his vehicle. Upon exhaustion of the card balance, the charging would automatically stop. This kind of a secure charging system can be used for various use cases scenarios, thus creating a robust, portable easy to use EV slow charging station.

Index Terms—Energy Monitoring System, Electrical Parameters, Arduino, RFID, PZEM module.

I. INTRODUCTION

An electric vehicle (EV) is one which operates on an electric motor, instead of an internal-combustion engine that generates energy with the aid of burning a mixture of fuel and gases. Consequently, which includes automobile is visible as a probable alternative for contemporary-technology car, in order to address the difficulty of growing pollutants, worldwide warming, depleting herbal sources, and so on. Although the idea of electrical automobiles has been round for a long term, it has drawn a considerable amount of interest within the past decade amid a rising carbon footprint and other environmental effects of gas-based totally cars. In keeping with a forecast via global energy organization, the use of electric cars will develop from three million to a hundred twenty five million by using the year 2030. This is almost 41 times of what it is today, with the growing call for of fossil fuel and issues with pollution it seems possibly to happen. As a result of that, all primary ic engine car producers like ford and gm are slowly turning their attention in the direction of the electrical motors. The market and customers are in want for a inexpensive personal transportation and even on pinnacle of that, the government

has started out supporting electric vehicles through its policies. Thinking about most of these statistics it's miles pretty plenty glaring that very quickly we will find electric powered vehicles zooming all round our roads.

A. Need of Energy Monitoring System

The problems of worldwide warming and depletion of fossil fuels have paved opportunities to electric powered cars (evs). Currently, the interest in electric cars has notably improved. Electric motors (evs) were brought inside the mid-19th century, but forfeited industrial viability to inner combustion engine (ice) motors. This become due to the strength density gain of gas as compared to battery generation on the time. In the past decade, evs have skilled a resurgence, inspired via environmental issues and assisted by way of improvements in battery era. To tract the amount of energy fed on via ev, energy tracking device performs very essential role in tracking the energy utilization. Energy monitoring system provide users with facts approximately their this package will display the monitoring of energy this is given to the automobile. From this we are able to have a short idea approximately how a lot amount of energy has consumed by using electric car. This work supposed to growing of power measuring device that ensures the awareness and economy of electricity consumption through an accurate display of strength intake statistics for these devices used. Energy monitoring is very important to saving energy. As energy management is means to monitoring, controlling and minimizing the energy consumption. Controlling and minimizing energy consumption is important because it helps us to : 1. Minimize cost: As energy cost is rising, it is becoming very important. By monitoring energy, we get better insights into cost per energy unit. This can help us to minimize cost. 2. Accurate Measuring: The real-time monitoring of energy usage gives daily report of energy usage nad it makes it easier to check trends and spikes. By analyzing trends over daily report, we can determine solution to minimize consumption.

II. LITERATURE REVIEW

We have discussed few papers related to Energy Monitoring System. In the paper [1], development of a remote monitoring of EV charging stations for Smart Campus Parking is discussed. The aim of this paper is to control EV charging and to achieve this parking lot local controller needs transfer of data with stations through some sort of communication. This paper focuses on investigating the underlying networks for

remote monitoring of EV charging stations in campuses. The communication network consists of two sub networks which are Parking Area Network (PAN) and Campus Area Network (CAN). Range of PAN is among Charging stations, EVs and PLLC. CAN provides communication between PLLC and global controller of university. Lack of unified communication architecture to integrate EVCS in the power grid being one of the major problem in EV system, communication system for in-vehicle system is developed. EVCSs relies on logical node concept of IEC 61850 standard. Basically, for modeling, simulation and implementation, various communication concepts are taken into consideration and end-to-end delay is discussed and observed. In the paper [2], development and testing of components for electric vehicles is discussed. Since, electric vehicles can be controlled at various distance from operating position, it is very crucial to ensure transmission of data to remote supervision centre. This data can be useful for energy monitoring. This data can have information about each component that is installed in vehicle, parameters such as current position, time, energy consumption, etc. The paper deals with energy consumption monitoring and data transmission from an electric vehicle. The proposed system in this paper consists of a microcomputer control system, energy meter, device for tracking of mobile device position and data transmission using wireless technology. In the paper [3], design and implementation of an electric propulsion system, energy management system(EMS) and battery management system (BMS) is discussed. The given paper deals with conversion of conventional-internal-combustion engine vehicle to a full electric vehicle. With the aim of optimizing electric power consumption of achieved electric vehicle, an EMS is designed, implemented and tested. Its driving range also extended. To monitor performance of vehicle, the 'Driver-assist' system is used and monitoring is achieved via on-board data acquisition system. The main work of the system is to track vehicle speed, power consumption, battery, motor temperature and battery state of charge (SOC) and it gives feedbacks regarding suggested actions for the driver. The energy management system is developed on National Instruments' CompactRIO embedded controller and for programming purpose 'LabVIEW Real-Time software' is used. The paper also deals with development of graphical driver interface (GDI) using concept of web server function of the CompactRIO and it is implemented via TCP-IP connection with a tablet PC. The GDI provides the driver control of the EMS and in-vehicle data logging. It also provides remote monitoring and control of the EMS via wireless 3G internet connection.

III. OVERVIEW OF BLOCK DIAGRAM

The complete block diagram of Energy monitoring system for electric vehicle supply equipment (EVSE) is as shown in figure 1. The unit includes hardware that consists of Arduino Uno (ATmega328P), PZEM module, 2-channel 5V relay with optocoupler, Arduino Mega (Atmega2560), RC522 RFID module, 4x4 Membrane keypad, OLED display, electric junction box and power supply. Power supply is connected to PZEM module. It is also connected to main unit (consist

of Arduino Mega, RFID, keypad) via relay. Relay acts as a switch between main unit and power supply. PZEM module is used to monitor the energy consumption. It is interfaced with Arduino Uno. PZEM module sends information about monitoring of energy consumption to arduino uno. Arduino Uno communicates with Arduino Mega via SPI communication. Arduino Mega is interfaced with relay, RFID module, keypad and OLED display. RFID module is used to scan the card. It is used to check the authorization of the card and giving access to the system. Keypad is used to take users input in the form of numbers and certain symbols and to feed the inputs into the system for further operations. OLED display shows the required output to inform users. Electric junction box is connected to the relay of main unit. Relay is controlled by Arduino mega. When power supply is given to the system, current will pass through PZEM where monitoring process will happen and it will also passed through relay. If relay is on i.e circuit is closed, then current will pass further through junction box and charging process will take place. If relay is off, then electrical junction box will not get any current.

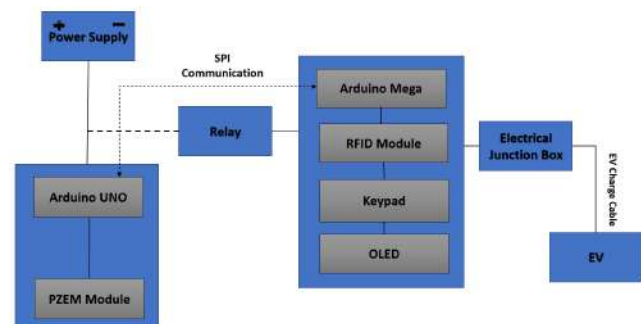


Fig. 1. Overview of Block Diagram

IV. METHODOLOGY

The operational flow of our Energy monitoring system is as shown in figure 2. User will scan the card. If card is authorized, then user can access the system. If card is unauthorized, then access will be denied and flow will go back to the scan card option. For authorized card, menu will be displayed on OLED display and user can see options such as charge EV, check balance and add balance. If user choose charge EV option, then the system will enter charge EV operation and it will ask user to enter max capacity of battery and current battery percentage. From this information, system will analyze and inform user about max. capacity to charge and equivalent cost. Now, system will ask user to enter charge units (i.e. how much units user wants to charge). Now: Case 1: If user gives input greater than max. limit, then user will be informed to enter units within limit. Case 2 : If user enters limit within max. limit, system will calculate the cost equivalent to entered limit and system will compare it with balance. If it is less than balance, then relay will be switched on and charging process will be done and once done, flow will break the operation and will go back to the scan card option. If cost is less than balance, then insufficient balance will be displayed and user

will be asked to recharge the card. So this is the flow of charge EV operation. If user chooses check balance option, available balance in the card will be displayed. If user chooses add balance operation, it will show enter amount and that amount will be added to existing card.

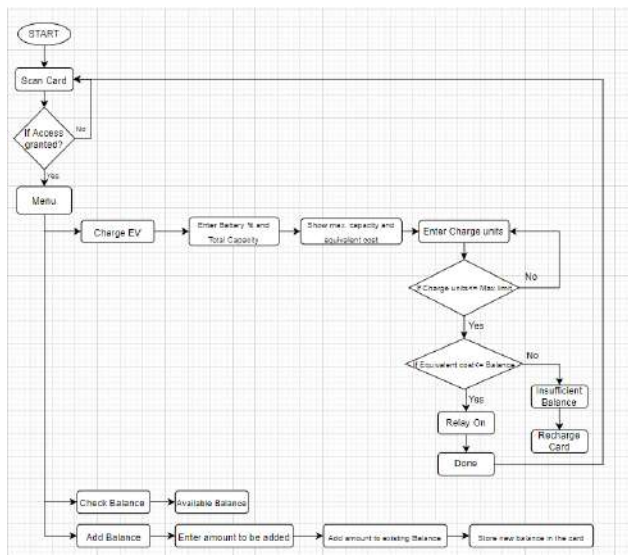


Fig. 2. Operational Flow Of System

V. RESULTS AND DISCUSSION

During this semester, we extensively discussed the implementation of the project with each other as well as with our Guide. We had regular meetings with our Guide in order to keep a track and maintain the flow of the Project. We discussed about various topics which included Microcontrollers, Energy monitoring system, RFID modules and platforms to be used. During each of these meeting, tasks were assigned to us and status of the project was regularly kept in check. Once we were done with software part, we worked on hardware and implementation with the help of our guide and lab assistant.

```

COMB
FF FF FF FF FF FF
SERIAL: Data will be written to the EEPROM in module A1
Some other device
0000 0000
00 00 00 00
0000 0000
Authentication success
Block was read successfully
Authentication success
Block was read successfully
Authentication success
Block was read successfully
0000 0000
MAX CARD IN USE
0
0
0000 0000 0000 0000
BATTERY ON 0
0
0
CURRENT BATTERY PERCENT = 100
AVAILABLE CREDIT = 1000000 DE CARD
YOUR CHARGE MAX LIMIT=10000 MAX PRICE = 0.00
  
```

Fig. 3. Software outputs of Authentication details and details regarding charge EV

```

COMB
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging In Progress!
RELAY IS ON
Charging Done!
1
1
Voltage:246.60V
Current: 0.03A
Power: 4.80W
Energy: 0.030kWh
Frequency: 49.8Hz
PF: 0.56
Sum: 1.02
Done
  
```

Fig. 4. Output of Charging Process and Energy Monitoring



Fig. 5. Energy Monitoring System Prototype



Fig. 6. Internal Connections of Energy Monitoring System Prototype



Fig. 7. Working prototype of Energy Monitoring System

VI. CONCLUSION

Our project is a complete package which offers security, Monitoring and billing system. Security is provided by means of an RFID card. User can access the system only if user have an authorized card. Monitoring is done by means of PZEM-004T module. It can monitor energy parameters such as voltage ,current, energy, power, etc. Transaction is done by auto debit of card equivalent to energy usage. To have this feature, we have provided “add balance” and “check balance” operation in the card. So, this is how our energy monitoring system fulfills all the requirements i.e. security, monitoring and billing.

The references for this paper are [1], [2], [3], [4] and [5].

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LOW POWER CMOS VLSI DESIGN MAC UNIT

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Abstract—Low power is a vitally important requirement for multimedia devices which are portable, employing various signal processing methods and architecture. During the recent years the rapid increase in the number of portable systems and the requirement to limit the static power usage in extremely dense VLSI chips have led to immediate developments in low power design which are innovative. The requirement of low power design in high performance digital devices, such as digital signal processors, microprocessors, and other applications has become a crucial issue. Design at the circuit level such as the correct choice of the style in circuit design, limiting of the swing in voltage and clocking methods must be used for reduction of power dissipation at the level of transistor. At last, the power consumption of the device can be minimized by properly picking the methods of data processing, specifically to reduce the number of event switching for a given job. We focus on to providing lower complexity in logic at the level of transistors as an different strategy to get the upper hand of the relaxation in numerical precision. We illustrate this idea by utilising different types of imprecise or approximate full adder circuits with complexity reduction and manage them to build overall architecture. Furthermore, we demonstrate the utility of these approximate adders in architecture like the Multiply and Accumulate Unit (MAC). The results will give us the power reduction of various approximate adders as compared to the conventional adder. The results will also help to understand the behaviour of power reduction at nanometer technology.

Index Terms—MAC unit, Low Power CMOS, Approximate Adders, VLSI Design.

I. INTRODUCTION

The reach of digital audio processing in today's tech savvy world is humongous. It offers a huge amount of flexibility and an almost infinite amount of possibility to manipulate and process audio in a way that would not be possible using analogue techniques.

The process of developing an integrated circuit on a large scale by merging several millions of MOS transistors onto a single silicon area called silicon chip is known as Very large-scale integration (VLSI). It all started in the early 1970s, when the VLSI Metal Oxide Semiconductor integrated circuit chips were widely developed which as a result aided the complex semi-conductor and telecommunication technologies to emerge. Earlier that is before the existence of the VLSI technology, almost all ICs had a small number of functions which they could perform. Any electronic circuit generally

consists of a ROM, RAM, ALU and other glue logic. VLSI allows the designers of ICs to attach all these modules into a small area in one chip.[1][2]

Designing of Low-power VLSI circuit is a fundamental area of research driven by the growing dependency and demand of portable computing and wireless communications devices which are powered by battery.[3] Furthermore, it has become crucial to the on going development of high-performance and robust microelectronic systems. The insufficiency of battery lifetime forces uncompromising constraints on the overall consumption of power corresponding to the systems which are portable. The currents namely subthreshold and reverse leakage corresponding to the CMOS logic circuits consisting of NMOS and PMOS are generally considered as non zero. Even when transistors not subject to any switching events, In CMOS VLSI an integrated circuit containing a number of NMOS and PMOS transistors, these currents makes a significant contribution to the overall energy use. Several techniques namely sleepy stack, dual sleep approach, forced stack, sleepy keeper, techniques like transistor sizing, dual-V_{th}, multi-V_{th}, stacking transistors etc had been introduced in the past, these focused on leakage power reduction. In this Technology, power dissipation, leakage, area, speed are the high-performance parameters and these play major role in the design of clock storage element, these elements are basic blocks in portable devices (for example batteries, microprocessors etc). Automatically bringing down power usage in these devices upgrade the life of battery. The size of chips is major problem in digital integrated circuit because millions of transistors consume more energy. For reducing the size of chips in integrated circuit, scale down the VLSI Technology (180nm, 90nm, 45nm, etc). A lot of problems are associated with the using of these transistors among which power dissipation is one of the vital design concern.[4][5]

In any calculation or processing of digital signal, multiply – accumulate (MAC) or Multiply-add performance is the most important module that combines dual product numbers and add that product to the accumulator. The hardware that performs this calculation is called the multiplier-accumulator unit (MAC); this operation is itself commonly referred to as MAC operation. Nowadays computers have a different part of the MAC unit, which includes repetition accomplished by a coherent concept followed by adder and accumulator that stores the effect. The output of the register is connected to one adder input, so now after every clock cycle, the output in the multiplier is added to register. The basic MAC unit

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is built using three components namely adder, multiplier and accumulator. and built-in add-ons are usually Carry-Select or Carry-Save add-ons, because speed is a key component in DSP. MAC unit input connected to two input probes, MAC unit multiplier block will perform multiplication function and send result on the adder and will save the result in memory location. The whole process should be accomplished in a single clock cycle.[6]

During the study for our project, we acknowledged that there are many methods in which software level low power techniques are employed to reduce power consumption of digital signal processors, however it is only possible to some extent and the power consumption cannot be reduced without increasing the complexity of logic in software level, to encounter this problem we propose some hardware changes that is at transistor level, these techniques decrease the power consumption and also reduce the logical complexity.

During recent years, power dissipation is being given more importance in comparison to area and speed design metrics which we have seen that in the past the majority of concerns in the VLSI circuit design were speed, area and cost.[7] Now around the world, declining energy requirement has become a major task for researchers in this field. Leakage power is usually the result of an unwanted current that is the subthreshold current in the transistor station where the transistor is switched off.[8]. In our project we proposed to reduce the difficulty at the level of the transistor as another way to take advantage of the freedom of numerical accuracy. A digital signal processing algorithm usually requires a large amount of mathematical work to be done quickly and repeatedly in a data set. Therefore high speed, high output and a multiplication unit and low-power accumulator (MAC) are required for DSPs.[9][10]

II. METHODOLOGY

As an important arithmetic function, the adder plays a very important role determine the speed and power of digital signal processing system. Speed requirements and environment for error tolerance some applications have encouraged the development of limited add-ons. In the project we proposed to reduce the difficulty at the level of the transistor as another way to take advantage of the freedom of numerical accuracy. We demonstrate this concept by proposing various imprecise or approximate full adder cells. In the project we have selected four different approximate adder designs with different transistor counts and less than the conventional adder. Since there are less transistors in approximate adder as compared to conventional adder the leakage current reduces in the circuit which leads to less static power consumption. In this Project we are directly replacing the conventional full adder with approximate adder and calculating the reduction in static power. We design the circuit in Ngspice Circuit Simulator which is an open source software, after designing of circuit we can get the static power values in simulation as a result of static current being multiplied by supply voltage that is 1.2v for 45nm technology. For the implementation of this project, we had designed and simulated various components using ngspice and Itspice that would be required for low power mac unit.

Then we proceed with development of mac unit block by block.

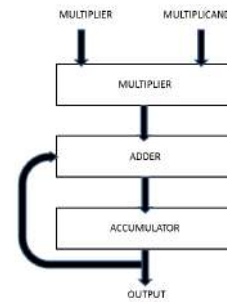


Figure 1. This is the block diagram of MAC unit.

A. BLOCK 1: MULTIPLIER SECTION

In the multiplier section we have used 8x8 array multiplier which we have performed on NGspice simulation software. Conventional 8x8 Array Multiplier:

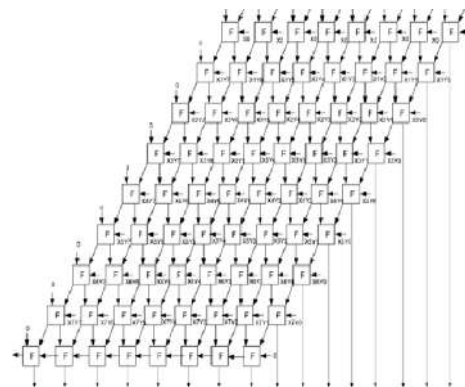


Figure 2. Block Diagram of Array Multiplier

B. BLOCK 2: ADDER SECTION

In a Conventional Adder the number of transistors are 28 however in Approximate Adder 1,2,3 and 4 there are 20,16,13,15 transistors respectively.

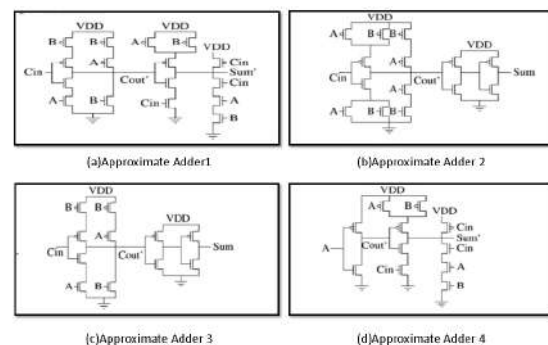


Figure 3. Block Diagram of Approximate Adders[11]

C. BLOCK 3: ACCUMULATOR [D FLIP FLOP]

For the accumulator section we have used d flip flop to store the bits Here in this diagram we see the use of logic of the

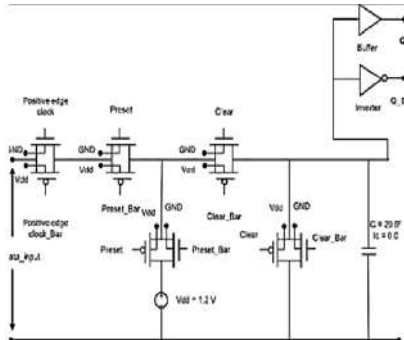


Figure 4. Block Diagram of D Flip Flop

transmission gate in the construction of the D flip flop. CMOS-based switch, where PMOS accepts strong 1 but rejects poor 0, and NMOS accepts strong 0 but rejects 1. Both PMOS and NMOS operate simultaneously.

Table I
TRUTH TABLE OF APPROXIMATE ADDER1

Inputs			Accurate Outputs		Approximate Outputs	
A	B	Cin	Sum	Cout	Sum1	Cout1
0	0	0	0	0	0	0
0	0	1	1	0	1	0
0	1	0	1	0	0(X)	1(X)
0	1	1	0	1	0	1
1	0	0	1	0	0(X)	0
1	0	1	0	1	0	1
1	1	0	0	1	0	1
1	1	1	1	1	1	1
Number Of Errors					2	1

Table II
TRUTH TABLE OF APPROXIMATE ADDER 2,3,4

Inputs		Approximate Outputs					
A,B,Cin		Sum2	Cout2	Sum3	Cout3	Sum4	Cout4
0,0,0		1(X)	0	1(X)	0	0	0
0,0,1		1	0	1	0	1	0
0,1,0		1	0	0(X)	1(X)	0(X)	0
0,1,1		0	1	0	1	1(X)	0(X)
1,0,0		1	0	1	0	0(X)	1(X)
1,0,1		0	1	0	1	0	1
1,1,0		0	1	0	1	0	1
1,1,1		0(X)	1	0(X)	1	1	1
Errors		2	0	3	1	3	2

From the truth table we acknowledge that maximum number of bits in error is three, minimum is as low as zero, of all these carry bit of approximate adder 2 is having no error i.e it is error free despite having approximate setup.

III. RESULTS AND DISCUSSION

In this project we have proposed various imprecise and approximate adders with different transistor counts as compared to conventional adder. The main objective of the experiment was to achieve static power consumption in MAC unit. The power dissipation occurs in the form of leakage current when the system is in standby mode. Firstly, we have obtained power consumption in full adders and then as compared to the conventional adder, approximate 2 adder consumes the lowest power. In the multiplier section, approximate 4 adder has the lowest power consumption. In the MAC unit architecture, approximate 4 adder consumes the lowest power.

MAC UNIT	STATIC POWER OF MAC UNIT (In W)
CONVENTIONAL	1.05E-05
APPROXIMATE 1	9.87E-06
APPROXIMATE 2	1.01E-05
APPROXIMATE 3	1.02E-05
APPROXIMATE 4	9.76E-06

Reduction of power consumption is very important as it makes a device more reliable. The need for devices that consumes a minimum amount of power was a major driving force behind the development of this project. The graph shows the percentage power reduction of various blocks of mac unit. In the full adder section approximate 2 adder has the best percentage reduction and in the multiplier section, approximate adder 4 has the best percentage power reduction. In the MAC unit approximate 4 adder has the best percentage power consumption.

IV. CONCLUSION

MAC operation is the basis of DSP operation and is mainly used in digital filter design. A 8x8 multiplier accumulator design is presented in this work. For the multiplier section a 8x8 array multiplier is used and for the adder section conventional as well as approximate adders are used. For the accumulator section D Flip flop is used as a storage element. We have implemented the Multiply and Accumulate Unit(MAC) in a pipelined architecture in NGspice software. In this work, we have used various ambiguities or limited appendages that can be used effectively for power trading as well quality of DSP systems that can withstand errors. Our approach was intended to simplify conceptual complexity at the transistor level by reducing the power usage of transistors. We have used four designs of approximate adders to reduce the static power consumption as compared to a conventional adder. The static power dissipation of various blocks are calculated. The full custom design is carried out for the proposed work and verified using NGspice tool.

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Design & Development of Wireless Charger for EV

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Abstract—The main functions of wireless charging is to transmit power by an electromagnetic field across a given space. Since electric vehicles are a better option for reducing pollution, changes to the battery charging procedure must be made to provide improved dependability. The design of the project was based on the Inductive Power Transfer method, which uses electromagnetic induction to wirelessly transmit power from a transmitting coil called the ground assembly, which is placed on the floor, to a receiving coil called the vehicle assembly, which is placed below the vehicle. A Class II type Wireless Power Transfer system at 85 KHz which is capable of giving an output of 7.7 KW is designed with a highest efficiency of 80% in accordance with the SAE J2954 International Standard.

It may be charged in a variety of ways because it is cordless, including static, quasi-dynamic, and dynamic charging. As name suggests, static charging occurs when the vehicle is at rest. It might be used in situations where automobiles are motionless or at rest, such as personal garages or parking lot. The Quasi-dynamic wireless charging technique allows charging while electric cars are stopped for short periods of time, such as at bus depots or traffic lights. This extends the range of vehicle on the road also reducing the battery size in vehicle. The dynamic wireless charging method charges the EV as it passes through electrified road, increasing its range and reducing its dependence on power storage. [4]

I. INTRODUCTION

To minimise air pollution, the upcoming vision of on road transporting is based on zero emissions. Over the last decade, persistent environmental circumstances have prompted research and development of electric automobiles. As global warming rises, people have become more aware of the need to switch to electric vehicles. As a result, only renewable fuels are used, or technologies such as electric vehicles are used (EVs). These cars have batteries that can be recharge quickly and effectively.

II. MOTIVATION

Electric vehicles are a feasible option, but their charging systems need to improve before they can become the preferred means of transportation. This necessitates the development of charging mechanisms. Charging may be classified into two types: Wired charging or conductive and inductive charging, commonly known as wireless charging. Wired charging is less expensive than other types, it has limitations in terms of charging time, electric vehicle mileage, potential traffic jams, and charging station waiting line. It has the ability to solve disadvantages of wired charging. The electromagnetic induction concept is employed in wireless charging and power transfer. Wireless charging provides a number of benefits, including comfort and security of use, and it is always convenient. [1].

III. WPT(WIRELESS POWER TRANSFER)

Wireless charging systems are usually suggested for high-power applications such as EVs. When compared to wired charging systems, wireless charging systems can provide extra benefits in terms of dependability, convenience, and user acceptance. The main drawback of WCS is that it can only be used when the vehicle is stopped or in a motionless state, such as in garages, parking lots or when signals turn red. Additionally, motionless WCS have a number of difficulties, including electromagnetic compatibility (EMC), restricted power transmission, heavy constructions, reduced range, and higher efficiency. The dynamic method of the WCS for EVs has been examined to expand the two areas that are reach and satisfactory volume of battery storage. This innovation grants battery capacity gadgets to be charged while the vehicle is moving. The vehicle requires more affordable battery storage and has a more noteworthy scope of transportation. In any case, before a powerful WCS can be broadly embraced, it should beat two significant snags: gigantic air gaps and coil misalignment. The viable power transfer is determined by the alignment of coil and the distance between the primary and secondary coils. The typical air gap distance for little traveler vehicles is from 150 to 300 mm, and it might develop for bigger vehicles. Since the car is continuously moving in dynamic mode, it is easy to adjust the best driving situation on the transmitter coil. Besides, different remuneration strategies, like series and parallel mixes, are utilized on both the ground assembly and vehicle assembly to diminish parasitic losses and increment framework effectiveness. To upgrade power

transmission proficiency, various wireless transformer plans are utilized. [6]

IV. INDUCTIVE POWER TRANSFER

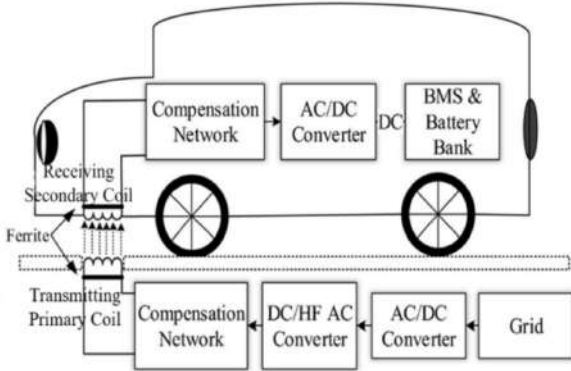


Fig. 1. Block Diagram [8].

Nikola Tesla created conventional IPT in 1914 to move power wirelessly. It is planned on an assortment of EV charging structures. IPT has been tried and used to send contactless power from the source to the recipient in an assortment of utilizations going from milliwatts to kilowatts. The magnetic charge's primary coil, known as a charging paddle (inductive coupler), was placed into the vehicle charging port, where the secondary coil got power and had the option to charge the EV. Primary and secondary coils are organized in a common attractive field with very small distance between the inductors in this strategy. The specialists proposed the IPT strategy of power transmission on the grounds that the productivity of power transfer decreases as the air gap between the inductors increments. IPT turned into the essential WPT technique because of the legitimate distance between the primary and secondary coils. Among the numerous static inductive WPT frameworks, IPT has drawn in the consideration of most of analysts on the grounds that to its inborn attributes like misalignment resistance, high proficiency, and activity in any weather patterns. [5]

V. COMPENSATION TOPOLOGIES

These networks are commonly utilised in networks to generate resonant cases. Compensating capacitors are used to generate a resonant case and maximise output, leading in higher efficiency. Power factor correction capacitors or compensation capacitors are used to minimise reactive power. Capacitors are connected in series or parallel with the transmitting and receiving coils to lower power loss caused by the large air gap between the coupled inductor coils. The compensating circuit is classified into four variants based on the series or parallel

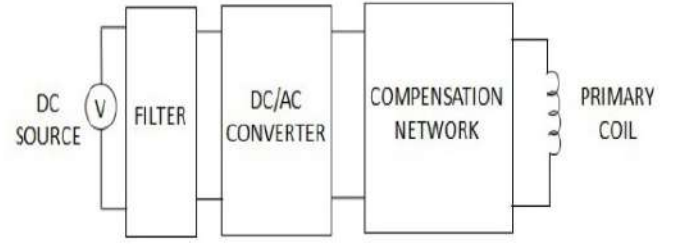


Fig. 2. Transmitter Side

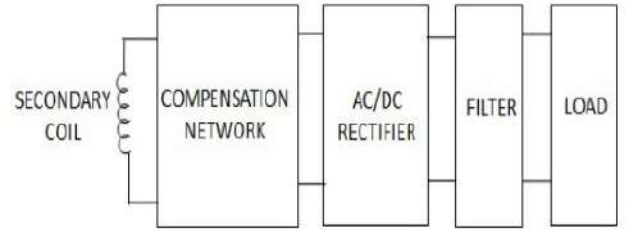


Fig. 3. Receiver Side

connection of capacitors known as series-series (SS), series-parallel (SP), parallel-parallel (PP), and parallel-series (PS) combinations. New compensation topology, known as LCC compensation topology, is also introduced. [3]

A. SS COMPENSATION TOPOLOGY

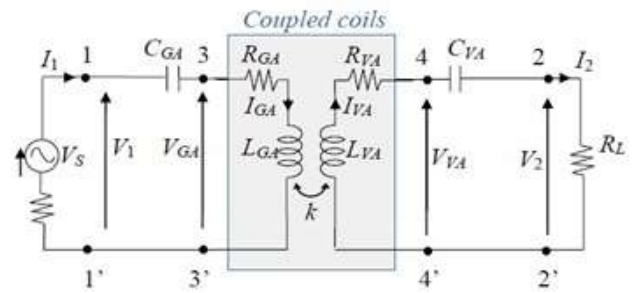


Fig 4: SS Compensation Topology

Frequency at resonance is given by:

$$\omega_o = \frac{1}{\sqrt{LC}}$$

$$\omega_o^2 = \frac{1}{LC}$$

Hence the compensation capacitors C_{GA} and C_{VA} are

given by:

$$C_{GA} = \frac{1}{\omega_o^2 L_{GA}}$$

$$C_{VA} = \frac{1}{\omega_o^2 L_{VA}}$$

Where $\omega_o = 2\pi f_o$ is angular frequency & f_o is resonant frequency.

Applying KCL to loop 2,

$$-I_{VA} = \frac{j\omega_o M I_{GA}}{R_{VA} + R_L}$$

Where M is mutual between the primary & secondary coil.

$$I_{VA} = -\frac{j\omega_o M I_{GA}}{R_{VA} + R_L}$$

The input impedance at port 11' at resonance is given by:

$$Z_{11'} = [R_{GA}] + \frac{\omega_o^2 M^2}{R_{VA} + R_L}$$

$$Z_{11'} = \frac{[R_{GA} [R_{VA} + R_L] + \omega_o^2 M^2]}{R_{VA} + R_L}$$

Efficiency (η) is the ratio of output power to input power :

$$\eta = \frac{P_B}{P_A} = \frac{Z_{22'} |I_{VA}|^2}{Z_{11'} |I_{GA}|^2}$$

$$\eta = \frac{R_L}{Z_{11'}} \frac{|I_{VA}|^2}{|I_{GA}|^2}$$

Therefore, Efficiency of SS network is:

$$\eta_{ss} = \frac{R_L}{[R_{GA} [R_{VA} + R_L] + \omega_o^2 M^2]} * \frac{\left| -\frac{j\omega_o M I_{GA}}{R_{VA} + R_L} \right|^2}{|I_{GA}|^2}$$

$$\eta_{ss} = \frac{R_L \omega_o^2 M^2 |I_{GA}|^2 / (R_{VA} + R_L)^2}{[R_{GA} [R_{VA} + R_L] + \omega_o^2 M^2] \cdot |I_{GA}|^2 / (R_{VA} + R_L)}$$

$$\eta_{ss} = \frac{R_L \omega_o^2 M^2}{(R_{VA} + R_L) \cdot [R_{GA} [R_{VA} + R_L] + \omega_o^2 M^2]}$$

$$\eta_{ss} = \frac{R_L \omega_o^2 M^2}{R_L \left(\frac{R_{VA}}{R_L} + 1 \right) \cdot [R_{GA} [R_{VA} + R_L] + \omega_o^2 M^2]}$$

$$\eta_{ss} = \frac{\omega_o^2 M^2}{\left(1 + \frac{R_{VA}}{R_L} \right) \cdot [R_{GA} [R_{VA} + R_L] + \omega_o^2 M^2]}$$

B. LCC COMPENSATION TOPOLOGY

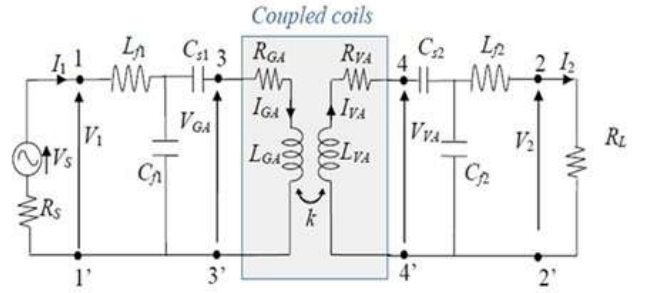


Fig 5: LCC Compensation Topology

V_s = source voltage, R_s = source resistance

L_{GA} = self-inductance of transmitting coil

R_{GA} = transmitting coil resistance

L_{VA} = self-inductance of transmitting coil

R_{VA} = transmitting coil resistance

R_L = equivalent load resistance

$$L_{f1} C_{f1} = \frac{1}{\omega_o^2}$$

$$L_{f2} C_{f2} = \frac{1}{\omega_o^2}$$

$$L_{GA} - L_{f1} = \frac{1}{\omega_o^2 C_{s1}}$$

$$L_{VA} - L_{f1} = \frac{1}{\omega_o^2 C_{s1}}$$

For Resonant Condition,

$$C_{VA} = C_{s2} + C_{f2}$$

The Load resistance will be

$$R'_L = \frac{(\omega_0 L_{f2})^2}{R_L}$$

$$z'_{11LCC} = \frac{(\omega_0 L_{f1})^2}{R_{GA} + \frac{\omega_0^2 M^2 R_L}{(R_{VA} R_L) + (\omega_0 L_{f2})^2}}$$

Compensation Capacitors C_{GA} and C_{VA} are given by:

$$C_{GA} = \frac{1}{\omega_0^2 L_{GA}} \quad C_{VA} = \frac{1}{\omega_0^2 L_{VA}}$$

[Where $\omega_0 = 2\pi f_0$ is the angular frequency and f_0 is the resonant frequency]

Efficiency is the ratio of output power to the input power

$$\eta = \frac{P_2}{P_1} = \frac{z'_{22} |I_2|^2}{z'_{11} |I_1|^2} = \frac{R_L |I_2|^2}{z'_{11} |I_1|^2}$$

Efficiency of LCC network is:

$$\eta_{LCC} = \frac{\omega_0^2 M^2}{[1 + \frac{R_L R_{VA}}{(\omega_0 L_{f2})^2}] [R_{GA} [R_{VA} + \frac{\omega_0 L_{f2}}{R_L}] + \omega_0^2 M^2]}$$

VI. MATERIAL AND METHODOLOGY

Static Wireless Charging As outlined in Fig.1, a DC voltage source furnishes the circuit with the required voltage. A signal is filtered to eliminate any undesirable noise. It's followed by a DC to AC converter, which creates the AC signal required for the primary coil to convey power wirelessly. The AC signal creates an magnetic field around the primary coil when it arrives at it. As shown , the entire coil assembly comprises of an transmitting or primary coil(ground assembly) situated on the floor and receiving coil(vehicle assembly) situated underneath the vehicle.Between the two coil assemblies, a proper air gap is considered.The receiving coil, which is situated underneath the vehicle, is in nearness to the primary coil, causing an AC signal to be enlisted on the receiving side, bringing about electromagnetic induction. As seen LCC simulation, the AC signal is changed over completely to DC signal using a full bridge diode rectifier. Finally,the last DC signal is smoothed utilizing another filter, and the subsequent power is applied to the load. To increase the coil's power transmission efficiency,several compensation networks are used.

AC mains from the grid are changed into high frequency (HF) AC by utilizing AC/DC and DC/AC converters to allow power move from the transmission coil to the receiving coil. On both the primary and secondary sides, compensation

topologies in view of series and parallel combinations are utilized to increment overall system productivity. The oscillating magnetic flux fields are changed over completely to HF AC by the receiving coil, which is typically situated underneath the vehicle. The HF AC is then changed over completely to a steady DC supply, which the on-board batteries might use. The power control, interchanges, and battery management systems(BMS) are totally coordinated to keep away from any wellbeing and security worries that could influence the framework's capacity to consistently work. [1]

VII. PROTEUS SIMULATIONS

A. SS Proteus Simulation

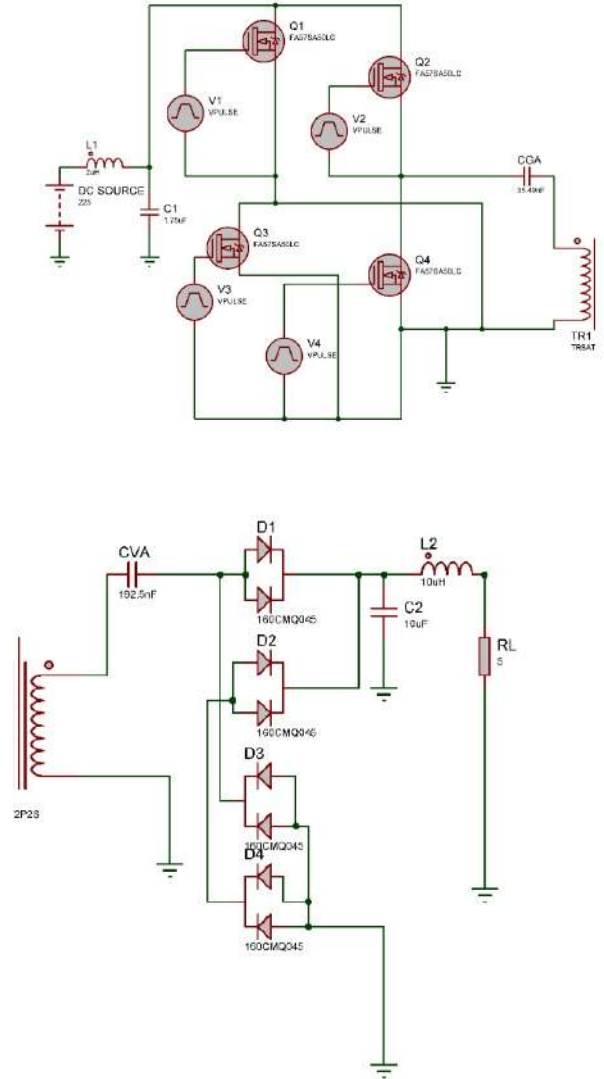


Fig 6: SS Proteus

B. LCC Proteus Simulation

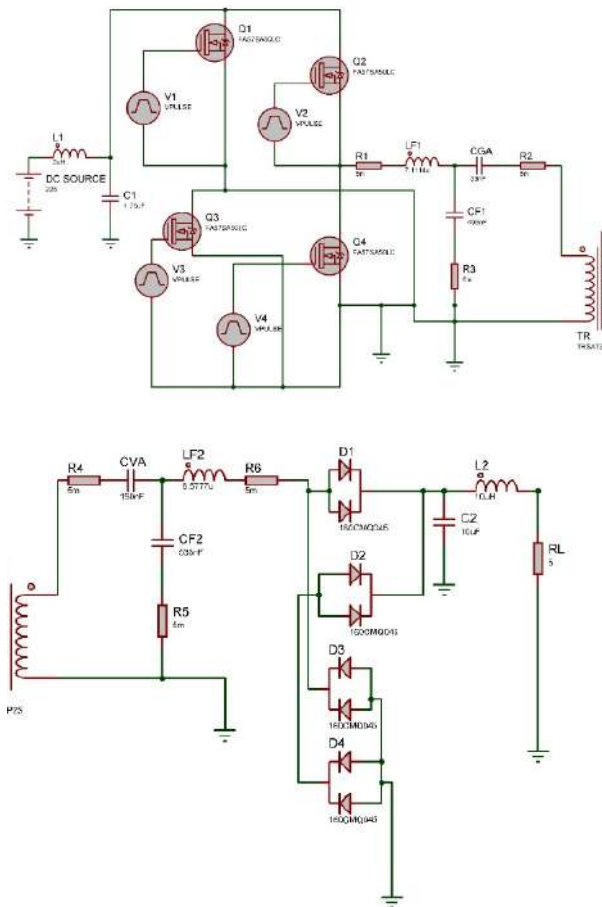


Fig 7: LCC Proteus

The Proteus show variant is utilized to create and test the charging systems operating efficiency in contrast with SS and LCC compensation networks. The circuit gets the required input voltage from the DC voltage source. Then, at that point, a LC low pass filter is utilized. With this filter, the signal is flattened and undesirable noise is removed. Following that is the full-bridge DC to AC converter, which is included of four n-channel power MOSFETs. To guarantee appropriate driving, MOSFETs Q1 and Q4 are in phase, while MOSFETs Q2 and Q3 have a 0.5 us delay, which is determined by provided MOSFET IR740 switching timer circuit and $\leq 1\%$ duty cycle. The created AC signal is then moved to compensation network of transmitting or primary coil. Electromagnetic induction eventually influences the primary coil. The alternating current going through the transmitting coil makes an magnetic field around it. Whenever the receiving or secondary coil is situated close and aligned up with the primary coil, the magnetic field causes a alternating current in the receiving coil. An AC to DC converter and a full bridge diode rectifier are likewise utilized. At the result end, a LC filter is used to smooth the resulting signal. The objective power of 7.7 KW is accomplished at the output load.

Parameters	LCC	SS
LGA	98.78 μH	98.78 μH
LVA	18.22 μH	18.22 μH
LF1	7.459 μH	-
LF2	5.1557 μH	-
CGA	33 nF	35.49 nF
CVA	150 nF	192.5 nF
CF1	470 nF	-
CF2	680 nF	-

Component Values

VIII. GATE DRIVING CIRCUIT

A. 555 timer pulse generator circuit

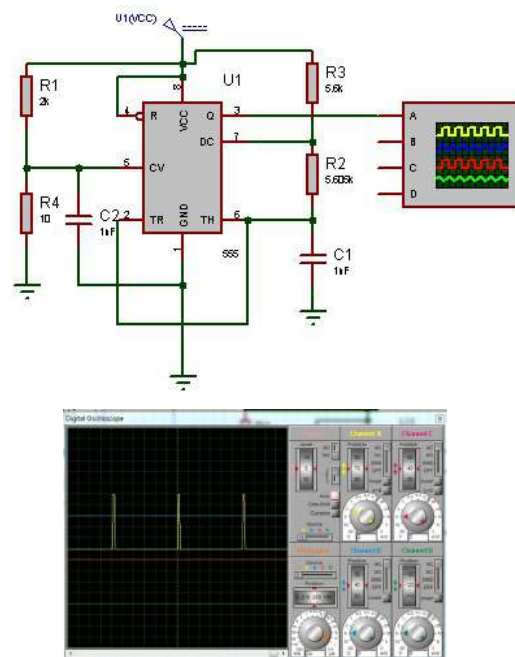


Fig 8: 555 timer pulse generator circuit

In LCC compensation topology in circuit for rectifier bridge, four MOSFETs are connected, to ensure proper driving of MOSFET we need to give pulse 85kHz frequency as it is required. 555 timer is used to generate the pulse which will drive the MOSFET at required frequency of wireless ev charging standard. An Output pulse of 85kHz frequency i.e. 11.76us time and pulse width of 0.5 us is generated.

B. IRF740 MOSFET Gate Switching Timer Circuit

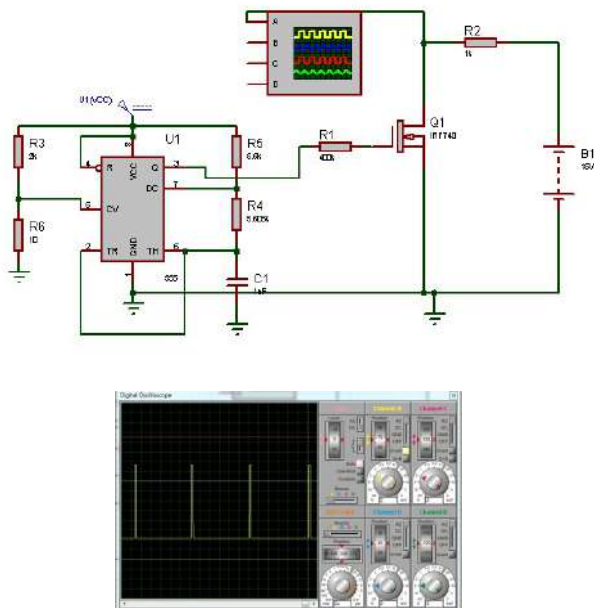
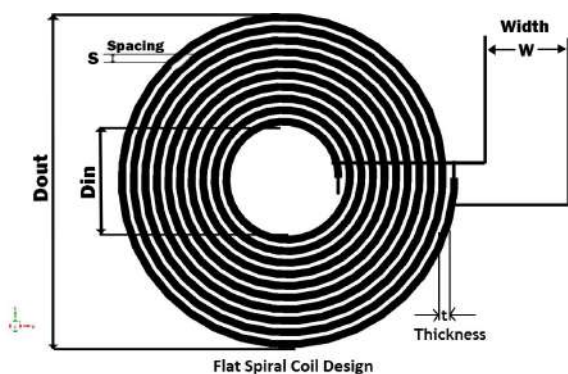


Fig 9: Gate switching timer circuit

The output of 555 timer is fed into the MOSFET as input. For driving gate of IRF 740 MOSFET we have referred to data sheet and chosen the switching timer circuit of pulse width 1us which is obtained from 555 timer circuit which can drive gate of MOSFET. This circuit ensures proper driving of the MOSFET IRF740 and provides us with a pulse width of 0.5us.

IX. COIL DESIGN



For Ground Assembly,

Let N = Number of turns = 20

Thickness $t = \frac{1}{4}$ inch = 6.35mm

Spacing $S = 5\text{mm} = 0.1968$ inch

Inner Diameter (D_{in}) = 78.46 mm

$$D_{out} = D_{in} + (2N(t+S))\text{mm}$$

$$D_{out} = 78.46 + 2(20)(6.35+5)$$

$$D_{out} = 532.46\text{mm}$$

$$\text{Length}(l) = \left[\frac{N(D_{out} + D_{in})}{2} \right] / 1000 \text{ meters}$$

$$\text{Length}(l) = \left[\frac{\pi(20)(532.46+78.46)}{2} \right] / 1000 \text{ meters}$$

$$L = 19.19 \text{ m}$$

$$\text{Width of coil } (W) = \left(\frac{t}{25.4} + \frac{s}{25.4} \right) (N) \text{ inches}$$

$$W = \left(\frac{6.35}{25.4} + \frac{5}{25.4} \right) (N) \text{ inches,}$$

$$W = 8.93 \text{ inches}$$

$$\text{Radius of coil } (r) = \left(\frac{D_{in}}{25} + W \right) / 2 \text{ inch} = \left(\frac{78.46}{25.4} + 8.936 \right) / 2$$

$$r = 6.013 \text{ inches}$$

By Wheelers Formula,

For Flat Spiral Coil,

$$L = \frac{r^2 N^2}{8r+11W} \mu\text{H}$$

$$L = \frac{(6.013)^2 (20)^2}{8(6.013)+11(8.936)} \mu\text{H}$$

$$L = 98.78 \mu\text{H}$$

For Vehicle Assembly,

$$N=10,$$

$$D_{in} = 79.9 \text{ mm}$$

Similarly we get,

$$D_{out} = 306.9 \text{ mm}$$

$$\text{Length}(l) = 6.08\text{m}$$

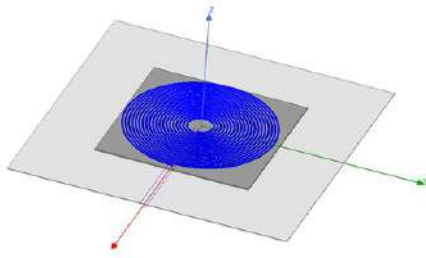
$$\text{Width}(W) = 4.4685 \text{ inches}$$

$$\text{Radius}(r) = 3.81 \text{ inches}$$

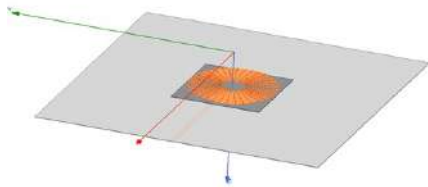
$$L = 18.21 \mu\text{H}$$

X. ANSYS MAXWELL COIL SIMULATION

The goal is to develop a Wireless Power Transfer system with a 7.7 KW output and an operating frequency of 85 KHz. Two connected coils are designed using the Ansys Maxwell Simulator. The WPT system is intended to transmit power at a nominal voltage of 40 volts. Two circular planar coils with the following geometrical features make up the coil configuration: 20 cm is the distance between the primary and secondary coils.

**Fig 10:** Ground Assembly

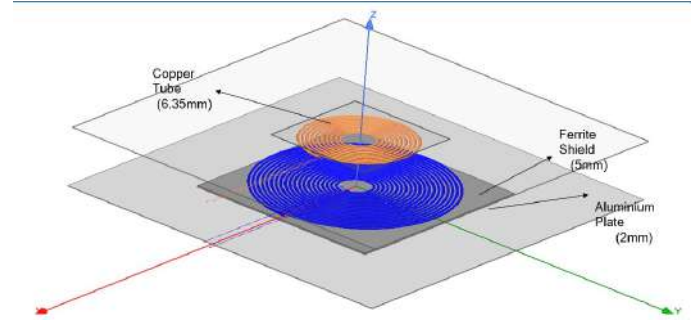
Where D_{in} is the coil's inner diameter and D_{out} is the coil's outer diameter. The coil for the Ground Assembly is an AC Copper Pipe with a wire diameter of 6.35 mm. To prevent power losses, AC Copper Pipe is used. A magnetic shield made of a ferrite plate is put under the winding to increase the coupling factor and prevent magnetic flux leakage. Eddy currents in external metallic objects are significantly reduced by ferrite. To further reduce magnetic field emissions, a conductive aluminium plate is placed both below and above the ferrite shield in respective Vehicle and Ground assemblies.

**Fig 11:** Vehicle Assembly

The Vehicle Assembly, which is the receiver portion, is built similarly to the Ground Assembly. Over the ferrite plate, another aluminium layer is used to screen the magnetic field and safeguard the passengers and on-board electronic systems. The coil's material needs are shown in the table above. The circuit parameters (LGA, LVA, M) are calculated using Ohm's Law as follows: $LGA = \text{Im}V1/(LVA)$; $IGA = 0$; $IVA = 0$ $LVA = \text{Im}V2/(LVA)$; $IGA = 0$; $IVA = 0$ $M = \text{Im}VGA/(ILGA)$; $IGA = 0$; $IVA = 0$ where LGA, LVA are the coils self inductances and M is the mutual inductance. Because there is an air gap between the primary and secondary coils of a WPT, they are linked. The two coils create a loosely coupled transformer with a coupling coefficient of k equal to [3]:

$$K = \frac{M}{\sqrt{L_{GA}L_{VA}}}$$

Therefore, the coupling factor k can be often small. For automotive applications in the range 0.072 – 0.148 depending on the size, distance, transmission efficiency and alignment of the coils. In order to achieve a transmission efficiency close to 84%, perfect alignment of the two coils is essential.

**Fig 12:** Coil Simulation

XI. RESULTS

TABLE I
COMPONENT VALUES

Parameters	LCC	SS
LGA	98.78uH	98.78uH
LVA	18.22uH	18.22uH
LF1	7.459uH	-
LF2	5.1557uH	-
CGA	33nF	35.49nF
CVA	150nF	192.5nF
CF1	470nF	-
CF2	680nF	-

For gap between ground assembly and vehicle assembly
GAP = 200mm (20cm)

Parameters	Ground Assembly	Vehicle Assembly
Simulated Self Inductance	99.1567 uH	18.4674 uH
Theoretical Self Inductance	99.93 uH	19.71 uH
Mutual Inductance	4.957 uH	
Coupling Coefficient	0.1117	

We used Wheeler's formula to calculate Inductance of both GA & VA coils without considering coupling. After simulating in ANSYS MAXWELL software both GA & VA inductor values, coupling coefficient & mutual inductance values were obtained as shown.

TABLE II
COIL DESIGN PARAMETERS WITHOUT FERRITE SHEET

PARAMETERS	GROUND ASSEMBLY	VEHICLE ASSEMBLY
Din	78.46mm	79.90mm
Dout	532.46mm	306.90mm
Length	19.19m	6.08m
N=Turns	20	10

TABLE III
COIL DESIGN PARAMETERS WITH FERRITE SHEET

PARAMETERS	GROUND ASSEMBLY	VEHICLE ASSEMBLY
Din	78.46mm	79.90mm
Dout	441.66mm	261.5mm
Length	13.07m	4.29m
N=Turns	16	8

TABLE IV
GAP VS MUTUAL INDUCTANCE

Gap [mm]	Mutual Inductance[uH]
150	8.1987
160	7.3595
170	6.5411
180	5.8828
190	5.3592
200	4.9578
210	4.3187
220	3.9174
230	3.5582
240	3.2081
250	2.9948

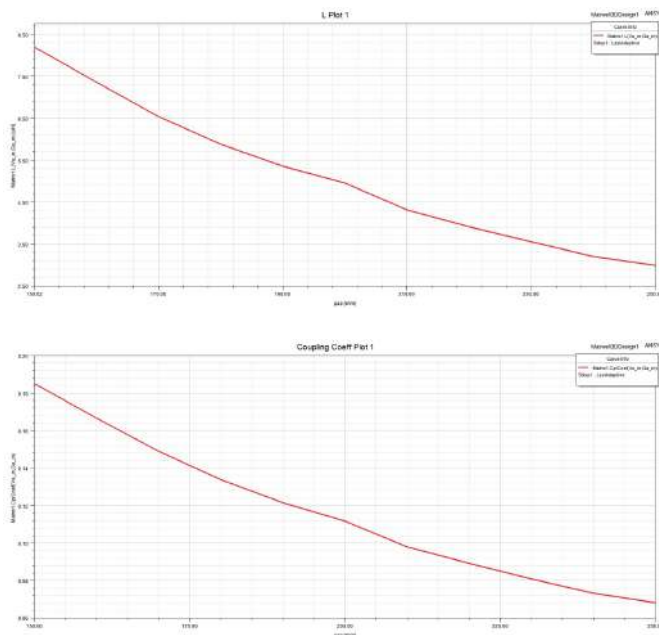


TABLE V
GAP VS COUPLING COEFFICIENT

gap [mm]	Coupling Coefficient
150	0.1850
160	0.1666
170	0.1490
180	0.1338
190	0.1215
200	0.1117
210	0.0980
220	0.0892
230	0.0808
240	0.0732
250	0.0681

XII. CONCLUSION

A thorough examination of existing EV charging technologies was conducted, including both conductive and wireless charging techniques. The literature re-view provided the necessary architecture for implementing wireless charging solutions. The static wireless charging technique was chosen because it has a greater power transfer efficiency than other methods. Five various types of compensation topology are investigated, and the LCC compensation topology is shown to be the most efficient after a thorough design and analysis method. The design of compensation circuit was done by implementing different stages of circuit including high frequency AC bridge which results in the required output. The coil parameters are determined by analysing and deriving the coil specifications, kinds, geometrical dimensions, and needs. After evaluating the results in simulation on ANSYS MAXWELL, the ideal Mutual inductance (M) was evaluated at 3.9585 uH and the coupling coefficient (K) at 0.0925 for a gap of 200mm/20cm. The coil values acquired assist in the estimation of circuit parameters. The output power is 7.7 kW, which meets the SAE J2954 WPT2 standard with an operating frequency of 85KHz.

XIII. ACKNOWLEDGMENT

We express our sincere gratitude towards our guide, **Dr. Ashwini Kotrashetti**, who has encouraged and provided invaluable guidance during this project work. It has been a great honour and privilege to work under her supervision and to be her student.

We take this opportunity to convey our sincere thanks to **Mr. Sandeep Gupte**, *Industry Supervisor Director Business Development, Customized Energy Solutions, Pune, India*, for his motivation and wholehearted support during the project work.

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MULTIPURPOSE STAIR CLIMBING ROBOT

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Abstract—Robots are currently used in various sectors such as defence, medical, security, transportation just to name a few. We aim at building a robot that will be capable of climbing stairs and move through rough terrain with ease. The robot will be radio-controlled by a transmitter and it can cross any obstacle with good flexibility. For disaster mitigation and certain rescue missions, it is of utmost importance to position the sensors or cameras in such a manner that we are better able to get a clearer picture of the situation for the safety of the rescue personnel. The design of such systems is extremely difficult because they must be quick and agile while also being able to deal with rough terrain and even climb stairs. The design and implementation of a feedback control system for a remote-controlled stair-climbing robot is presented in this paper.

I. INTRODUCTION

Robots are becoming an increasingly important part of our daily lives. The number of robots used in many everyday applications has grown dramatically in recent years, and the variety of tasks and designs of these robots is complex, making them suitable for a wide range of applications. There are a plenty of of stair-climbing robots available, each with a distinct design to accomplish a specific task. Electric stair climbing wheelchairs, for example, are used to assist disabled people in climbing the stairs, and many designs of stair climbing robots can be used for military and safety purposes. Furthermore, stair climbing robot designs can be used and executed within the platforms of several other robots to enable these robots to climb the stairs. Despite the large number of stair climbing robot designs available, sufficient designs are limited.[4] Engineers obtained a sufficient design for a stair-climbing robot after studying and learning from many other designs of stair climbing robots. Robots are increasingly being used to replace humans in the workplace. They are currently used in a variety of fields, including the headquarters, military tasks, hospital operations, industrial automation, security systems, hazardous environments, and agriculture. The robot was created to assist rescue workers. The robot is commonly used in urban disasters, hostage situations, and explosions.[5] The advantages of using Rescue robots for these operations include fewer personnel requirements, less fatigue, and access to previously inaccessible areas. This robot can navigate stairs, rough terrain, and move quickly on flat ground.

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 This paper is a research contribution of students of Batch (2021-2022)
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A RF remote control unit wirelessly connects the robot to a transmitter/receiver circuit, ensuring fast and reliable two-way communication. The robot's body was mechanically prepared, and electrical components were chosen to be appropriate for the robot's task. The Stair-climbing Robot will be operated in two ways: First, the robot can be controlled by a serial joystick, which includes pushbuttons and a potentiometer. Push buttons control motor movement (both DC and stepper motors), while potentiometers control PWM. Second, an RF module is used to wirelessly control the robot. 433MHz RF Transmitter and Receiver is a VHF/UHF super high frequency wireless data transmit and receive module.

II. HARDWARE ROBOT DESIGN

The hardware of the robot design is described in this paper, which is divided into two sections: electrical and mechanical design.

A. Mechanical Design

The chassis was 14cm tall at first, and the wheel was 14cm in diameter. As a result, there was a problem with ground clearance when mounting the stairwell. To avoid this, the robot's height was reduced from 14cm to 12cm. A 2cm gap was created between the chassis and the ground surface as a result of this. We used four Johnson motors in the prototype since they provide 9kg/cm torque at 9V DC. Individual motors were examined and found to be in good operating order. We shorted the negative and positive terminals of the front and rear wheels because we only had two power supply and four motors. The motor has been stationary whenever the power supply was turned on. The reason for this was because the engine produced reverse magnetic flux, which was unfavourable. L298N motor driver was employed specifically in the robot. Because we're employing a high-torque motor, a huge amount of electricity is needed.

Robot Movement Mechanism: The mechanism of the driver motor working with all six wheels powered and the direction of the drive motor driver, respectively. Six motors are used to control the robot's mobility. The case of climbing the stairs utilising the motor driver to regulate the location of the motor.



Fig. 1. Structure of Robot



Fig. 2. Stair Climbing Robot

Advantages of Wheels:

- 1) Placed in lengthy lines and on highways.
- 2) It's more powerful and less wreaking havoc.
- 3) More stable and comfortable.
- 4) Front wheels have no pressure build-up.
- 5) The rear wheel's job is to spin while absorbing torque and acceleration, resulting in greater robot control.
- 6) The front wheel is in charge of steering, while the back wheel is in charge of pushing.[1]

B. Block Diagram

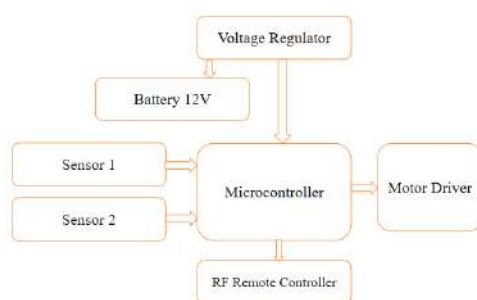


Fig. 3. Block Diagram

C. Flow Chart

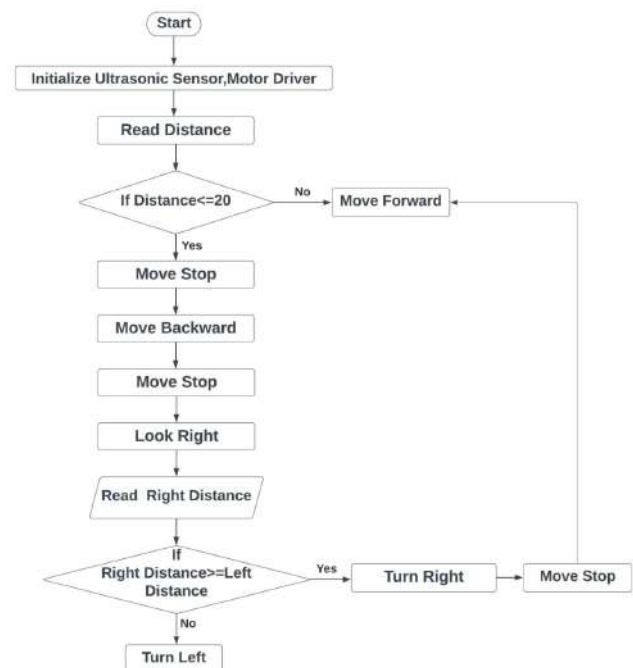


Fig. 4. Flow Chart

D. Power Source

The main source of power is provided by the lithium battery and uses a BF922 9v battery for the small circuitry, respectively. The main source battery can be recharged by a charging circuit.

RF MODULE

An RF module (radio frequency module) is a (typically) small electronic device that allows two devices to broadcast and/or receive radio signals. It's common in embedded systems to want to interact with another device wirelessly. Radio Frequency (RF) communication can be used for wireless communication. Because it does not require line of sight, RF is the preferred medium for many applications. A transmitter and/or a receiver are used in RF communications. [3]

Features of RF Transmitter and Receiver:

- 1) Receiver frequency: 433MHz
- 2) Receiver typical sensitivity: 105Dbm
- 3) Receiver current supply: 3.5mA
- 4) Receiver operating voltage: 5V
- 5) Low power consumption
- 6) Transmitter frequency range: 433.92MHz
- 7) Transmitter supply voltage: 3V 6V
- 8) Transmitter output power: 4 12Dbm

It has a wide range of uses, including remote lighting controls, long-range RFID, wireless alarm and security systems.

RF Transmitter Circuit:

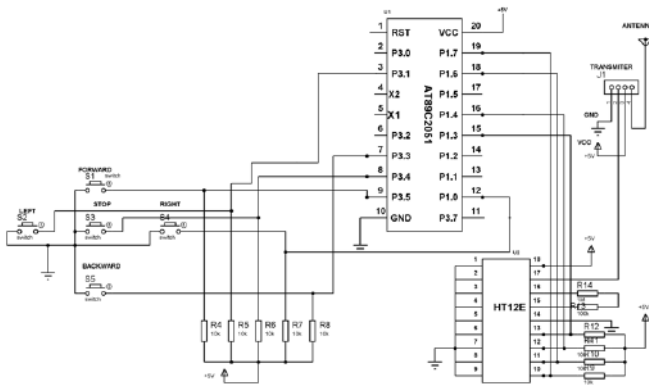


Fig. 5. RF Transmitter Circuit

Working of RF Transmitter Module:

The power supply +5V is connected to the microcontroller's 40 pins, and the ground is attached to the 20th pin, according to the schematic. We have two switches that are properly attached to the microcontroller and are brought up to 5V, and these two switches comprise the microcontroller's input command. We also purchased an LCD monitor to show the data that was going to be transmitted. We also have a setup for a computer keyboard to be attached for positive and negative portions from the clock, as well as a data pin that is connected as an input to the microcontroller from the keyboard's output, with the data being shown on the LCD. We have one RF transmitter as well. It has a VCC and GND supply. The microcontroller is connected to the data pin. The application is constructed in such a way that we first activate the keyboard by properly operating it. After pushing the buttons to activate the keyboard, you can enter data on the keyboard, which is displayed on the LCD. It will be displayed on LCD if it has to be submitted against codes ranging from 0 to 9. Every press advances the code from 0 to 9, and when we press one of the pushbuttons to send, it goes to a microcontroller and then to the RF transmitter module through a 433 MHz frequency sent by the antenna.[3]

RF Receiver

Working of RF Receiver Module:

We have comparable power supply connections at the receiver end because the microcontroller requires +5V. For the RF Module, we're utilising two pushbuttons with 10k pull up resistors and a 5V supply, same as the transmitter. The data pin of the RF module is connected to pin 3.0, while GND and VCC are connected to pins 1 and 2 of the RF module. There are also two buttons for selecting a code and receiving data. When the data is received by the receiver module, it is demodulated and sent to the microcontroller's receiver pin 10 according to the program.[3]

RF Receiver Circuit:

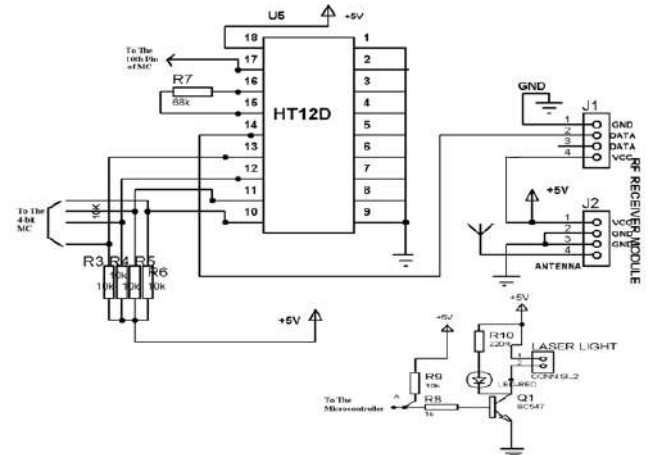


Fig. 6. RF Receiver Circuit

III. SOFTWARE ROBOT DESIGN

According to the programme, the robot software requires the hardware structure of the stair-climbing robots. to be controlled by hardware control. During the testing, the sensor's value and the speed of the motor are always controlled.

A. Simulation of Proteus

By providing extensive guidance on how to use schematics and programmatic-based strategies to create new simulation models, we were able to simulate the missing modes of circuit simulation interactive components and the micro-processor models to allow the simulation of completing a microcontroller-based design.

B. DC Motor control

The DC motor, as shown in Figure 7, makes use of the robot's powerful engine. For the stair climbing robot to ascend the stairs, it needed a lot of torque and very little current. A brushless DC motor provides the least current and high speed, while the gears of wiper motors provide the high torque.



Fig. 7. DC Motor

C. Solidwork

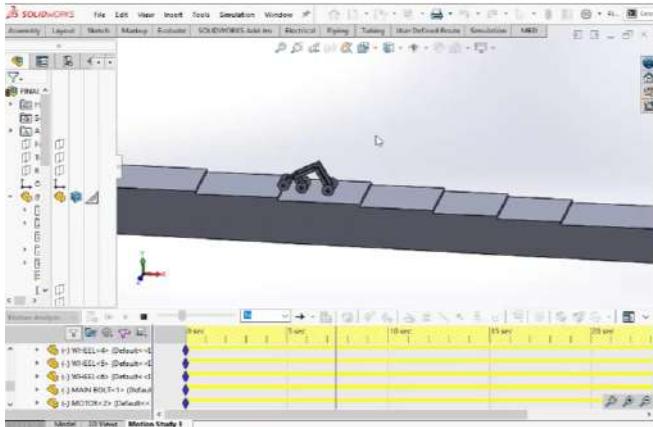


Fig. 8. Solidwork simulation of Stair Climbing Robot

D. Direction and Speed Control

A h-bridge, as shown in the diagram, is used to control the speed and direction of a DC motor. It controls the start and the stop and also controls the direction of the reserve. To make the robot structure, the current in the motor is reversed and the robot structure will be in reverses respective

EN	DIR	Q5	Q6	Q23	Q14	State of Motor
0	0	0	0	0	0	Stop
0	1	1	0	0	1	Left
1	0	0	0	0	1	Stop
1	1	0	1	1	0	Right

E. Feature of the L298N Motor Driver

- L298N is operated up to 46V
- Provide current up to as per Channel
- 3A is received per output channel in parallel combination.
- A separate ground is required for each channel.

IV. CONCLUSION

We find that the detailed development of stair climbing in a quadruped robot is dependent on geometrical interactions between the robot's legs and the stairs. The appropriate robot dimensions are presented, as well as how these characteristics affect the algorithm. and by the geometry of the robot, we use using a thesis wheel to balance the robot. And we also conclude that the future scope is very large in the stair

climbing field for industrial and mining sectors. This new robot should also be able to climb the stairs while employing distance or bumper sensors to detect each step. As a result of the better platform and the capacity to recognise stair steps, this new robot should be able to ascend any normal stairwell without falling. Moreover, this new robot can be employed in a variety of applications where little goods are required, such as the delivery of disabled people's medications and small military equipment.

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Medical Report Generation using Chest X-Ray

Vidit Prabhu, *Student*, Varun Gokarn, *Student*, Ashutosh Rane, *Student*, Nikhit Rapelli, *Student* and Pratibha Dumane, *Assistant Professor*

Abstract— Advances in the domain of Deep Learning, Natural Language Processing, Natural Language Generation, significant advances in computing power and the availability of large datasets has led to encouraging results in the field of medical imaging and the analysis of medical reports. Chest X-rays is an important modality that is used by radiologists around the world for managing the diagnosis and treatment of a large number of ailments in patients. Automatic generation of the radiology reports can help the radiologists in coping up with their workload and can also minimize the rate of incorrect diagnosis and overlooked diagnosis. The studies lead us to the realization that Natural Language Processing and Natural Language Generation have a lot of potential as applied to medical imaging. However, lots of work needs to be further carried out for mitigating the challenges involved so that the automatic reports become trustworthy, and therefore acceptable by the medical fraternity.

Keywords— *Medical report generation, Chest X-Rays, Natural Language Processing, Convolutional Neural Networks*

I. INTRODUCTION

Chest X - rays is the most commonly prescribed examination by the radiologists for screening, diagnosing and managing a large number of conditions in the patients. Natural Language Processing (NLP) combines artificial intelligence, linguistics and computer science to allow machines to read and understand human language for meaningful and useful purposes. [12] Text can be converted into structured representation with the help of NLP and it also helps in enabling automatic identification and extraction of information. NLP can help in processing large amounts of data and its applications may improve with standardizing task-based performance requirements, report standardizations and external validation.

The superimposition of nearby anatomical structures along the direction of projection makes the interpretation of the chest x-rays a difficult task. As a result, there are variations in the analysis of the x-ray images when observed by different radiologists. Most often, the guidelines are based on irregular datasets without taking the historical data into account. Discrepancies in the clinical definitions and procedures is also a concern. There can be issues of not considering all the variables involved, thereby impacting the diagnosis. To create a robust NLP system, first establishing the knowledge base with an acceptable amount of structured data is a must.

There are several obstacles to overcome when it comes to importing handwritten notes and recording vocal dictation, etc. [11]. Accurately and quickly identifying the information contained in the radiology reports has a good potential in becoming a decision - support system for the radiologists and also in identifying the patients who need urgent care.

Deep learning in combination with Natural Language Processing can help enhance medical reasoning, prioritize the evidence and the results, and it can become a ubiquitous tool for providing better health care for all.

II. LITERATURE REVIEW

The authors [1] have employed the transformer model to generate radiology reports and believe that it outperforms competitive benchmarks when measured by the metrics used for language generation as well as the report coherence. The authors have utilized the MIMIC-CXR dataset that contains 227, 835 imaging reports along with 377,110 total images for 65, 379 patients. The dataset was constrained to radiology reports that contained findings columns and the rest of the data was divided into training (70%), validation (10%) and testing datasets (20%). The data was divided on the basis of patient ID instead of on specific radiology reports to avoid issues due to multiple radiology tests conducted by the subjects. For neural machine translation, the authors employed a transformer model, which comprises an encoder-decoder model. The encoder was made to operate directly on image features instead of operating on word embeddings. A pretrained DenseNet-121 model was used to extract the features from the chest radiographs. The decoder was used in a similar manner to its original neural machine translation setting. The continuous - bag-of - words Word2Vec method was used to pre-train word embeddings for all the words occurring at least five times in the training corpus. The model performance was analyzed for the metrics CIDER, METEOR, ROUGE-L, BLEU. The model was also analyzed and fine-tuned for the recall, precision and the F1 score for positive assessments. [1]

The authors [2] have used a LSTM model to generate radiology reports. They present a new model called Vispi, which annotates an image by visually identifying and localizing the typical thoracic diseases and then creates a report using the attentive LSTM model. The Indiana University (IU) X-ray dataset, which is a publicly available dataset with 3955 radiology reports associated with chest X-rays, has been used for the purpose of this study. The dataset was constrained to radiology reports that consisted of the findings columns and the rest of the data was divided into training (70%), validation (10%) and testing datasets (20%). The authors have gone about this report generation by initially describing an integrated image interpretation framework that gives disease annotation and medical report generation. The authors employed massive datasets to enhance medical image translation while training on a small number of reports. They assessed the applicability of NLP performance metrics for medical report generation and, lastly, proved the usefulness of using a heatmap to localize critical results in an X-ray. The training data here is the IU X-ray dataset. The disease classification and localization module are built on a 121-layer DenseNet which is

pre-trained with Chest X-ray8 dataset. Grad-CAMs were used for the heatmap. The report generation uses attentive LSTM model which works on an encoder-decoder model. A pre-trained ResNet 101 model was used for the encoder. The model performance was analyzed for the metrics CIDEr, ROUGE, BLEU-1, BLEU-2, BLEU-3, BLEU-4. And a ROC Curve was plotted to compare results of TieNet and Vispi. [2]

The authors [3] trained a Deep Convolutional Neural Network (DCNN) model using a Tuberculosis (TB)-specific chest x-ray (CXR) dataset and assessed it on a non-TB-specific CXR dataset from another source. The NIH ChestX-ray8 database, HIPAA-compliant datasets, and the National Library of Medicine (NLM) Shenzhen No.3 Hospital X-ray collection were used in this research. They divided the dataset into three categories: training (75%), intramural test (10%) and validation (15%) sets. Using Inception V3, a pre-trained DCNN, they used color-space augmentation, crop-flip, and rotational algorithms to classify each image as having TB characteristics or as healthy. The DCNN model that resulted was used to estimate the prevalence of TB-associated CXR in the ChestX-ray8 dataset. Researchers used receiver operating characteristic (ROC) curves and areas under the curve (AUC) to evaluate model performance and establish the appropriate cut point for TB detections. The predictive performance of the Inception V3 TensorFlow model in the Shenzhen dataset was maintained in this study for training, validation, and intramural test images. Higher resolution pictures may enhance accuracy, especially for subtle results, and more study is needed in this area.

The authors [4] have implemented a layered convolutional neural network model to generate radiology reports. Their model named CheXnet returned a report accompanied with a heatmap limiting the areas indicative of thoracic diseases though mostly concerned with detecting pneumonia. The authors utilized the ChestX-ray14 dataset, which includes 112,120 frontal view X-ray images from 30,805 people. The dataset was constrained to radiology reports that contained findings columns and the rest of the data was divided into training (70%), validation (10%) and testing datasets (20%). The data was divided on specific radiology reports avoiding the issues of a patient overlap. The authors used Class Activation Maps (CAMs) for generation of heatmaps which help in localizing and classifying the pathologies. The CheXnet is a 121-layer DenseNet pretrained on ImageNet. The model performance was analyzed for the AUROC metric. The model was also analyzed and compared with four practicing radiologists, the average F1 score of the model far exceeded the radiologists' average F1 score.

In [5], the authors have used a To produce medical reports for different views of chest X-ray pictures, a Multilevel Multi-Attention (MLMA) encoder-decoder system based on integrating Context Level Visual Attention and Textual Attention was used. To achieve the objective the author has used the IU Chest X-ray dataset. The dataset comprises 3955 radiological reports of different forms with 7470 multiple views of Chest X-rays. TRepeated sentences are replaced with a single sentence; images with no report

and inaccurate words are removed. 500 samples were used for testing and 500 samples were chosen at random for validation in order to assess performance.

The VGG16's block5 pool layer encoded the images. All reports were processed in advance to eliminate unnecessary words, numbers, and punctuation. The Nadam (Nesterov-Adam) optimizer was used to train all proposed models to minimize cross-entropy with an initial learning rate of 0.001. To train the end-to-end MLMA model, the initial batch of input had a size of 128. The adaptive beam search approach was utilized for testing to create the best initial word sequentially. The author compared the Bleu-1, Bleu-2, Bleu-3, Bleu-4, Meteor, Rouge-L, and CIDEr models to the data. The author's MLMA model yields excellent results for unknown X-ray images; according to the author, this strategy beats state-of-the-art methods for the development of medical reports for any chest X-ray.

The authors [6] utilized the MIMIC-CXR dataset. MIMIC-CXR contains 473,057 chest x-ray pictures and 206,563 reports. The authors have tested various language generation models to evaluate and understand the NLG metrics. The models that were tested for the evaluation were Conditional n-gram language model, CNN-RNN model, Nearest neighbor (1-NN) and random retrieval baseline amongst many. The CNN-RNN model used a LSTM based encoder-decoder approach for extraction of the output with captions. This approach was used to minimize the cross-entropy loss. The decoding mechanism was beam search. The authors have taken the help of CheXpert during the evaluation process to assess the models for accuracy and precision. The models were analyzed for the BLEU and CIDEr metrics. The authors concluded that the CNN-RNN model and 1-NN model top the linguistic and clinical accuracy table. In the BLEU and CIDEr metrics, the CNN model with beam search decoding outdid the other models. The authors are of the opinion that adding additional decoding techniques yields benefits for neural models and better image extractors. The authors have concluded that the standard NLG metrics give a skewed output which favors irrelevant reports based on the number of grammatical blunders.

The authors [7] utilized the Indiana University (IU) X-ray dataset, an accessible image dataset containing 3955 radiology reports matched with chest X-rays, for their investigation. The dataset was restricted to radiology reports with findings columns, and the rest of the data was split into training (70%), validation (10%), and testing datasets (20 percent). For their study, the authors used an LSTM model. They have developed a new approach for assessing the trained chest X-ray report production, in which the encoder is employed for visual feature extraction and the learned features are used to assess their performance for thoracic disease categorization. CheXNet is used to classify thoracic disease, which in turn employs DenseNet-121. The Chest X-ray 14 dataset was utilized for this. Chest X-ray 14 is one of the largest publicly accessible radiograph datasets, including 112,120 frontal view chest X-rays of 30,805 distinct individuals. In this case, each picture is tagged with up to 14 different thoracic pathology tags taken from the appropriate report. The tags are accurate more than 90% of

the time. The samples are randomly selected as 70% for training, 10% for validation and 20% for testing purposes. The report generator first uses CNN-RNN model to process the input image followed by Bi-LSTM model. The pre-trained model ResNet-152 has been used for building the image encoder model. The report decoder uses a stacked 2-layer LSTM model. The model performance was analyzed for the metrics BLEU, METEOR, ROUGE and CIDEr.

The authors [8] concentrated on producing clinically accurate reports. Their system model produces a list of topics. The system creates the final report based on each topic. To improve readability, the system is fine-tuned using reinforcement learning. The authors have tested this model on the MIMIC-CXR dataset and Open-I dataset. They have introduced the hierarchical strategy of generation with a CNN-RNN-RNN architecture. Evaluation metrics used by authors for Automatic LG are CIDEr-D, ROUGE-L, and BLEU. The authors have also compared their model with some baseline models like 1-NN, Show and Tell (S&T), Show, Attend and Tell (SA&T), and TieNet. After testing different models, the authors observed that their NLG model that promptly helps to optimize the CIDEr score, and can reach a much remarkable performance in terms of the metrics of NLP.

The authors [9] have worked on the Indiana University chest x-ray dataset (IU-Xray) consisting of 7430 images from 3825 individuals. The authors modified a transformer-based model that had previously been trained and used GPT2 to train it. This model works on an encoder-decoder approach where The encoder is a CheXNet model that has already been trained. used for extracting the image information and the decoder is used for generating the full-text reports. For the encoder part of the model the authors tweaked the CheXnet model which is a DenseNet121 trained on the Chest X ray 14 dataset by the addition of a new final layer. The decoder consisted of a pre-trained distilGPT2 because of its adaptability and speed compared to the normal GPT2 model. This model was compared with 4 different models on the basis of NLG, BLEU, METEOR, ROGUE-L and Cider metrics. The model's results were also cross-checked by an expert radiologist and the results for the normal ones were almost 99% accurate but the abnormal ones needed some improvement. The time taken by the model to generate the report turned out to be faster when compared to existing models. In addition, the authors argue that traditional word-overlap-based techniques are inadequate for systems like this. This model puts heavy emphasis on the semantic feature similarities for better reports.

The authors [10] suggested a framework for adversarial reinforced report generation for chest x-ray images. The Adversarial Reinforced framework focuses on diagnostic accuracy and language fluency. The authors used the Indiana University Chest X-ray dataset, which consists of 7470 frontal and lateral view images combined with 3955 diagnostic reports. Each report is divided into four sections: comparison, indication, findings, and impression. Authors were focused on generating the findings. They have used the PyTorch Python library to implement all the proposed models. To verify the performance of the proposed

approach, the authors have used four competitive models viz. CNN-RNN, CoAtt, MvH-Attl-MC and NLGR-CCR. For evaluation of language fluency, the authors have used Natural Language Generation viz. BLEU-4, METEOR, ROUGE-L, and CIDEr. The CheXpert labeler was used to produce reports for diagnostic accuracy, and the precision, recall, and F1 scores were determined.

III. BACKGROUND

In medical imaging, X-rays which are a form of electromagnetic radiation are used. In order to recommend the correct diagnosis to the patients, the radiologists must analyze the X-ray properly. The most common radiologic examination ordered is a chest X-ray. This image helps your doctor determine whether you have heart disease, a collapsed lung, pneumonia, fractured ribs, emphysema, cancer, or any of a variety of other conditions. Preparing medical-imaging reports can be difficult for unskilled radiologists and pathologists, especially those operating in remote locations with insufficient healthcare quality; on the other side, writing imaging reports can be monotonous and time consuming for experienced radiologists and pathologists.

IV. PROPOSED SYSTEM

A. Design Details

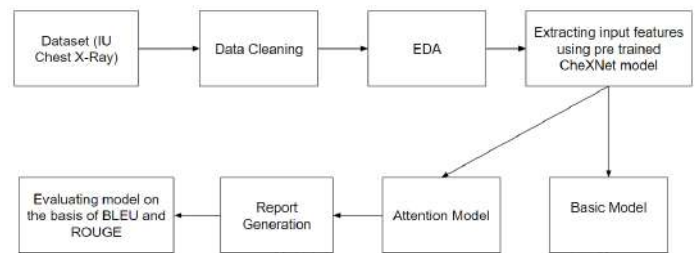


Fig. 1. Flow Diagram of the Project

B. Methodology

For this project we have used various mechanisms and methodologies. Below are the descriptions of the same. During Preprocessing of Data we have used various python libraries like Numpy,Pandas,Natural Language Toolkit Library for text data type and for images we have libraries like PIL and Computer Vision. For Data Analysis we have used EDA i.e Exploratory Data Analysis process.We have used this process because it helps us to visualize common traits or anomalies in our data.For visualization we have used python libraries like matplotlib.pyplot and matplotlib.image and Seaborn. Further for extracting image features/vectors from images we have used Transfer Learning Mechanism and for that we have used the CheXNet pre-trained model. After extraction of image vectors we created train,test and validation data set using sklearn library from Python and we also did tokenization using the Tokenizer module from Natural Language Toolkit Library. Now we move on to creating models. First we created a Basic Encoder-Decoder model. We used the

Tensorflow.Keras library from Python. Then we created an Attention model to improve our result for that we used Bahdanau Additive Attention Mechanism.

C. Implementation

1. Preprocessing of Data

Preprocessing of data is a very important step for any data related projects. In this step we clean the data i.e we remove redundancy, null values and gibberish values from our datasets. For this project we have used IU Chest X-ray dataset [15] which contains 7471 images with both front view and lateral view of each patient's chest. Around 3955 patient reports are available. Every image in the dataset has four captions namely Indication, Comparison, Findings and Impressions. These give a better description of the salient entities and events. The finding caption gives maximum information present in images.

2. Exploratory Data Analysis

We obtain insights about the data after properly analyzing the data and can make decisions based on these insights. So the process of Exploratory Data Analysis is done to get some key insights about the data. This process enables us to get information like the maximum and minimum number of images associated with a report, most frequently used words in the report. Most of the reports are associated with 2 images. This process also helps us to find any anomalies in our datasets.

3. Feature Extraction

Before creating any model we need to be careful about what kind of data we are feeding into the model. Feature Extraction is a technique we have used to extract input features from our image dataset and then divide it into training, test and validation dataset.

4. Encoder - Decoder Model

Encoder - Decoder model is a sequence-to-sequence deep learning model that takes a set of items (in this case, image characteristics) and produces a new set of items (reports). The encoder examines each item in the input sequence and aggregates the data into a vector known as the context. The encoder delivers the context to the decoder after processing the complete input sequence, and the decoder begins producing the output sequence item by item. For precise tuning, we used the Dense and Dropout layers in the encoder component of our model. For better output, we used an additional embedding layer and an LSTM layer in the decoder.

5. Attention Model

The Attention model [14] is an improvisation of the Encoder-Decoder model. We have used Bahdanau Additive Attention Mechanism here. The Attention can be stated as a vector of important weights. The encoder here is on similar lines as the Encoder-Decoder model while the decoder has some additions. The context vector in this case is produced by the Attention layer after getting the encoder output and decoder input. Then the initial state of the previous decoder and the context vector is passed through the RNN for

generating the output. Dropout layer is used for tuning and regularization of the model. The Beam Width Search algorithm has been used here in order to predict the most probable impression of the images.

D. Comparison of Models

TABLE I. COMPARISON OF BOTH MODELS BASED ON BLEU SCORE

Papers	Model	Encoder	ROUGE Score
Ours	Attention LSTM	DenseNet-121	0.272
[2]	LSTM	ResNet-101	0.371
[5]	Attention LSTM	VGG16	0.440
[7]	LSTM	ResNet-152	0.380
[9]	CDGPT2	DenseNet-121	0.281

The score which is taken into consideration here is the recall of the ROUGE-L Score [16]. Recall is the ratio of total number of n-grams in the reference and the number of overlapping n-grams found in both the model output and the reference.

The ROUGE Score obtained is comparable with the other existing work and the score can be improved with better resources available like a larger dataset which would help train the model better thus improving the accuracy and provision of more X-ray images with diseases as most of the images here showed no diseases.

Using much more advanced techniques can also help to obtain a better score. These techniques could be either using Transformers or using Bidirectional Encoder Representations from Transformers (BERT).

V. RESULTS

The performance of each model has been depicted in the tables below. Cumulative N-Gram Scores (BLEU Score) [17] and ROUGE Scores have been used here.

TABLE II. COMPARISON OF BOTH MODELS BASED ON BLEU SCORE

Model	BLEU - 1	BLEU - 2	BLEU - 3	BLEU - 4
Encoder-Decoder	0.165	0.113	0.115	0.127
Attention	0.299	0.225	0.226	0.259

TABLE III. COMPARISON OF BOTH MODELS BASED ON ROUGE SCORE

Model	ROUGE - 1			ROUGE - L		
	r	p	f	r	p	f

Encoder-Decoder	0.105	0.400	0.166	0.105	0.400	0.166
Attention	0.272	0.692	0.391	0.272	0.692	0.391

r - Recall, p - Precision, f - F1 Score

According to the BLEU score and the precision gained from the ROUGE Score, the Attention Model provides superior accuracy. When compared to the Encoder-Decoder Model, the Attention Model's recall and F1-Score are also significantly greater.

Individual N-Gram scores are generated and weighted using the weighted geometric mean for all orders from 1 to N to provide a cumulative N-Gram score. BLEU-1 is a 1-gram score with the weight distribution as (1, 0, 0, 0) i.e. 100% of the weight being assigned to the 1-gram score. Similarly, BLEU-2, BLEU-3 and BLEU-4 are 2-gram, 3-gram and 4-gram scores respectively with weight distribution as (0.5, 0.5, 0, 0), (0.33, 0.33, 0.33, 0) and (0.25, 0.25, 0.25, 0.25).

The number of matching 1-grams between our model-generated text and the reference is measured by ROUGE-1, while the longest common subsequence (LCS) between our model output and the reference is measured by ROUGE-L. The precision in ROUGE Score is the ratio of the number of n-grams detected in the model and reference to the total number of n-grams in the model. The F1 Score is calculated with the help of recall and precision.

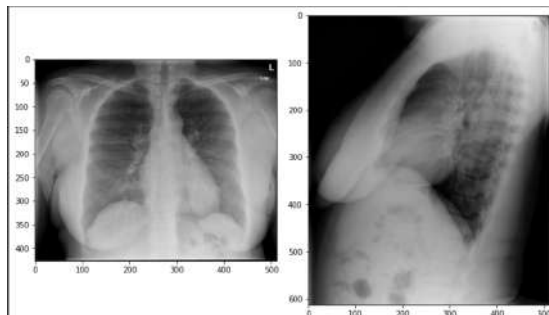


Fig. 2. Frontal and Lateral Chest X-ray

TABLE IV. ENCODER DECODER MODEL RESULTS

Actual	<start> the lungs are clear bilaterally specifically no evidence of focal consolidation pneumothorax or pleural effusion cardio mediastinal silhouette is unremarkable visualized osseous structures of the thorax are without acute abnormality <end>
Predicted	<start> no lungs focal pleural lobe size is in size is in size
BLEU Score	0.213
ROUGE - 1 Score	r - 0.206, p - 0.666, f - 0.315
ROUGE - L Score	r - 0.172, p - 0.555, f - 0.263

TABLE V. ATTENTION MODEL RESULTS

Actual	<start> the lungs are clear bilaterally specifically no evidence of focal consolidation pneumothorax or pleural effusion cardio mediastinal silhouette is unremarkable visualized osseous structures of the thorax are without acute abnormality <end>
Predicted	<start> the heart is normal in size and contour there is no focal airspace opacity no pleural effusion or pneumothorax is seen <end>
BLEU Score	0.301
ROUGE - 1 Score	r - 0.344, p - 0.500, f - 0.408
ROUGE - L Score	r - 0.276, p - 0.400, f - 0.327

VI. LIMITATIONS

The size of the dataset in this study is very limited hence model predictions could be improved by adding more data. Additionally, most of the data available in the dataset belonged to the “no disease” category. This could be tackled by obtaining more chest X-ray images with diseases.

VII. CONCLUSION

It can be clearly stated that the score obtained by the Attention model is higher compared to the Encoder-Decoder model thus proving the efficiency of the Additive Attention Mechanism. As per the resources available, the results may vary and upon further investigation it can be said that there are various other techniques available for report generation which give different accuracies. The application of this project is to act as an aid in becoming a decision support system for the radiologists. The project's long-term goal is to utilize much more modern approaches to produce better results, as well as to create an android or desktop application that can be used as a presentation tool for the generated reports by submitting X-ray images from the radiologist.

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Design and Implementation of Intravenous fluid monitoring and alerting system

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Abstract—In recent years, due to technological advancements, many sophisticated techniques have evolved to assure the fast recovery of patients in hospitals. For good patient care in hospitals, assessment and management of fluid and electrolytes using intravenous drips is the most fundamental thing required. Almost in all hospitals, a nurse is responsible for monitoring this. With a greater number of patients, this becomes a tedious task. In case the fluid in the IV bottle reduces and the nurse is not able to replace/remove it on time, there is a risk of air embolism which is a serious threat as air bubbles in the blood can be fatal. In order to overcome this critical situation an automatic alerting and indicating device has been built in this project using microcontrollers and sensors. Whenever the fluid level will go beyond a threshold a warning signal will be given to alert the medical personnel. This will prevent the need for constant manual monitoring which needs to be done by the hospital staff, especially during the night.

Keywords—IV Drip, Arduino Uno, Buzzer, WIFI Module 8266, HX711 module

I. INTRODUCTION

Intravenous Drip is a common treatment method for patients that involves a gradual Infusion of medical fluid into the patient's body. More often when the liquid interior in the bag is almost to run out the medical attendants can be mindful of the event as it can be either by themselves going to the patient's ward to check from time to time or by asking the signal directly from the patient.

This type of method for checking IV drip will bring interference in nurses' errands and in increment of staff cost. Manual method of IV monitoring has caught quite an attraction of modern technology. But in recent methodologies some led to complexity in the fetched system and increase in cost. At times some consequences can take place like as a matter of reality, the settled dribble rate may fluctuate because of various causes like enlargement or contraction of veins, Lessing of liquid pressure factor, variation in patient's internal heat level and so on.

Due to Covid-19 outbreak which we are experiencing at current time, the doctor to patient and nurse to patient ratio is really vexatious according to the ThePrint which states that 1 doctor for 1511 people and 1 nurse for 670 people which is much higher than the WHO's norm of one doctor for every

1000 people. Even the nurse to population ratio according to WHO's norm should be 1:300.

According to WHO's guidelines it is important for everyone to avoid direct contact with anyone and especially for doctors it is jeopardizing to come in contact with patients, in case of manual IV monitoring the doctors, nurses have to come face to face with patients which is risky for both the patients and the doctors, nurses.

So it is need of the hour to think ahead of manual IV drip monitoring and come over it with modern techniques to implement and lessen the threat of virus spreading.

If IV drip is not monitored properly it can lead to various hazardous situations like backflow of blood, air embolism, sharps injury, air can enter into the veins and various risks are involved if proper monitoring is not implemented.

- Advantages of IV therapy :
 - 1) Works fast
 - 2) Easy to monitor
 - 3) Promotes fast recovery from cold and flu
 - 4) Inexpensive
 - 5) Few medicines can only be given through IV

The advances to see the physical conditions of the patients such as blood oxygen saturation, electrocardiogram, blood weight screens (Blood Pressure) have been already created impressively and are being utilised in many hospitals. In some cases, it is still inadequate and further research is needed.

In the paper various techniques have been reviewed such as Radio Frequency Identification (RFID), RFID with tag/reader with Local Area Network (LAN), Microwave time domain reflectometry (TDR) with help of a sensing element attached to bottle from external surface, Power Line Communication (PLC) is used to design remote capacitance to monitor system. Various methodologies have been put further for better understanding

A. HEALTHCARE INFORMATION

IV drip is a common infusion technique used nowadays to deliver essential nutrients and fluids directly into the bloodstream bypassing the digestive tract. This is a fast infusion technique where nutrition is available readily to remedy the body's health and nutritional needs. An average drip takes 30-45 mins to complete one session. IV drip contains electrolytes and salts while some contain antioxidants, sugars, vitamins. Most common ingredients are electrolytes and vitamins.

Liquids are managed this way for different reasons, all of which require control of the sum given, without proper control the rate of liquid organization depends on the gravity alone itself. This will effect in accepting either as well much or well small liquid.

The stream in an IV is supervised either physically or by utilizing an electric pump. In any case of how the stream is controlled, medical caretakers or caregivers must check IV's frequently to guarantee both rate of stream and conveyance of the right dose.

- In Manual Regulation,

The rate of liquid dripping from a pack into an IV can be controlled through a manual strategy. Nurse increases/decreases the pressure which the clamp puts on an IV tube to control rate of flow. They can tally the number of drops per minute to create beyond any doubt the rate of stream is adjusted and can alter as needed.

- In Electric Pump,

The rate of flow of IV can moreover be tweaked with an electric pump. Nurse programs the pump to convey the required sum of fluid into the IV at the proper rate.

B. METHODOLOGY

A load cell is implemented which has a weighing capacity of 20kg where the IV drip bottle will be hung. The load sensor has Four lead wires which can be connected to HX711 A/D Pressure Sensor. It is easy to use with a driving voltage of 5-10V and produces the output voltage as per the force changes over it. The HX711 module is a Load Cell Amplifier breakout board for the HX711 IC that allows you to easily read load cells to measure weight. This module uses 24 high-precision A/D converter chip HX711. The load cell takes the input and transmits it further to the load cell amplifier which converts the analogue signal to digital and forwards it to Arduino. In the Arduino code, the LCD pins are declared along with load cell calibration is set at 365.37 and the weight of the IV Drip bag set at 3030 mg. The value of the weight is first converted into milligrams. The volume of fluid in the drip bag is then calculated with the following formula – $0.924 * \text{Weight Of The Bag}$. And the percentage – $(\text{Volume Of}$

$\text{Fluid}/500) * 100$. The Arduino then sends these values and projects them on the LCD mount. When the fluid level drops below the 40ml threshold the Arduino alerts the buzzer which then sounds till the fluid level does not rise back above 40ml.

C. IMPLEMENTATION FLOWCHART

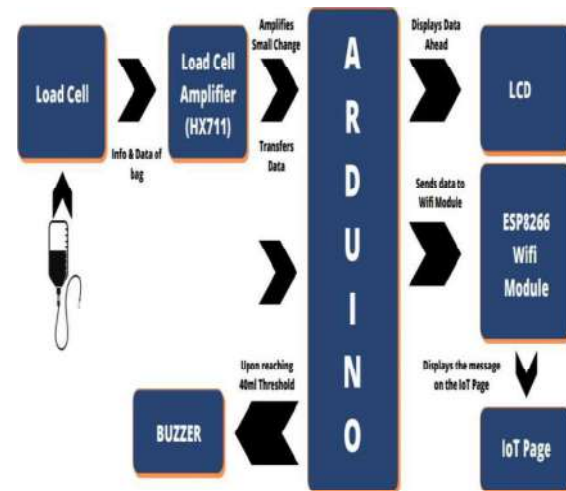


Fig 1.1 Flowchart of the System

D. RESULTS

The components and circuitry used in the suggested system are thoroughly tested individually before amalgamating them and executing the entire system as a whole. The load cell gives an output voltage variable from 0-5mV. The HX711 amplifier is also tested. The Arduino uno board is run individually & tested successfully on the IDE by supplying certain voltages to the analog pin furthermore the first sub circuitry is verified by hanging a load on the load cell and feeding program to the microcontroller before reading and displaying the load.

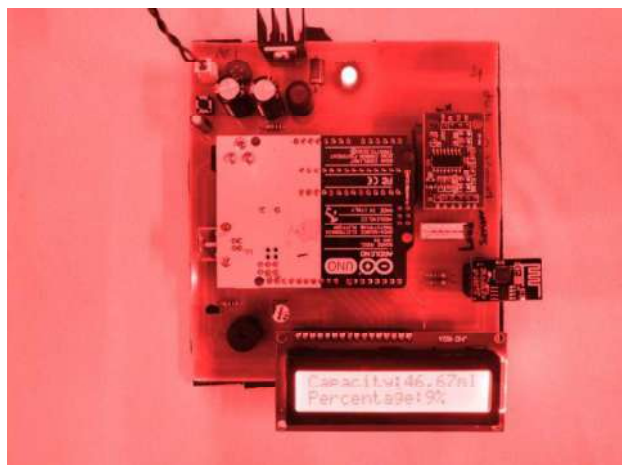


Fig 1.2 Prototype of the Circuit board

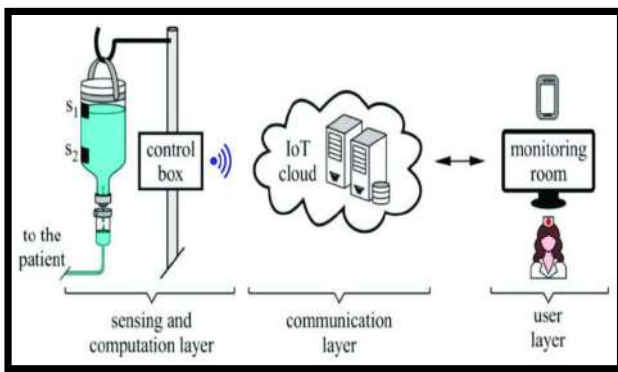


Fig 1.3 Overview of the Project



Fig 1.4 Final View of the Project Prototype

II. CONCLUSION

In this report the implementation of smart bottle monitoring systems with the help of load cell, Wi-Fi module and Arduino are described. The operative of the system and associated risks are discussed. The bottle is monitored by an IOT Page and also shown on the mounted LCD. The information transferred from the load cell to the app via the Wi-Fi module.. LCD shows the level of water in the bottle in terms of percentage. This is a very easy implementation straight forward method to reduce the chance of patient hazard. Our arrangement assimilates a lot of features of the prevailing systems and also adds on new features to it which upgrade the performance of the system by many margins. With this new found knowledge a simple user interface is formed for real time monitoring of not only one patient but many patients with the help of Arduino IDE we were able to provide the number for alerting nurses and Arduino help to handle all the information transaction at a time.

ACKNOWLEDGEMENT

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Implementation of Smart Electronic Voting Machine

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Abstract—The essence of every democracy is that people choose their representatives, and India is the world's largest democratic country. However, in today's world, issues such as booth capturing, manipulation, fraudulent voting, and interference with Electronic Voting Machines (EVMs) plague the democratic process. As responsible engineers, we must take action to combat this threat. The voting process takes place electronically in most EVMs, which removes the use of ballot paper to cast votes in elections because it is time-consuming and prone to errors, both purposefully and inadvertently. Today, voter authenticity is a major worry, and it should be ensured that the same voter does not have the ability to vote twice. This problem can be solved by implementing a biometric-based voting system, in which a voter's identity is verified using their fingerprint. As a result, the rule will be "one person, one vote." We employed a Xilinx Spartan 6 FPGA, an ESP8266 Wifi module, and a Finger Print Scanner in the suggested implementation to distinguish each voter, count the votes, prohibit fraudulent votes, also allow remote voting. We bring remote voting using this proposed technology, which allows us to vote from any authorised voting station in India. The results can be read instantly on the FPGA's central system, saving time on trip. Our goal is to adhere to the premise of "one person, one genuine vote."

Index Terms—Xilinx Spartan 6 FPGA, Fingerprint module, Wifi module ESP8266.

I. INTRODUCTION

In India, all elections, from state to national, were conducted in such a way that a voter would stamp their favourite candidate's name and then fold the ballot paper according to a set procedure before placing it in the ballot box. As this can be time-consuming method that is prone to errors and necessitates voters' knowledge of the process prior to voting. This leads to waste of paper in a time where we are promoting to save trees and also mishaps during transportation of ballots is very likely. EVM presents as a solution as it removes different components of the old process such as ballot boxes, stamping, ballot paper etc. In the early days of voting, for the uneducated, marking system was introduced to specify their votes. The Election Commission of India introduced this system to curb these issues with the previous system. In 1981 The Electronics Corporation of India Ltd. (ECIL), Hyderabad, and Bharat Electronics Ltd. (BEL), Bangalore introduced the electronic voting machine system.

A. Electronic Voting Machine

The EVM is made up of two primary components: (a) the Control Unit and (b) the Balloting Unit, which is connected to the Control Unit through a cable. A Balloting Unit can accommodate up to 16 people. With one control unit, four balloting units linked together may serve to a total of 64 candidates. The Presiding Officer keeps the control unit, while the voter uses the Balloting Unit for polling. The EVM Balloting Unit can be described as a compact-case device. The contestant and their party's emblem are listed. A red LED and a blue button are placed next to each candidate's name. The voter polls his vote by pushing the blue button next to the name of the candidate he wants to vote for.

How the Vote is cast with this EVM?

The entire process is very easy to understand:

- Previously, your name would be announced, and you would be required to sign or register your thumbprint.
- After the Election Officer has verified your identity, an ink mark is applied on your finger in a same manner from before.
- The Election Officer next gives you a piece of paper with your voter registration number on it, which you must sign or leave your thumb impression on.
- You hand this slip to the presiding officer, who checks the serial number and authorises you to vote by pressing the Control Unit's button on the EVM.
- You will not be given a ballot after that and will be sent to the EV Machine, which is placed behind a card board in a corner. Your polled vote will be kept confidential because the machine is set up in such a way.
- You press the blue button in front of your favoured candidate on the EVM Balloting Unit and release.
- The red LED indicator illuminates as soon as the button is pressed, and the machine emits a whistle sound. This indicates that your vote was correctly cast. You are now free to leave.
- If the red LED does not operate, push the Blue button firmly once more. Consult the Presiding Officer if you're having trouble.
- Your vote is completely secure and anonymous, and there is no space for error. In any scenario, you may rest confident that your vote will not be invalidated.
- The 'Control Unit' is connected to the voting machine. When the user clicks the button, his vote is recorded in the control unit, and the total number of votes cast for

each candidate is automatically calculated.

What Happens After the Polls Close?

When the poll is closed and the last voter has recorded his vote, the EVM is closed, and no additional votes can be recorded in the machine. Only the control unit is necessary at the counting location to determine the outcome of the poll at the polling station where the EVM was employed. It is not necessary to use a balloting unit. This used to be the case every time an election was held.

B. Booth Section

EVMs do not allow for rigging, which is a big advantage. Attackers can identify multiple ballots and deposit them in the voting machine using the ballot paper system. Because voting machines are only designed to record a maximum of five votes per minute, this is not possible. (Before manufacture, the polling rate can be set to any specified number). As a result, even casting 100 fraudulent entries would take the booth robbers about 25 minutes, and in that time, law enforcement might assist to bring an end to the corruption. Furthermore, if the presiding officer suspects any wrongdoing, he can halt the poll by activating a unique switch, which prevents any votes from being recorded. The polling station's presiding officer has the authority to close the voting machine's control unit so that "no further vote may be recorded." After the polls close and the machines are taken from the polling site to the counting centre, there is no possibility to poll fake votes. A vote cast in an EVM cannot be tampered with, while votes written on paper and placed in a container in a ballot box method can be taken out and damaged. The votes recorded by the EVMs can be stored in memory for three years. For three years, the votes recorded by the EVMs can be retained in memory. It will be immediately apparent if the machine has been tampered with in any way during the polling session or before the results are tabulated, allowing a new poll to be organised.

The EVMs have following advantages:

- The saving of a significant amount of printing stationery and the transportation of big quantities of election material
- Transport, storage, and maintenance are all made simple.
- No invalid votes,
- Polling time reduction, resulting in less issues with electoral preparations, law and order, candidate expenditures, and so on.
- Counting is simple and accurate, with no malice.
- Eco friendly.

Interestingly, the "Diebold Accuvote Technology" is a smarter system than the traditional EVMs utilised in India. DIEBOLD is a new voting mechanism approved by the US government. The Diebold system is based on Microsoft software and lacks tamper-resistant sealing on locks and panels. It has a keyboard interface, and it was found to be infected with the "Blaster" virus. A woman entered certain Diebold files and discovered that the votes were recorded in MS Access files, according to a Wired report. A PCMCIA Scandisk card is also included for local storage. After the findings have been

encrypted with DES, they must be communicated to a server via a touch screen interface and a network connection.

II. LITERATURE SURVEY

In a paper [1], the author has proposed a digital EVM which was prototyped on Xilinx ISE (Verilog HDL). The method consisted of 3 phases : In the first phase, they determined the total number of voters and participants. The voting procedure begins in phase two when an individual records their vote for a candidate, and the polled vote is recorded in the individual contestant registration. The votes are validated in phase three once the voting procedure is completed by matching the votes polled to the contestants to the registered ones and then the process for election is completed. [1]

In the paper [2], they had implemented it on field programmable gate array. Instead of using a microcontroller, they employed an ASIC-based EVM. According to the author, before the voting process begins, the self-testing system examines the computer for any tampering or malicious behaviour. The EVM ensures that each voter has just one voting opportunity. This is accomplished by the machine's blocking mechanism (10s). A single contender can receive up to 2048 votes from the machine, for a total of 8192 votes. After voting is done, the mode button is turned down (output mode), and the EVM cannot be reversed back to input mode under any circumstances. [2]

In the paper [3], they proposed a fingerprint voting system using Arduino Mega256 technology. For Fingerprint scanning they used a R305 module as a scanner which has in-built ROM and RAM. This module has two modes of operation: Master and User. A unique ID will be created for the register fingerprints which will be collected in the ROM of the scanner, this is done by Master Mode and then transferred to user mode after interacting with MEGA256. By using this controller they have controlled the scanning process for which the fingerprint module is used to register the fingerprint of every voter and at the time of voting one must show his finger at the fingerprint module to cast his vote. The wifi module is used for accessing the webpage. An indicator will be issued by a buzzer that is interfaced to the controller if an unauthorised individual tries to scan his image. [3]

In the paper [4], to improve existing technology by using GSM and SMARTCARD to cast and count votes with greater ease and efficiency, as well as simplify election procedures and reduce ballot examination error rates. On FPGA, the proposed EVM has been implemented. The setup consists of two units: a Control Unit and a Balloting Unit with a connection to connect them, as well as a Balloting Unit that can accommodate up to 16 candidates. With one control unit, four balloting units linked together may serve to a total of 64 candidates. The Presiding Officer keeps the control unit, while the voter uses the Balloting Unit for polling. Experts have offered capabilities such as GSM-based voting, whereby enables residents from anywhere in the country using their mobile phones. Smart card-based voting with RFID, which enables voters to validate their identification and vote using a smart card, as well as a

tamper-proof system with security features including password protection at various stages of the voting process. [4]

In the paper [5], They have developed a method that includes an electronic voting machine that can be installed at any voting location. In this system, they have used Raspberry Pi 3B+ (RPI). The user will insert their Aadhaar-ID on the touch screen module, and Then their fingerprints will be read and verified using a cloud-based database, as this machine will have access to the Aadhaar database of all Indian voters. Aadhaar card number and fingerprint recognition can be used to authenticate the user. If it matches, only then will the next steps be initiated. The user must first choose his region. The voter can now exercise his right to vote. The candidate's vote total will be enhanced after casting a vote. The vote totals are encrypted and stored in the device's memory for a limited time. The encrypted vote count is then stored in the cloud. After the vote count is increased, the database will get a user disable request to prevent duplicate voting. [5]

In the paper [6], they presented the design, building, and operation of an electronic voting system using an ATMEGA 32 microcontroller with increased three-layered extra security. They built a system that can accommodate up to 32 candidates to keep things simple. The buzzer and light confirm that the button is pressed anytime one of the four buttons is pressed. The corresponding person is then given a vote, and the number of votes received by each person is displayed on an LCD. Furthermore, pressing the button causes the printer to produce an acknowledgement. When a voter casts a ballot for a certain contender, they are asked to confirm their vote with a yes or no response. When a voter's vote is verified, the tally of the candidate's vote rises, and the voter receives a printed recognition of the vote, providing more security to the voter's vote. They also studied and devised strategies to deal with security vulnerabilities that could jeopardise the voting process' availability and integrity. [6]

III. EXISTING SYSTEM

In India, traditional electronic voting machines are manually operated micro-controller/microprocessor-based equipment with numerous problems. The following features of the current electronic voting machine, are mentioned below.

- EVMs are powered by a standard volt alkaline battery. In India, power issues are still present in certain parts of the nation. With this model, it can be used all over the nation with no interference.
- An EVM can currently record up to 3840 votes, which is more than adequate for a polling place.
- A maximum of 64 candidates can currently be accommodated by an EVM. In a Balloting Unit, there is space for 16 candidates. If there are more than 16 candidates, a second Balloting Unit can be attached in parallel to the first Balloting Unit, and so on, up to four units and 64 candidates.
- By continually pressing the button, you will not be able to vote more than once. The vote for the candidate is entered and the Balloting Unit is secured when a certain

button is pressed. If that or any other button is pressed again, no more votes will be recorded. The EVMs ensure that the "one person, one vote" principle is upheld.

- EVMs cannot be designed to prejudice a party or a candidate since the order in which nominations are registered and the validity of the candidate's candidacy determine the order in which a candidate's/name party's name appears on the balloting unit.

IV. PROPOSED SYSTEM

The Proposed System is a biometric fingerprint-based voting system This enables everyone to vote from any location. The technology allows voters to vote from anywhere in India, from any authorized polling station.

A combination of software and hardware in this system. Xilinx Spartan 6 FPGA board, 16x2 LCD screen, Fingerprint Scanner R307 module, ESP 8266 are hardware devices. FPGA stores the information in its memory.

A. Authentication using R307 Fingerprint module

Fingerprint enrollment and fingerprint matching are the two stages of the fingerprint processing technique. The user must place his or her finger on the finger-print sensor twice during the enrollment process. Based on the processing results, the system validates the two-time finger image and build a finger template, which will be saved in the fingerprint module's database. While voting, the voter needs to place their finger for biometrics and after authentication, voter can cast the vote to their favoured party..

B. System Architecture

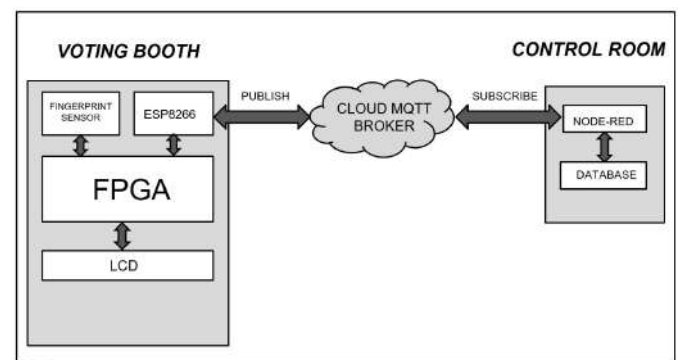


Fig. 1: Block diagram of the proposed system

C. Enrollment process

In enrollment process, first the voter enters a unique UserID using the push buttons of FPGA. Then the system will ask for FingerID which user has to set using the DIP switches of FPGA. Then system will transmit the user's data to the control room and check whether the details are unique. If the details are unique the control room sends the acknowledgement to the FPGA and hence the system will ask for the fingerprint image. Then the user has to set the constituency using the

push buttons. Then the final user data is sent to the control room and the data is updated in the MySQL database using Node-Red.

D. Voting process

This voting procedure is very similar to how we vote in our country. The user first enters his UserID and then scans his finger with the Fingerprint module. The data is then checked in the control room's database. If the fingerprints do not match, the voter is deemed ineligible and the procedure is terminated. If the entered fingerprint matches, the voter's status, i.e. whether he or she has previously voted, is checked. When all of these requirements are met, a voter is valid and eligible to vote for the parties of the constituency in which he was enrolled. The voter's vote count and status are then updated in the database.

V. RESULTS AND DISCUSSION

We designed and interfaced various components using Verilog for the implementation of this project. The testing of each component was done individually by generating a testbench for the same and interfacing them according to the need of the effect.

A. Design of EVM on PCB

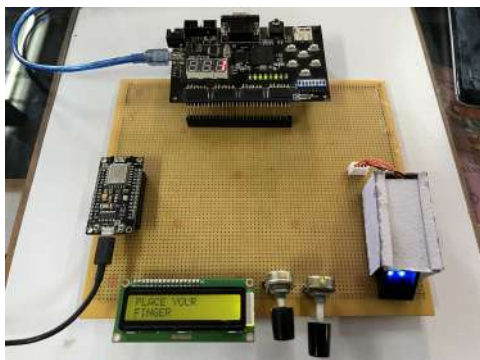


Fig. 2: PCB design of EVM

B. Dashboard of EVM on Node-Red

In order to verify the number of voters enrolled and voted we have used Dashboard in Node-red.

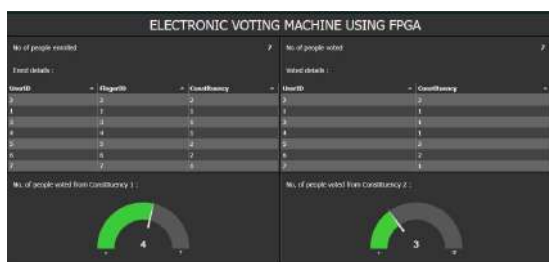


Fig. 3: Dashboard for Voting Machine present at the voting booth

The following result is final election result that will be only displayed in Control Room.



Fig. 4: Dashboard at Control Room

VI. CONCLUSION

A concerted attempt was made to make India's voting system more robust and efficient, so that it would be appealing to all types of citizens. The key issue of the entire operation was security. With the addition to biometrics authentication, which makes it safer, ensuring that no one can commit fraud while voting. We can observe that with smart voting system, the time taken after voting process is considerably reduced as the results is sent to the server directly which means that there is no need to take the machine to the election commission. This allows us to save time and avoid having to transport the machine. To summarize, this proposed model will upgrade the voting system's reliability and security. It is favored in comparison to the traditional ballot-paper voting method. In a developing countries such as india, where the government is attempting to integrate technology into each element of the nation 's development, the voting system is an effective place to incorporate modern technology like this, which allows the general public to elect their right representatives in a more intelligent and secure manner.

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MRI based Classification and Segmentation of Brain Tumour using Deep Learning

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Abstract: Brain tumour is a severe cancer caused by uncontrollable and abnormal growth of cells in the central nervous system. Patients suffering from glioblastoma which is a lethal type of cancer, have a very low survival rate as compared to other types of cancers. In this project, the classification of brain tumours into benign and malignant categories and the segmentation of intra-tumour glioblastoma using Deep Learning approach is experimented. Convolutional Neural Network (CNN) is used to categorize the brain MRI images into benign and malignant tumours and the U-Net architecture is used for intra-tumour segmentation of glioblastoma images. The developed model provides a classification accuracy of 76.38% and a Dice similarity coefficient of 0.9905 for segmentation. This work will be helpful to radiologists in detecting and outlining the spread of the disease.

Index terms: Magnetic Resonance Imaging, CNN, UNET, Confusion matrix, Temperature-based color coding, Rectified Linear Unit (ReLU), Feature maps etc.

I. INTRODUCTION

The fundamental clue in image segmentation is edge information in image processing. Unfortunately, it cannot achieve a higher result in image content analysis without adding other data. To improve the effect of segmentation, many studies integrate edge information with additional approaches. [1] [2] [3].

X-rays and magnetic resonance pictures have become indispensable techniques for detecting tumours in the brain and other regions of the body. [4][5]. Although MRI is more expensive than X-ray inspection, its application development is faster since MR inspection causes less harm to humans than X-ray inspection. Medical image segmentation offers the considerable advantage of revealing intriguing traits prior to analysing symptom states. [7]. Magnetic resonance imaging segmentation of brain tissue is also critical for detecting the presence and outline of tumours. However, because the intensity distributions of healthy tissue, tumour, and surrounding edoema overlap, tumour segmentation becomes a difficult task. To improve the segmentation impact, we leverage the layer differentiation feature of brain MRI. [8].

II. LITERATURE SURVEY

The edge and contrast of X-ray or MR images are frequently weakened, resulting in a damaged image. As a result, the initial stage of image processing for this type of medical image is to increase image quality. Many researchers have developed some effective algorithms about it [2] [5] [9].

For tumour detection, we used a CNN-based detection approach. For deformed pixels, however, an edge-based technique is employed to determine image boundaries and discontinuities. [5]. Following the improvement of picture quality, the next stage is to choose the interesting items or particular sections from the images, a process known as segmentation. [15]. It has been subjected to a variety of procedures. The focus of this paper is on MRI-based brain tumour segmentation. [3-5]. For the time being, there are some highly useful methods, such as the mixture Gaussian model for statistical classification of global intensity distributions, texture analysis, neural networks, and elastically fitting borders [7],[4]. An atlas prior was used for initialization and also for geometric constraints in an artificial segmentation of MR images of normal brains using statistical classification. [12][14]. Even so, due to overlapping intensities with normal tissue and/or substantial size, brain tumours are challenging to describe using forms.

Exact tumour border detection: The CNN model outputs the normalised bounding box coordinates, which are in relation to the low-resolution pictures (128x128). After recognising the tumour region's matrix, it's mapped to the image's original resolution (512x512) to determine the estimated malignant tumour area. [10]. Despite the fact that the system architecture has so far been able to identify a tumour region with a high Dice Coefficient (DSC), the model provides an estimate of the actual position and area of the invasive tumour.

III. PROBLEM STATEMENT

A To develop a Deep Learning algorithm for efficient classification and segmentation of Brain tumour using MRI scans that is accurate at high pace, reliable and cost efficient. To develop a training schema that enables high-resolution segmentation with a limited memory budget and is consistent in delivering highest information and to

provide the surgeons with layered Segmented image of the brain tumour for better accuracy of tumour location. At present, brain tumours are detected by imaging only after the onset of neurological invasion, there are many techniques for brain tumour detection [15]. Furthermore, the tumour's position within the brain has a significant impact on the patient's symptoms, surgical treatment options, and the possibility of receiving a clear diagnosis. The CNN approach was used to detect brain tumours.

IV. THE PROPOSED SYSTEM

The algorithm's first step is to identify the brain tumor's location. A CNN-based method for tumour classification and segmentation is proposed in this study. It was able to achieve a similar degree of classification accuracy using the method provided with a relatively simple design employing only two convolutional layers and a smaller number of kernels [8-9]. The first model was also expanded to predict the likelihood of a malignant tumour with a 93.2 percent specificity. Furthermore, the suggested method is capable of extracting tumour mask with great precision. The majority of detections based on CNN segmentation are focused on non-medical applications. The prospect of using CNN in medical imaging is also explored in this research.

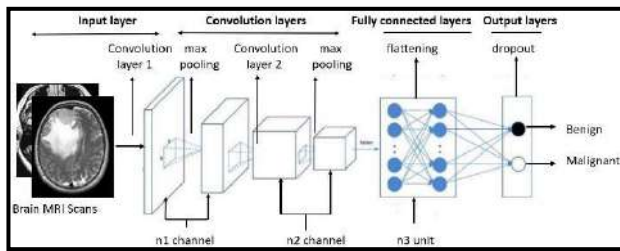


Fig. 5.1 Block diagram of CNN based proposed system

A 33-sliding window passes across the feature map at the CNN's last layer, mapping to a lower dimension. The main goal is to look for each site in the final feature map that is focused on the region of interest. Each zone specifies the location's coordinates as well as whether or not an object is present. Every time a negative number appears, the Convolution Neural Network replaces it with a zero. This keeps the CNN mathematically valid and real.

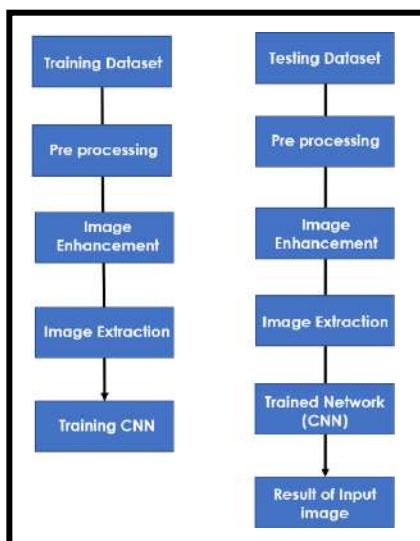


Fig. 5.2 Flow of CNN processing

A feature's match to an image layer is calculated in CNN by multiplying each pixel in the feature by the value of the image's corresponding pixel [8]. We continue this approach to complete our convolution, aligning the feature with every conceivable image layer.

We take the result of each convolution and create a new two-dimensional array based on where each layer is in the image [12]. This filtered version of our original image is likewise a map of matches. It's a map of where the feature appears in the image. Pooling is a technique for reducing the size of huge photographs while keeping the most critical information. [14]. It involves moving a small window across a picture and extracting the greatest value from each step. In practice, a 2- or 3-pixel wide window with 2-pixel steps works nicely. [6],[17]. A tumour mask with a high accuracy level is required to identify the dissemination of the particular tumour [4]. The first step in interpreting an image is to pre-process it. Pre-processing approaches, in general, aim to minimize the artefacts generated by the imaging modality. [1],[19]. In general, noise removal and contrast enhancement are two pre-processing approaches that can be used in image segmentation. To decrease noise and artefacts, the resulting grayscale MR images were median filtered in this study.

V. DATASET USED

There are 241 MRI images of patients with positive malignant brain tumours and 85 images of patients with benign brain tumours. All of the photos have a resolution of 240 x 240 pixels. For the segmentation method, a tumor-oriented data set was acquired from IBSR & BRATS 2015. Pixel intensity-based features, calculated pixel intensity-based features, and edge and texture-based features are the three types of features. A single image, a volume data collection, a multispectral data set, or a multimodal image set can all provide intensity values. Pixel intensity-based characteristics are extracted in this tumour detection approach. In many biological applications, a minimal number of objects must be found; nevertheless, small datasets are frequently available, class imbalance exists, and very good identification quality and robustness are required. [3],[7]. Although the experiment was conducted on a limited dataset, the results demonstrate that our model's accuracy result is quite successful, with a rate of 76.38 percent. To achieve dense prediction in hidden layers of CNN (convolutional neural networks), architectures such as EffNet or U-Net have been frequently utilised to increase efficiency and accuracy [1]. It provides a great deal of freedom and practically limitless possibilities for manipulating and processing MRI scans. In comparison to existing pre-trained models, our model requires extremely less processing power and produces far superior accuracy outcomes. This data collection includes tissue that is affected by tumours as well as tissue that is not affected by tumours. The training dataset is used 50% of the time, 30% of the time for testing, and 20% of the time for validation.

Table 1: Datasets before and after augmentation

Features	Database	Training Set	Testing Set	Validation Set	Benign/LGG	Malignant/HGG
Classification	MRI-Brain images (326)	163	98	65	85	241

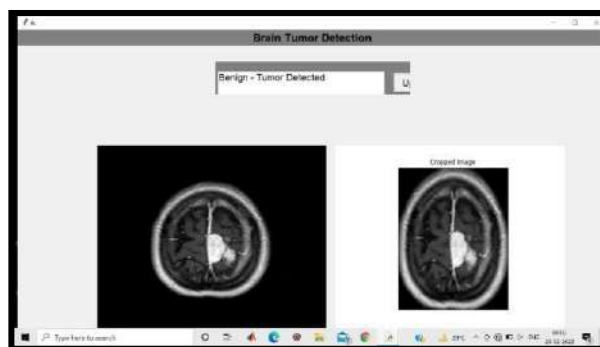
(a) before Augmentation

Total no. of Images	Training(70%)	Testing(15%)	Validation(15%)
2055	1145	310	310

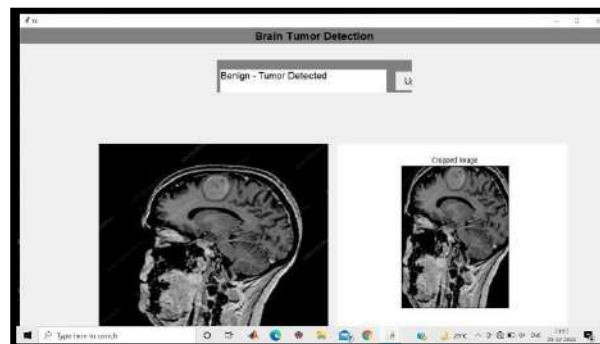
(b) after Augmentation

Data augmentation expands the amount of data that may be utilized to train a model. Deep learning models frequently demand a large amount of training data, which is not always available. [7]. Flipping is the process of rotating an image vertically or horizontally. This is accomplished by rotating the image to a specific degree, shearing or shifting one section of the image like a parallelogram, cropping the object appearing in various spots in the image in various proportions, and zooming in and out. [5].

VI. RESULTS FOR CLASSIFICATION

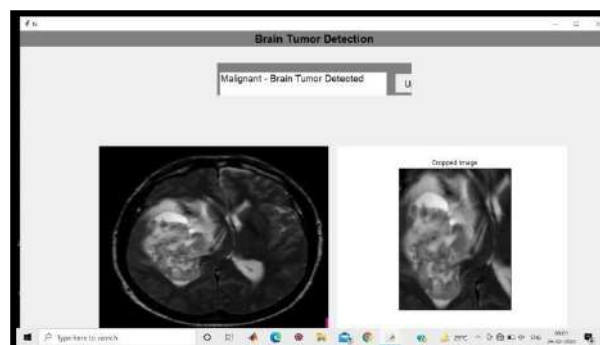


(a)

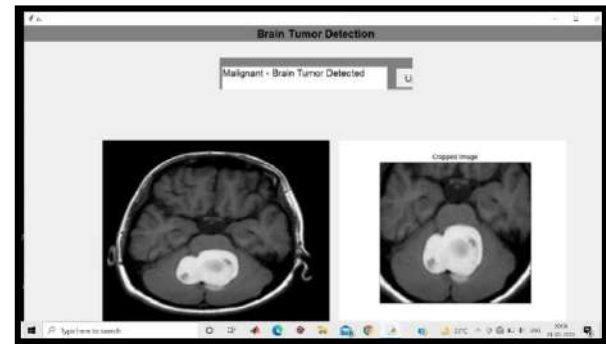


(b)

Fig 7.1 Classification of Benign tumours using CNN



(a)



(b)

Fig 7.2 Classification of Malignant tumours using CNN

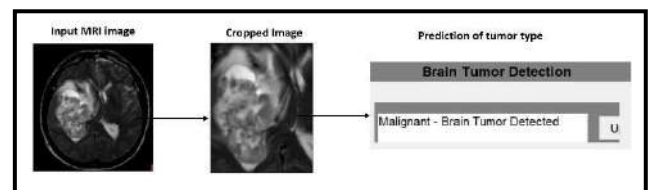


Fig 7.3. CNN Implementation

Detection techniques use the variations in grey tones in the images to translate them into edge images. The edge detection achieved from CNN is obtained using Adam Optimizer and Sigmoid activation function. [4],[3]. The operators determine the direction of intensity changes by calculating the gradient of image intensities at each pixel position. As a result, current data is supplemented in order to produce a more comprehensive model.

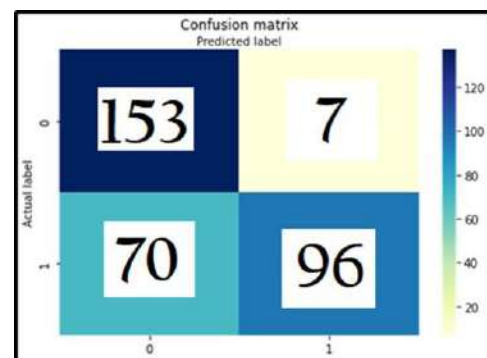


Figure.7.4: Confusion matrix of Benign and Malignant tumour.

Finally, we added a fully connected dense layer of 256 neurons to the output layer, which calculates the probability score for each class and classifies the final decision labels as malignant or non-cancerous in Malignant or Benign, respectively. [12]. Furthermore, the suggested method can extract tumour mask with great precision. The ability of CNN to learn progressively complex features from the input for the classification task is its most appealing feature. [1],[7].

Parameters	Accuracy (%)	Precision (%)	Recall (%)	F1 score (%)	Specificity (%)
Values obtained	76.38	95.6	68.6	79.26	93.20

Table 2: Results obtained from Confusion matrix

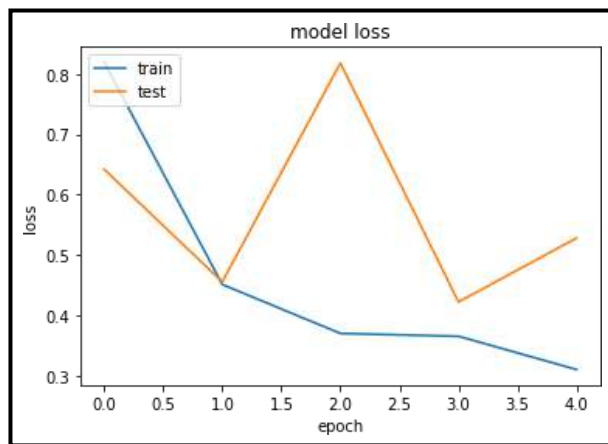


Figure.7.5: Model loss

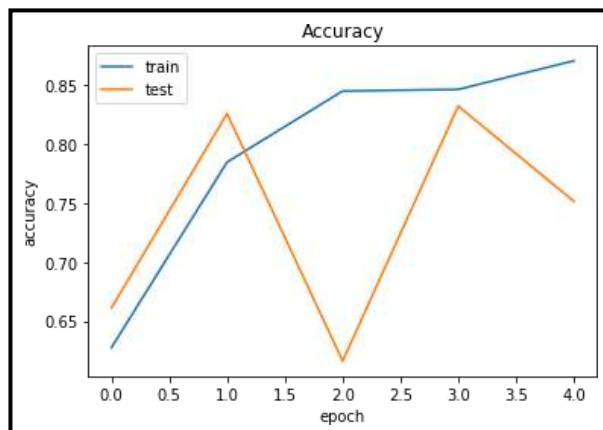


Figure.7.6: Accuracy

VI. CONCLUSION

All of the classifiers in the described system have an average accuracy of 76.38 percent. Furthermore, ground truth demarcations are used to ensure that the segmentation procedure is accurate, supporting the Neurologist. The automated procedure for T2-weighted and Flair-weighted MR images of diverse planes, such as sagittal and coronal plane slices, could be generalized in the future. As a result, the suggested system will give additional diagnostic help to healthcare facilities that have a limited number of skilled personnel and resources.

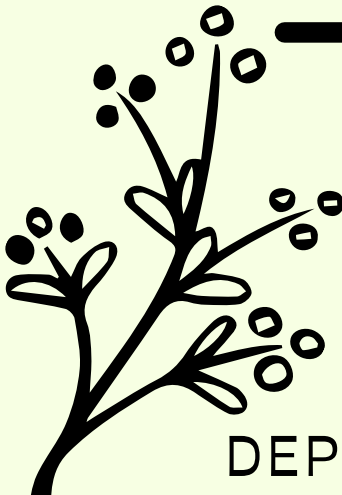
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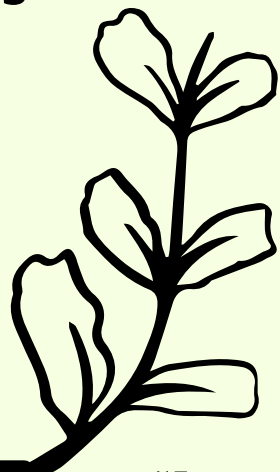


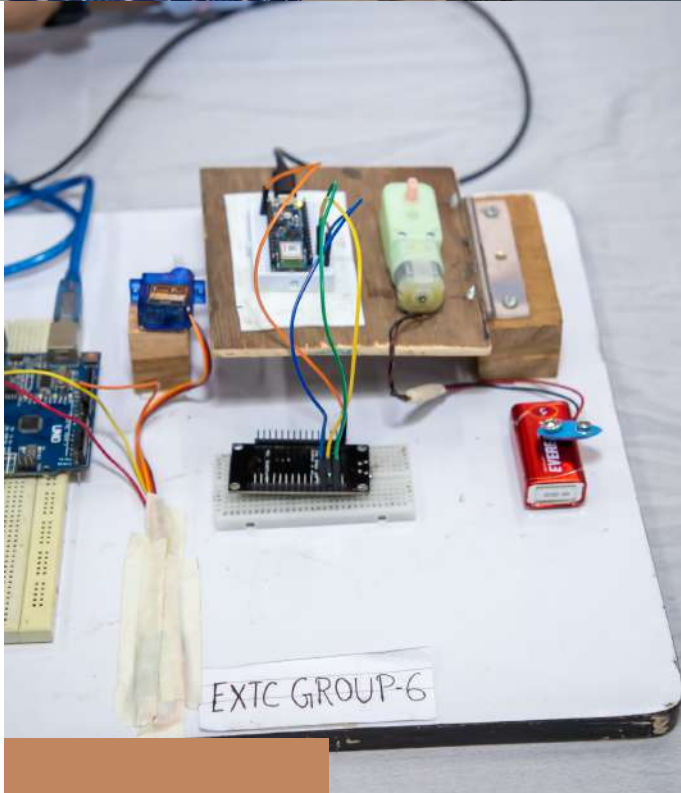
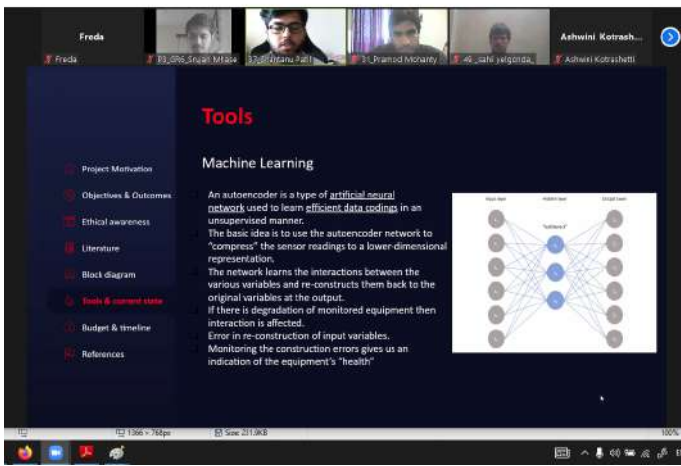
DEPARTMENT OF ELECTRONICS &
TELECOMMUNICATION
ENGINEERING

COLLABORATION PROJECTS

Two Projects with IIT (BHU)
&
One with QDNet Technologies

AY 2021-2022





HOME AUTOMATION SYSTEM

Preeti Rajpure, Rushali Kadam, Sakshi Gadekar, Ankita Kadam, Under the guidance of Ms. Aparna Telgote.

Abstract—For several years, the Internet of Things (IoT) has sparked interest, with both start-ups and established corporations betting on the industry's growth. IoT has proven critical in linking items to the internet, in addition to business solutions. As a result, communication between the connected devices is possible. The Security Sector is one of the most important application segments of the Internet of Things framework. It's critical to find a one-of-a-kind, low-cost solution to avoid theft and safeguard the safety of family members. The Internet of Things (IoT) Layered Architecture-based design technique aids the system designer in distinguishing system component needs at various layers. The model-driven development methodology for ThingSpeak-based Security and Automation is highlighted in this project. It makes a point about

I. INTRODUCTION

More than 10 percent of cloud-based appliances and applications do not exchange data. The Internet of Things (IoT) is a technology that allows devices to communicate with one another. The Internet of Things is a communication standard that refers to the concept of linking common objects to the internet. These objects are built with microcontrollers, transceivers for communication, and protocol stacks that allow the items to interact with one another to achieve common goals without the need for human intervention. This pattern's strength originates from the fact that it interacts with a wide range of devices that generate data, including robots, drones, heating, and air-conditioning systems, security alarms, domestic appliances, power generation systems, office equipment, and so on a vast amount of data in order to give innovative services to the public and private sectors Every year, new management and energy difficulties emerge as the school expands. Managing campus resources has become a major issue. Another key limitation is the inability to monitor and control the unused devices that drain power while humans are not present. Furthermore, when the population of people using the space exceeds a tolerable threshold, organizing the people engaging in the laboratory's daily activities becomes difficult. Power management is another issue. It's challenging to keep track of all subsystems, including lighting, projection, and air conditioning. However, if these are not done in a methodical manner, energy would be lost. People are unable to check on the state of a self-contained unit. With ease, you can create a system within a larger system. IoT technology is an appropriate way for resolving these issues. IoT-enabled smart devices can easily replace long-established systems inside a bigger system. IoT technology is an appropriate way for resolving these issues. IoT smart devices can be utilized to replace long-established systems.

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II. PROPOSED METHODOLOGY

1. This project uses ESP32 Cam Board microcontroller.
2. The ESP32 Cam Board is used to detect and capture face.
3. The captured face will be processed for recognition. If someone whose face is registered in the system then the door will open automatically for them.
4. For faces that aren't registered; and intruder alert label will be added to their face.
5. Live streaming can be viewed over server IP along with real time face detection and recognition.
6. For unregistered person the user can select whether the door should be opened or not.
7. Along with this, another device can be automated.
8. For e.g., lights fans ac etc. can be switched on or off using ThingSpeak API.
9. Android App is developed for this purpose.

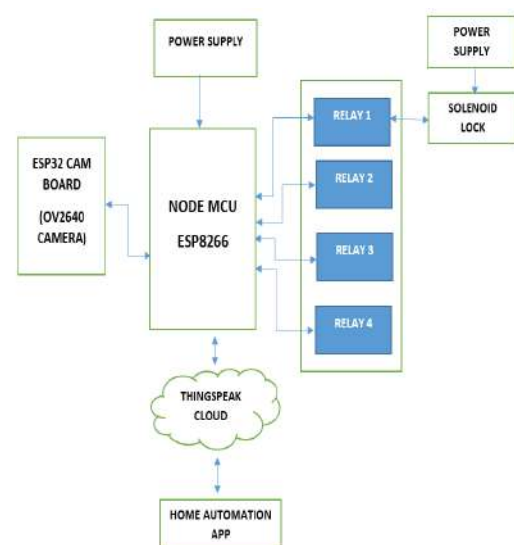
App Implementation

App implementation using Kodular

Kodular: Kodular is an online site for mobile app development. It mainly provides a free drag-and-drop Android app creator without coding, based on MIT AppInventor. It brings lots of new features like new components and blocks.

III. DESIGN IMPLEMENTATION

A. Block Diagram

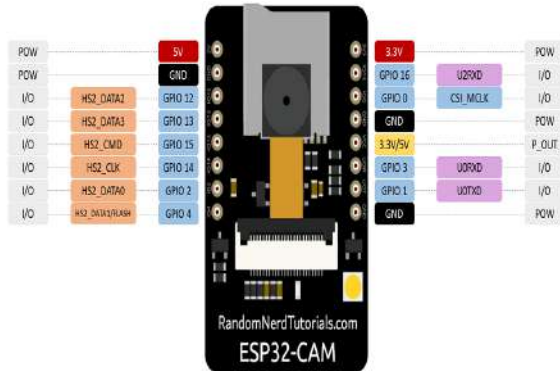


Block Diagram

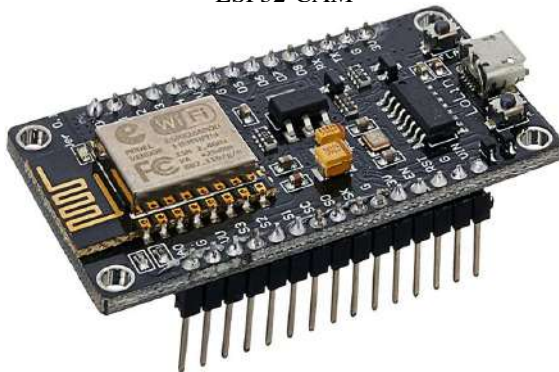
Figure shows the block diagram of "Home Automation System". Hardware used in the block diagram are ESP32

CAM Board,4 Channel Relay Module,Node MCU ESP8266, Solenoid Lock, Thing-speak cloud, Home Automation APP.

1) Hardware Used:



ESP32-CAM



ESP8266-NodeMCU

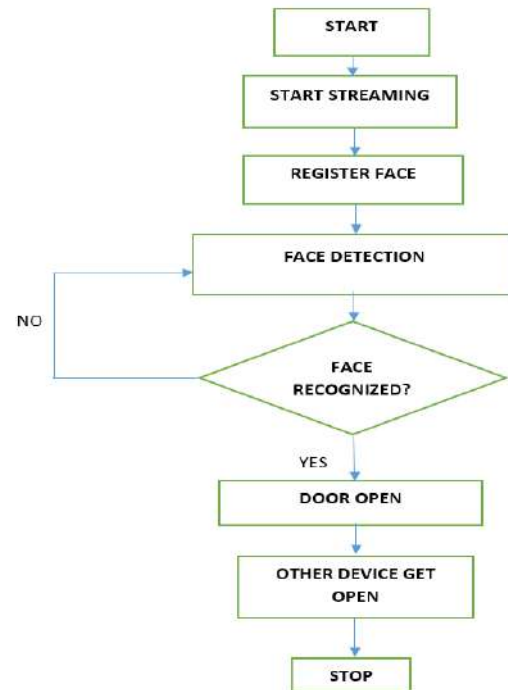


4 Channel Relay Module



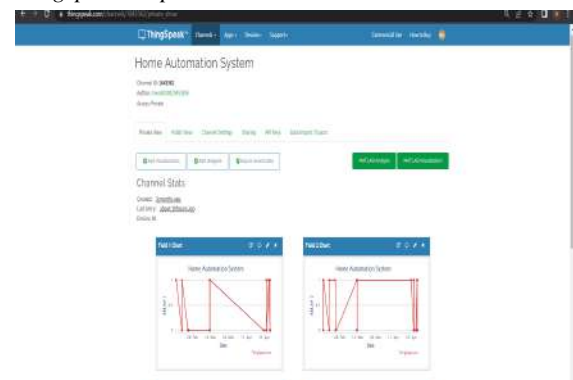
4 Channel Relay Module

B. Flow Chart



Flow Chart

C. Thingspeak Implementation

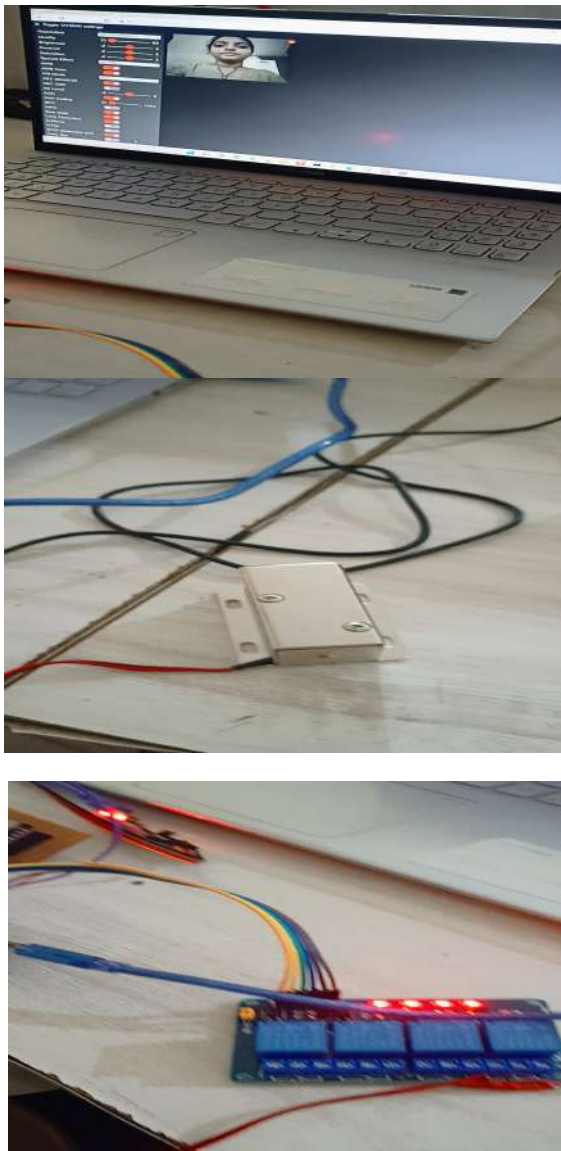


ThingSpeak Cloud

According to its creators, "ThingSpeak is an open-source Internet of Things (IoT) application and API for storing and retrieving data from things over the Internet or via a Local Area Network using the HTTP and MQTT protocols." ThingSpeak allows you to build sensor logging apps, location tracking apps, and a social network of things with status updates." ThingSpeak was originally launched in 2010 by ioBridge as a service to support IoT applications. ThingSpeak has integrated support from MathWorks' numerical computing software MATLAB, allowing ThingSpeak users to analyse

and visualise data. Visualize uploaded data in MATLAB without purchasing a MATLAB licence from MathWorks. MathWorks, Inc. is a close partner of ThingSpeak. All ThingSpeak documentation is integrated into MathWorks' MATLAB documentation site, and registered MathWorks user accounts can be used as valid login credentials on the ThingSpeak website. ThingSpeak.com's terms of service and privacy policy are between the agreeing user and MathWorks, Inc. ThingSpeak has been featured in articles on maker websites such as Instructables, Codeproject, and Channel 9.

IV. PROJECT OVERVIEW



V. ADVANTAGE

1. Easy to use with low power requirements.
2. Live Streaming with face detection and face recognition proves to be an important feature for security aspect.
3. Automatic door lock along with automation of any

device simplifies the task of user.

4. Can be used from anywhere in the world.

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A project is a teamwork which involves the contribution of many people. We would like to thank everyone who have contributed by taking interest in our work and motivating us all the way through. Our sincere thanks to our project guide Prof. Aparna Telgote, for motivating, co-operating and guiding us throughout the project work, with his effective skills and huge knowledge base. We would like to thank Dr. Ashwini Kotrashetti, Head of Department and Ms. Freda Carvalho, Project Coordinator for their continuous valuable guidance, support, suggestions and their precious time in every possible way through-out the project activity.

CONCLUSION

In this project, we are designing an advanced automation system with a surveillance system that reduces the majority of human interactions by supporting this system with the Internet of Things (IoT) and Artificial Intelligence (AI) using ESP32 microcontrollers. Finally, it is unquestionably a cost-effective system. It is possible with the help of a cloud server and Thingspeak, it is linked to various other options such as face recognition and registration for a door lock system. Additional fingerprint applications can be added to the project listed below.

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Age Progression and Regression using cycleGAN

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Abstract—Face detection and face related processing are emerging areas of research in computer vision and is rapidly growing topic of large interest. Facial age progression and regression is one of such interesting new generation application. Automatic age face generation has become an important subject of study in recent times. Over the past decade, researchers have been working on developing face processing algorithms to tackle the challenge of producing realistic aged faces for applications related to smart systems. In this project, age progression and regression based on faces is achieved using Cycle Generative Adversarial Neural Network (CycleGAN). CycleGAN is a variant of the GAN architecture in which generator and discriminator pairs are used. The developed approach used to generate images with effects of face aging and rejuvenation. The dataset we have used is the UTKFace dataset which is readily available for use. It is a unpaired face dataset as there was no dataset for the same person in different age categories. The methodology is tested subjectively and objectively for the accuracy of the age progression and regression.

Index Terms—Age progression, Age regression, Face Aging, CycleGAN, Rejuvenation, UTKFace dataset, deep learning, computer vision.

I. INTRODUCTION

Age progression and regression is a useful tool for predicting how a person will look at various ages. Face ageing and rejuvenation, also known as face age progression (i.e., predicting future looks) and regression (i.e., estimating previous looks), tries to generate face photographs with or without the "ageing" effect while yet preserving personalised elements of the face. For illustration, the age progression/regression faces of three different persons are shown in figure 1.

An increased research activity in the area of facial aging simulation is recorded in the last two decades. Its applications range from social security to digital entertainment, such as cross-age identification and face age editing. Human trafficking victims are increasing at an alarming rate, with armed organisations and terrorists trafficking women and children. According to Bachpan Bachao Andolan, Missing Children of India [9], approximately 96,000 children go missing in India each year. For law enforcement organisations searching for missing children, the Automated Facial Recognition System (AFRS) is becoming increasingly popular. The Indian police department in New Delhi has successfully tracked and identified approximately 3,000 missing youngsters using this technology [9].

Prototype-based methods and physical model-based methods, which are traditional face ageing approaches, are utilised

for face age progression and regression. Physical model-based approaches use parametric or non-parametric learning to represent the biological pattern and physical mechanisms of ageing, such as muscles, wrinkles, and face structure. However, in order to better mimic the delicate ageing mechanism, a big face dataset with a wide age range (e.g., from 0 to 80 years old) of each individual will be required, which is extremely difficult to get [2]. Prototype-based techniques, on the other hand, frequently divide faces into age groups and use the average face of each group as its prototype. The ageing pattern is then defined as the difference between prototypes from two age groups. All prototype-based approaches employ group-based learning, which necessitates the use of the true age of testing faces in order to pinpoint the transition state, which may not be practical. Deep learning-based systems, on the other hand, can deal with a larger and more complicated dataset as research progresses. In the field of face ageing, deep learning algorithms have demonstrated promising results. [6]

II. BACKGROUND WORK

GAN-based models have achieved impressive results in performing age progression and regression simultaneously. For the two processes of age progression and Regression, many proposed the use of two pair of generators trained on the patterns of facial changes and application to simulate these opposite processes of aging and rejuvenation. Further development involving the introduction of spacial attention modules [1] allowed the model to focus only on the areas relevant to the age transformation. Due to this the generative models can be more focused on the regions of interest and not be distracted by the environmental factors or complex structures. Quantitative evaluations for the age transformation accuracy and identity preservation was done and also the error between images of actual age and generated images can also be obtained.

Comparisons among the frequently used image-to-image translation GANs which are CycleGAN (Cycle-Consistent Adversarial Network) and AttentionGAN (Attention-Guided Generative Adversarial Network) can be done to analyse their working and advantages [6]. AttentionGAN consists of attention masks and content masks multiplied with the generated output in one domain to generate a highly realistic image in another domain. Whereas CycleGAN consists of two generators, two discriminators, and does not require a paired image dataset to convert a image from one domain to another. Our project will be making use of the cycleGAN approach as it has a better

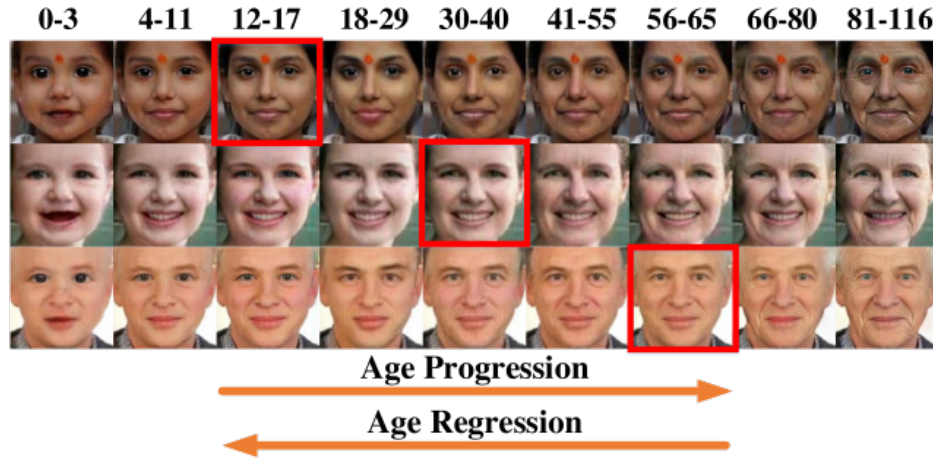


Fig. 1. Age Progression and Regression Example [1]

overall performance. CycleGAN may require many hours to train on different age groups and its Efficiency can be evaluated through different image quality assessment metrics for identity preservation and qualitatively through surveys and study on generated images.

Face aging can be approached by two methods one is Group-GAN based method on age groups other being the Face Aging GAN (FA-GAN) that does not require predefined age groups[10]. Satisfactory face aging can be obtained by pairwise training CycleGAN over age groups. A variant of CycleGAN which contains a pre-trained age prediction model can also be used which works better for smaller age differences.

We would like to approach this idea of GAN to create a neural network which gives us a age progressed as well as regressed image of the given input image as accurate as possible. Basically our main motive in the model will be to identify the features of the input image, understand the actual age features of the image and then pass it through the face aging model and try to maintain the same features of the image with the progressed or the regressed image output as per the requirement. We can understand it with the block diagram in figure 2.

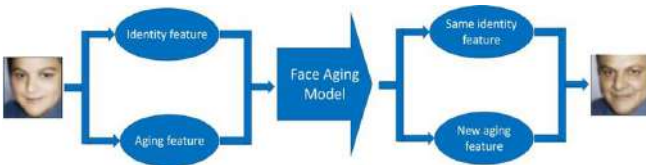


Fig. 2. Basic Block diagram of face aging model [12]

III. PROPOSED METHOD

Our face ageing and rejuvenation method is based on Cycle-GAN which uses two generators and two discriminators. The working of a GAN is explained in subsection A which explains working of generator and discriminator. In subsection B we present our approach for age progression and regression using cycle-GAN.

A. Generative Adversarial Networks

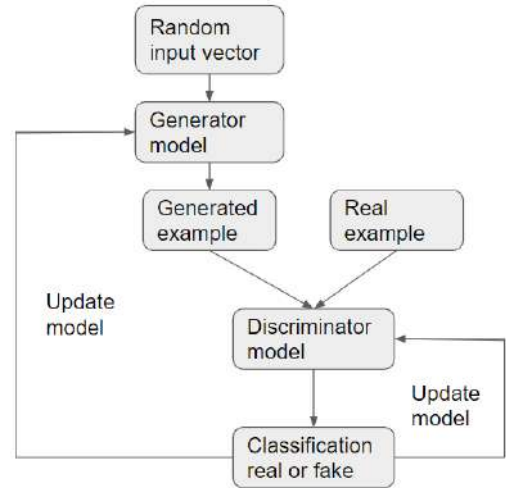


Fig. 3. General block diagram of GAN

GANs are a clever technique of training a generative model that frames the task as a supervised learning problem with two sub-models: the generator model, which generates new examples after training, and the discriminator model, which classifies examples as real or false. The generator and discriminator are trained jointly, with the generator attempting to deceive the discriminator by producing as precise an output as possible, and the discriminator being trained to catch the generator. The generator creates a batch of samples, which are fed to the discriminator, along with real instances from the domain, to determine if the inputs are real or fake. The discriminator is then updated to get better at discriminating real and fake samples in the next round, and the generator is updated based on how well, or not, the generated samples fooled the discriminator. As shown in Figure 3 a random vector of fixed-length is given as input to generator and generates a sample in the domain. The discriminator model takes an example from the domain as input and predicts a binary class

label of real or fake. The real example comes from the training dataset and the generated examples are output generated by the generator model.

B. Cycle GAN

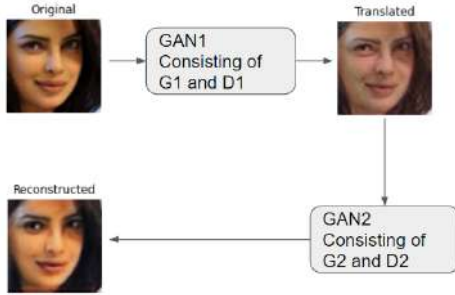


Fig. 4. Block diagram of CycleGAN

CycleGAN is a variation of the general GAN architecture with two generator and discriminator pairs instead of one. It was created to address the issue of requiring a large number of photos while translating from one domain to another. For example, if we want a general GAN to adapt a facial image to seem like its age progressed image, we'll need a large number of tagged facial images and similar age progressed photos. This type of data collecting is not only time consuming, but also nearly impossible because paired photos from different domains are not always available. CycleGAN solves the problem of requiring a tagged picture data collection from both domains. Instead of having a single network for converting from facial image to age progressed image, it has two networks: one which converts input facial image to age progressed image, and another which converts from age progressed image to age regressed image which ideally should look like our input facial image. This is demonstrated in figure 4.

Consider the two generator-discriminator pairs as shown in figure 4 (G1-D1 and G2-D2). G1 turns the input face image into an image that resembles the input image's age progression. D1's job is to figure out whether the image from G1 is an old age image from the dataset or a created age progressed image from the generator network. G1's created image is now transferred to G2's generator. G2's job is to turn the created age advanced image into an age regressed image that looks like our input image. So we take a facial image and transform it to an age progressed image with G1, then to an age regressed image with G2. The task of D2 is then to discriminate the image from G2 as a real image, or a generated one.

The network is then trained using numerous losses later on. We add a cyclic loss to the losses of the two generator-discriminator pairs. When the final image is obtained after passing the input image through both generators, this cyclic loss is applied; the resulting image should resemble the original input image.(i.e. when going from input face image $\rightarrow$ age progressed image $\rightarrow$ age regressed image, the

final age regressed image should look like the original input image). The need that an image translated from one domain to another retain the distinguishing traits of the original domain necessitates the use of cyclic loss.

IV. EXPERIMENTS

A. Dataset

The dataset used by us had face images from from the age 0 to 116 years of different genders and races and the count of the images was 20K and name of dataset was UTKFace dataset. Due to unequal age distribution, varied picture illumination, and image positions, the UTKFace data set is complex and can serve as an excellent benchmark for measuring the performance of the age estimation method[2]. We're just interested with two age groups: face photographs from the 20s and 30s, and face images from the 50s and 60s. Other than these age categories, the remaining facial ages are filtered out. Data from the 20s and 30s was designated A, and data from the 50s and 60s was labelled B. A data label represents a younger age group, whereas B represents an older age group.

B. Results

1) *Training results:* Figure 5 shows the output of our cycle-GAN after 50 epochs. The images in the first row shows age progression of our input (original) image which is shown as translated image, then this image is age regressed to obtain an image similar to original image. For the images in the second row we gave an image of old person as an input (original) image which is translated to an age regressed or an younger image which is then taken as an input for our age progression GAN which gives us an age progressed image which is similar to our input image.

2) *Testing:* After training both GANs we saved the generator weights and used them for testing. We designed a simple GUI which takes an input from user via camera as shown in figure 6 and give age progressed and regressed image of the person. Figure 7 shows the output of our GUI. For front end of our GUI we used basic HTML and bootstrap and for the backend we used firebase. The images which were captured were sent to the firebase and these images were then sent to google colab where we used the GAN generator weights to get an age progressed and an age regressed image. These images were then sent to the firebase and from there it was displayed on our webpage.

V. EVALUATION

A. Qualitative Evaluation

The Qualitative analysis of our project was done using a google form which was sent to people for survey and it consisted of questions that helped us to analyze our outputs. There were few questions which asked to evaluate parameters like similarity of images, age progression and age regression of images. The first and second question consisted of input image and reconstructed image and we asked people to rate the similarity of the two given images on a scale of 1 to 10. The

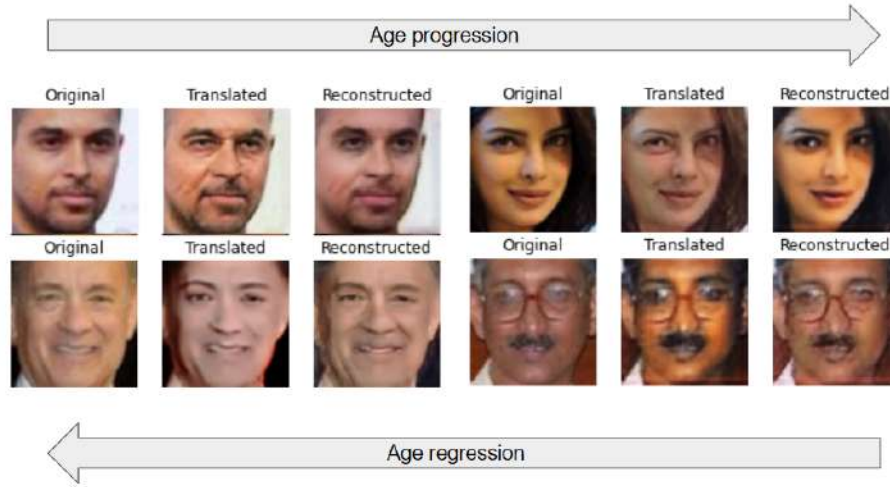


Fig. 5. Output of Cycle GAN



Fig. 6. Input GUI webpage

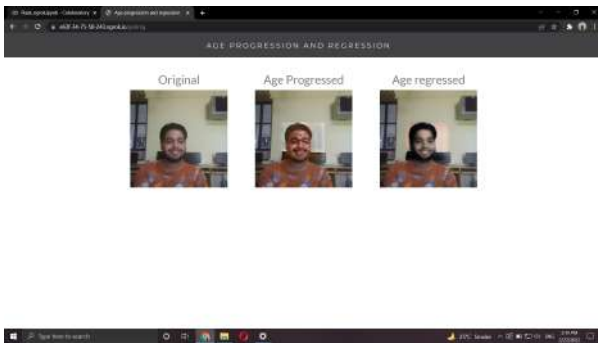


Fig. 7. Output GUI webpage

next questions consisted of input image and age progressed image, where we asked people whether second image looked somewhat older than first, and asked to give rating on it. Similarly, we also asked questions about input image and age regressed image, where we asked people whether second image looked younger than first, and asked to rate it on a scale of 1 to 10.

B. Quantitative Evaluation

In image fusion techniques and applications, such as duplicate product detection, picture clustering, visual search, change detection, quality evaluation, and recommendation tasks, image similarity measures play a significant role.

The age progression element of our project is represented by our cycle GAN, which changes an image of a human in his 20s to his 50s and then reconstructs it back to his 20s. Similarly, cycle GAN also converts an image of a person who is in his 50s to his 20s and reconstructs it back to 50s, this is the age regression part of our project. So we used some mathematical parameters to analyze the reconstructed image. These parameters help us to prove the similarity of input and reconstructed image mathematically. The parameters which were used to evaluate our input and reconstructed image are:

- Root Mean Square Error (RMSE)
- Structural Similar Index Measure (SSIM)
- Feature Similarity Indexing Method (FSIM)
- Universal Image Quality index (UIQ).

TABLE I
AVERAGE OF THE AGE PROGRESSION PERFORMANCE METRICS

Performance metric	Average value
RMSE	0.01024
SSIM	0.9455
UIQ	0.5978
FSIM	0.6459

TABLE II
AVERAGE OF THE AGE REGRESSION PERFORMANCE METRICS

Performance metric	Average value
RMSE	0.00742
SSIM	0.9702
UIQ	0.6494
FSIM	0.6663

VI. CONCLUSION AND FUTURE SCOPE

Age progression and regression has been a topic of immense interest and also has many applications which we have addressed in this topic, deep neural networks, such as the use of generative adversarial networks (GANs) for age synthesis, have become somewhat prominent. To train proposed approaches kaggle notebook platform is used. Our method is used to resolve the problem of face aging when we have unpaired image dataset. The proposed approach that is a Face Aging Cycle Generative Adversarial Networks (FA-CGAN) is used to transfer an image from the younger age group to an older age group and vice versa. The main goal of our work is to preserve the original identity of the face as it is. The qualitative performance is measured through the subjective result analysis from 139 people. The quantitative results were obtained in terms of Structured Similarity Index (SSIM) which provided us with fairly good results as a comparison between generated and original images and also different evaluation metrics were determined giving us a satisfactory outcome. As a realtime application of our project we hosted a web-app (GUI) using the generator weights obtained after 50 epochs.

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Liver Tumor Detection and Segmentation

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Abstract—Different deep learning methods are being used for image segmentation. Tumors are detected with the help of various deep learning algorithms to help the radiologists get an accurate segmentation of tumors at a minimal time. The first stage of liver cancer detection is liver tumour identification. The liver segmentation has to be accurate along with its tumor segmentation. The earlier the tumour is detected, the sooner it can be treated for cure. The current techniques of segmentation are time consuming and costly. Therefore there is a need of a new and better technique for segmentation. In this paper, UNET has paperused to segment the HCC lesion from the CT Scan images. This CT Scan image dataset is taken from 3Dircadb-1. The developed algorithm is able to accurately segment the tumor from the Liver. Further the accuracy of the segmentation is tested with the help of various coefficients.

I. INTRODUCTION

The liver is a major tissue in the abdomen of a human body. The liver is the largest organ in the human body it performs over 500 important tasks. The role of the liver includes detoxification, protein synthesis, and the production of chemicals that aid in the digestion of food. It is the largest internal organ of our body and is located in the upper right-hand portion of the abdominal cavity, beneath the diaphragm, and on top of the stomach, right kidney, and intestines. The major functions of liver include: Bile production, supporting blood clots, metabolizing carbohydrates, vitamin and mineral storage, absorbing and metabolizing bilirubin, helps metabolize proteins, filter blood, production of albumin, Synthesis of angiotensinogen, Immunological function and metabolizing fat.

II. MOTIVATION

Liver cancer is the fourth leading cause of cancer-related deaths worldwide. It is the second and sixth most common cause of cancer death in men and women, respectively. For patients with cirrhosis, it is the primary cause of death. Most common liver cancers are hepatocellular carcinomas (HCC). Symptoms for this disease don't appear in the early stages which makes it very hard to be detected. As a result prognosis of survival is very poor for this disease especially for patients suffering from cirrhosis. There are many types cancer one can

have in their liver and most common of it all is HCC which is Hepatocellular carcinoma. HCC has different growth patterns in which some of them begins as a single tumor which then becomes larger and larger and the second type starts as many small cancer nodules throughout the liver not just a single tumor. [10]. Standard treatments used for the diagnosis of liver cancer are: surveillance, Surgery, Ablation therapy, Liver transplant, Embolization therapy, Immunotherapy, Targeted therapy, and radiation therapy. The size shape and location of the tumour is mandatory for starting the treatment. The accurate segmentation of liver tumor is very difficult and very important for treatment, because its features such as shape, size and its location differ among persons. Liver cancer is the 10th leading cause of cancer and 8th leading cause of cancer related deaths in India whereas it ranks 5th and 4th for the same worldwide respectively. There has been 2.6 percent rise in new liver cancer cases in India and a 4 percent rise in deaths. [10]

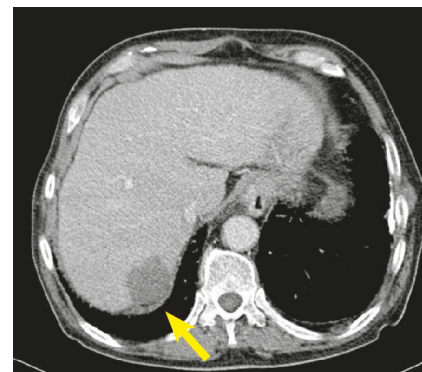


Fig. 1. Liver Tumor CT Scan

III. DATASET

The dataset contains CT scans 1 of 20 patients (10 male and 10 female). This dataset was taken from the 3Dircadb-1. The dataset is a mixture of livers affected with or without tumors. The dataset also contains mask images of every patient. The sample original images along with ground truth mask are as shown in Figure 2].

For the implementation of the project, a model will be created. This model will have 2 parts: 1) Training 2) Testing The training dataset had 408 images out which 26 images

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This paper is a research contribution of students of Batch (2021-2022)
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are used for validation. The remaining 382 images are used for Training. These CT image will be sent through the U-net model. The image will further be processed in which it will be separated from it's background which makes segmentation easier.

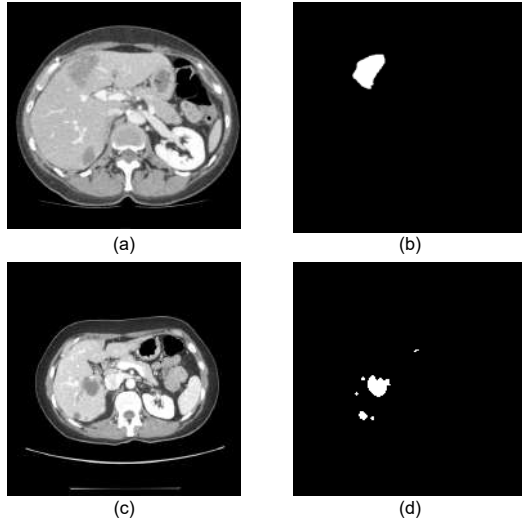


Fig. 2. Sample CT Input Image from Dataset

IV. CONVOLUTIONAL NEURAL NETWORK (CNN)

Machine Learning helps the machine to train itself to become more accurate to predict outcomes. Deep learning is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge. Convolutional Neural Networks is a type of Deep Learning which takes an input image and then is trained to differentiate among it's objects. A convolutional neural network (CNN) is a type of neural networks used in image identification and image processing that is designed to process pixels of data. This is done by using deep learning. A CNN uses a system that has been designed for reduced processing requirements. CNN consists of an input layer, output layer and a hidden layer that includes multiple convolutional layers, pooling layers, fully connected layers and normalisation layers. Because of its high efficiency, CNN is considered to be very effective and simpler to train. An image is just a matrix of pixels, A CNN simply separates an image into different matrices and studies and classifies those different matrices This technique is often used for medical purposes where image processing is required. In this case it is used for detection and segmentation of a Liver and its Tumor. [6]

V. METHODOLOGY

UNET was first designed and applied in 2015 to process Biomedical images. The input and output images are of the same size. U-Net is a convolutional neural network used for biomedical image segmentation. The architecture of this

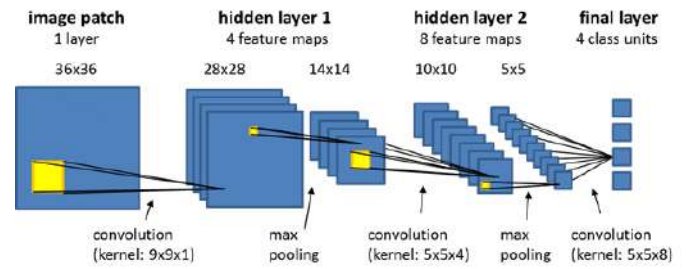


Fig. 3. CNN

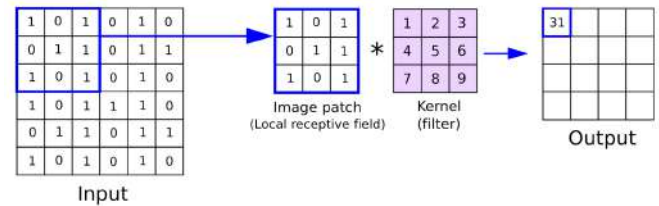


Fig. 4. Convolution

network is as the name itself suggests in the shape of U. The left path is the contracting path whereas the right path is known as the expansive path. Contracting path downsizes the image and the expansive path upsizes it back to it's original size. In the first block, the image of a certain size goes through a convolutional network. Unet consists of an encoder path on the left side and decoder path on the right side. The encoder path consists of repeated applications of convolution in which each is followed by a ReLU (Rectified Linear unit) layer and a max pooling layer. This path reduces spatial dimensions and increases number of featured channels. A convolutional layer is the first layer of Unet which extracts the features from the input layer. Second is the ReLU layer which returns a zero output if its input is negative. Then comes the max pooling layer which does the job of pooling operation by taking maximum number of outputs from the result of the featured maps. After that, the expansive path on the right side combines the featured and spatial information to a sequence of up convolutions. Thus in this way, the whole Unet architecture extracts the important features from an image and brings the input image back to its original size. The Encoder side (left path) consists two 3x3 convolutional layer which is followed by a ReLU layer. This is also followed by a 2x2 max pooling. This path reduces the spatial dimensions thus increasing the number of feature channels. CONVOLUTION LAYER: A convolution layer transforms the given input image with a kernel or filter in order to extract features from it. In this, the kernel is a matrix which is smaller than the image in order to convolve the input image.

RELU LAYER: The rectified linear unit layer returns the same output is the input is positive but if the input is negative then it returns a zero output. This layer is an activation function. In CNN an activation function transforms the summed weighted input from the node into the activation of the node or output

for that input.

MAX POOLING LAYER: This layer does the pooling operation. It selects the biggest element from a given feature map and output of this layer is a new feature map containing the maximum and most important elements of the previous feature maps.

The Decoder Side (right path) consists of upsampling layers followed by 2x2 transpose convolutional path. The upsampling layer simply doubles the input dimensions. Thus bringing the output image back to the size of the original layer. The U-Net architecture is as shown in Figure 5.

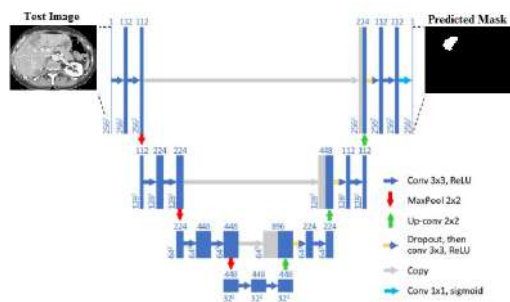


Fig. 5. U-Net architecture

VI. IMPLEMENTATION

In this part, the image are sent through the U-Net model where the model is trained. Training the model improves the accuracy of the output. To achieve more accurate results, large amount of data is needed. Different CT images of different types affected with tumor in different places or not at all affected trains the model well to detect and segment the tumors in the testing images.

The training data will be further segregated to form the validation set. This validation set allows the model to be evaluated before testing. Validation set is the primary test on the trained model which can give important insights on the working and accuracy of the model before the actual testing. The testing images are new new to the algorithm thus testing the model's accuracy. This is used to calculate the model's accuracy. Higher accuracy will result in the model being well trained thus providing a better output. Thus this step predicts the output of the CT image and calculation of it's accuracy can be done. Further there are various matrices available to evaluate a semantic segmentation model such as Jaccard Index, Dice Coefficient, Pixel Accuracy, etc. The implemented model was first tested on Breast Cancer Ultrasound Images. This dataset was taken from kaggle. The dataset was collected in 2018 which consisted on 600 female patients. The ultrasound images were of various types such as normal, benign and malignant. The results obtained for the segmentation were satisfactory and acceptable in terms of accuracy.

VII. CONCLUSION

Identifying the tumor in the earlier stages is a very important step in HCC treatment. As discussed, Liver Tumor segmentation is an important step in HCC detection. Many

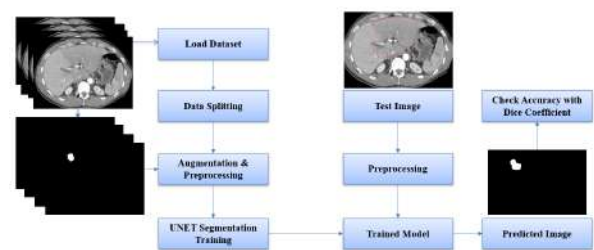


Fig. 6. Flowchart

other methods are very expensive and not accessible for everyone, thus this can be detected through Deep Learning techniques like CNN. This would be an assisting tool for radiologists to detect HCC cells. Many CNN methodologies were learnt and U-Net was finalised as the most efficient one. The proposed method undergoes pre-processing and augmentation before training the model. Thus, U-Net trained model is able to detect and segment the tumor from the liver. Various issues such as different organs present in the abdomen can be a challenge for the model to detect. Thus this report can also serve as a guide for further developments in semantic segmentation researches and be able to use it for practical purposes.

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Capacitive level sensor for water level detection

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Abstract—Water is the basic need and it is one of the most important necessities for all living beings. In many parts of the country water gets wasted due to continuous overflow of tanks. Accurate and error free detection is needed to stop this wastage. For this purpose, capacitor level sensing method is stable and efficient water level measurement method. The project is designed to give level information depending on charging and dis-charging rate of capacitor sensor. The sensor is made of 02 cylindrical insulated pipes, which is of 01 meter height and separated by 0.9 cm distance. When place inside water tank, water goes in between the pipes which changes dielectric properties of the sensor. This sensor is connected to a square wave generator using LM358 IC for getting output frequency changes. Output is processed by Arduino microcontroller which is programmed to detect the change in frequency and shown it in the form of percentage. All the hardware will be placed at the top of sensor pipes. Therefore it consists of no moving components Capacitive level sensors are thought to be the best to have minimum maintenance and high accuracy. This method will help to reduce water wastage in many applications like Overhead tanks, Swimming pools, Nuclear power plants etc.

Index Terms—capacitance level sensor;LM358;Insulated pipes.

I. INTRODUCTION

Water is a basic requirement and one of the most critical requirements for all living things. The water level is assessed using capacitor sensors in this Arduino-based programmable water level detector project. Assume the tank is emptied at beginning, and the Arduino's output is high when the control supply is turned on. Capacitor sensors are used to measure level of water and are connected to Arduino. When the tank is full, the water level is displayed, and the result is connected on the LCD. This water level sensor may also be used in power plants to monitor the water level in the reactor.

II. PROBLEM STATEMENT

In many regions of the globe, water is an important resource, and many people rely on water tanks to replenish their water supply. The purpose of this project is to design, develop a new product and calibrate a capacitive water level sensor that can provide accurate readings with minimal mistakes even when the water is not stationary. This project's purpose is to develop an independent water level detection system based on a capacitive sensor, which will solve the issues of delayed response and frequent contact sensor breakdown caused by

surface coating and corrosion from the aqueous medium that plague existing water level sensors.

III. SCOPE OF THE PROJECT

Level Sensor Requirements:

- It must be capable of measuring the process level within the required range, i.e. 0 to 100cm.
- It should be simple to use with fewer biasing components.
- The required power should be reasonable.
- It should be inexpensive and simple to obtain..

IV. LITERATURE SURVEY

This paper talks about the water level detection system. In this research the Capacitive level sensor is used. By using this method the water level can be measured and detected in the form of percentage.

Water level sensor based on capacitive principle made from two aluminium plates with a specific height, breadth, and distance between them, and an AC signal as the device's input signal. The sensor detects a change in water level, which causes the capacitance value in the sensor to change, resulting in a change in voltage on the output.

The second paper talks about the level monitoring system for water tanks. This paper uses the Ultrasonic sensor and that gives the level of the water in the tank.

The advantages and disadvantages of UMS (ultrasonic measuring systems) are discussed in this study. The study offered a system that is unaffected by external conditions such as temperature, humidity, sensor positioning, water storage containers, and so on. The impact of these external influences on the efficacy of ultrasonic sensors is the major topic of this research. The authors presented a system that comprises of numerous UMS linked to a single Arduino board, reducing the combined UMS system's error and standard deviation.

The Third paper talks about the HC-SR04 Sensor. By using this sensor the water level is measured. The WSN (wireless sensor network) has been employed in the suggested system. The suggested system is based on node Mcu and includes an HC-SR04 distance measuring sensor as well as an ESP8266 wifi module for data transmission to the cloud storage. The information obtained is utilised to monitor the situation in real time. Thingiverse.io is the cloud API that collects the data and plots the graph. Flood-prone locations are taken into account

for real-time flood monitoring and, as a result, preventive steps are conducted.

V. CONSTRUCTION

A capacitive sensor consists of two conducting plates, such as aluminium, that are electrically insulated from one another and separated by a gap 'd', as illustrated in Fig.1. The sensor's plates should have the same height 'h' and width 'b' dimensions.

The capacitance created by the sensor plates may be expressed as follows: the sensor plates' height 'h' and width 'b' should be equal. The capacitance generated by the sensor plates may be expressed as follows:

$$C = \epsilon * A/D \dots (1)$$

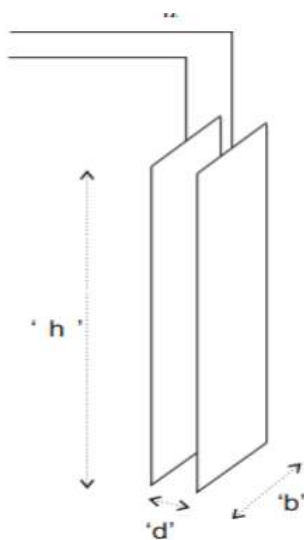


Fig. 1. Construction of Capacitor plates.

$$A = h * b \dots (2)$$

Consider the level of water as 'x' as shown in Fig2. Capacitance 'C' can be given by

$$C = \epsilon * A/b \dots (3)$$

where A is the area of the plate and ϵ is the dielectric constant. Area can be written $A = h * b \dots (4)$ Hence,

where A is the area of the plate and can be written as, substituting the equation (4) in equation (3)

$$C = \epsilon * h * b/d \dots (5)$$

The capacitance sensor functions as two parallel capacitors, one in the water and the other outside.

The effective capacitance can be given as

$$C = \epsilon_0 * b/d * (\epsilon_{air} * (h-x) + \epsilon_{water} * x) \dots (6)$$

where ϵ_0 denotes the permittivity of vacuum, air denotes the dielectric constant of air, and water denotes the dielectric constant of the water to be measured.

As a result, provided the dielectric constant of the water and the capacitance of the sensor are known, equation (6) may be used to compute the water level.

The dielectric constant of several materials is shown in Table I. These are pure material dielectric constants.

TABLE I DIELECTRIC CONSTANT OF DIFFERENT MATERIAL

Sr. No.	Material	Dielectric constant
1.	Air	1
2.	Diesel	2.1
3.	Gasoline	2
4.	Petroleum	2.0 to 2.2
5.	Kerosene	1.8
6.	Transformer Oil	2.2
**7.	Water	80

Fig. 2. Dielectric values for Different material

VI. CALCULATION OF CAPACITANCE

To measure capacitance, we are using LM358 dual op-amp IC which will work as square wave generator for checking capacitor charging dis-charging rate.

The output frequency (F) from the circuit can be given by

$$F = 1.44 / (R_a + 2 * R_b) * C \dots 7$$

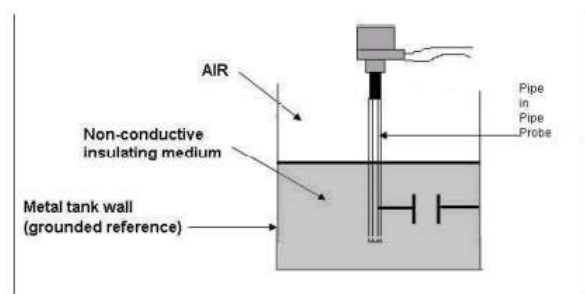


Fig. 3. Construction of the capacitance

A microcontroller may be used to measure frequency (F), and the resistance will be known. As a result, the capacitance value may be computed. As a result, the height of water may be estimated by replacing the value of capacitance in equation 4.

VII. PROBLEMS IN CAPACITIVE SENSOR

Liquid-level sensing using capacitive sensors has its own set of difficulties. It's the same principle as absolute capacitance sensing. The absolute value of the liquid level must be measured, unlike touch detection.

Furthermore, factors like as temperature and the presence of conductive items might have an impact on sensing accuracy. The following are some of the most prevalent elements that influence liquid-level sensing:

1. Drift in temperature
2. The thickness of the tank
3. Viscosity of liquid
4. Concentration of liquid salt
5. Conductive materials

6. There is an air gap between the sensors and the tank.

Drift in temperature:

The most important influence on performance is temperature variations during sensor operation. In contrast to When not being touched by a finger, detecting, the sensor value is tracked over time with finger-activated capacitive sensing buttons to account for any ambient temperature-induced offset. Temperature compensation is particularly problematic in liquid-level sensing applications because we cannot assume that the liquid sensor is not covered with liquid; it might be covered to any level for any amount of time. As a result, we must employ algorithms and specialised sensor designs to correct for temperature variations.

The influence of temperature drift, which affects a variety of parameters in a liquid-level sensor system, is minimised using this method. The capacitance to be measured comes first. Other system characteristics, such as the integrating capacitor and the capacitive sensing engine's current, are affected by drift.

Temperature compensating capacitor that is fixed. A temperature compensation capacitor is a sensor that shares many of the same features as other liquid level sensors. It is, however, not in direct touch with the liquid. In other words, the liquid level must have no effect on this sensor. For the real sensors, the raw count of this capacitor is utilised as a reference.

Thickness of tank:

The thickness of the overlay, which acts as an insulator between the sensor and the conducting substance to be detected, affects sensor response. If the tank thickness is too great, or the difference in signal with and without liquid is too tiny to detect, problems might develop.

The lower the capacitance detected by the measurement device, the thicker the tank. As a result, the signal to work with is reduced. Getting a large signal for a tiny difference in measuring capacitance is one answer to this challenge. It is possible to do this by scanning the sensor with a greater resolution.

When a sensor is scanned at 9 bits and a liquid is present, the raw count increases by 10. When the resolution is enhanced to 13 bits, the sensor is effectively scanned for 16 times longer than before. For the same capacitance sensing range, the signal will be 160 with this resolution.

Viscosity of liquid:

Assume the tank is emptied at this moment. It can be measured accurately. However, for highly viscous liquids, When the tank is drained, the liquid residue left behind will have an influence sensing. It delays the detection of tank emptiness, which can cause problems.

As a result, design compromises must be made in order to attain the greatest results. For comparison, the internal wall of the tank May be made slick and smooth so that the liquid doesn't stick to it so that the liquid doesn't stick to the wall.

Concentration of liquid salt:

The amount of salt in the liquid has an impact on the accuracy of the sensor. The lesser the sensor precision, the higher the salt concentration. The effect of salt content at room temperature is minimal. However, when the temperature rises, the effect of salt concentration rises as well.

Interference from conductive objects:

The liquid detection sensor as well as the temperature compensation capacitor should be kept away from other conductive objects such as people. If there is a conductive item nearby, there is a greater probability of reporting an incorrect result. As a result, appropriate isolation between the sensing circuitry and other conductive items through the use of shields is the answer to this problem.

Between the tank and the sensors, there is an air gap:

Sensing accuracy reduces when the air gap between the sensors and the tank widens. Using proper threshold settings and firmware algorithms, one approach to this problem is to maximise the sensitivity of the sensors and eliminate crosstalk between sensors.

Error in the Positioning:

The inaccuracy in the displacement computation model is examined in this section. The discrepancy between the displacement estimated using the displacement calculation model and the displacement from a reference calibration system is referred to as 'error.' This type of problem is also known as a mapping error. These flaws are caused by systematic errors in the capacitive displacement measurement system, and some of them may be accounted for by adjustments.

VIII. RESULTS

The change in capacitance was observed to be related to the change in water level.

Capacitance	Frequency
0.005	40
0.007	40
0.009	40
0.11	40
0.13	34.25
0.15	29.41
0.17	25
0.19	22.72
0.2	21.72

Fig. 4. Readings

Capacitance vs. the height of water in a tank has been displayed, demonstrating the proportionality of capacitance with regard to the fluid level. Capacitance is also discovered to vary depending on the substance.



Fig. 5. Capacitive Sensor

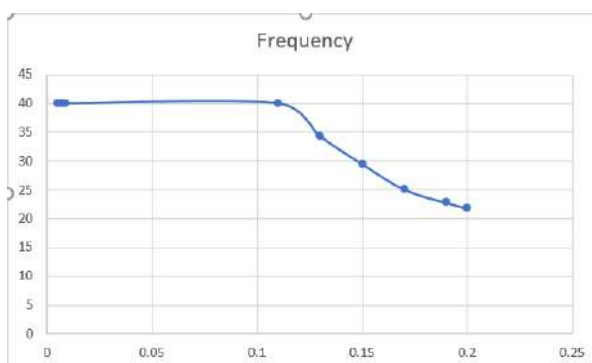


Fig. 6. Capacitance vs Frequency Graph

IX. CONCLUSION

In order to develop this system, a research technique was used, from which a practical circuit was designed. The amount of water in a tank is monitored using a capacitive type sensor in this project. The capacitance of the capacitive sensor varies depending on the level of water between the capacitor's two plates. The capacitive sensor functions as the charging capacitor of the IC LM358 square wave generating circuit, which is used to measure the changing capacitance. This circuit is essentially a Dual OPAMP circuit from which a square wave generator is created. As a result, the water level may be determined using the equivalent capacitance of parallel capacitors equation.

X. ACKNOWLEDGMENT

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Renal Cell Carcinoma Segmentation

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Abstract—Renal cell carcinoma accounts for approximately 9 out of 10 kidney cancer cases all over the world. In RCC, malignant cells are discovered inside the lining of tubules (tiny tubes) within the kidney. The main objective of this paper is to construct a model that represents the correct identification of the spatial location of a tumor. This model relies on U-Net architecture which comprises two paths - contraction and expansion paths that form a U shape. In this work, we have used patient dataset and Kits-19 [4] dataset for RCC. We have implemented a u-net architecture on breast cancer ultrasound dataset which has given the dice coefficient of 0.8272 and jaccard coefficient of 0.9899 and for RCC abdominal CT images results are

Keywords:- U-NET , RCC , CNN , Jaccard Coefficient

I. INTRODUCTION

The most diversified cancer kinds are seen in developing countries, which can be explained by social and economic variables. However, lifestyle has a significant impact on these figures. More than 400,000 cases of kidney cancer were diagnosed worldwide in 2018, according to cancer statistics. The majority of persons diagnosed with kidney cancer were between the ages of 60 and 70, and statistics show that the frequency of asymptomatic kidney tumours is on the rise. The kidneys are located on either side of the spine, within the retroperitoneal space. The left kidney is situated a touch above the proper one, due to the liver on the proper side of the abdomen, above the proper kidney. About one-third of all blood leaving the guts passes into the kidneys for filtration before being pumped to the cells and tissues of the body. When the kidneys malfunction, or if they pack up (kidney failure), it's going to cause various complications like fluid retention which will cause edema or swelling of the extremities, pulmonary edema or fluid within the lungs, hyperkalemia or increased potassium levels within the blood, anemia, heart condition, and pericarditis, among others. Kidney cancer is caused by a number of conditions, including smoking, obesity, and hypertension. Kidney tumours can be classified into two categories: benign and malignant. Renal cell carcinomas (RCC) account for the majority of these malignancies. Renal cell cancer (also called kidney cancer or renal cell adenocarcinoma) may be a disease during which malignant (cancer) cells are found within the lining of tubules (very small tubes) within the kidney.

There are 2 kidneys, one on all sides of the backbone, above the waist. Tiny tubules within the kidneys filter and clean the blood. They remove waste products and make urine. The urine passes from each kidney through an extended tube called a ureter into the bladder. The bladder holds the urine until it passes through the urethra and leaves the body. Symptoms of RCC are blood in the urine, lump in abdomen, pain in the side that doesn't go away, weight loss, loss of appetite and anemia. While kidney or tumour removal was an useful treatment option in the past, thanks to today's sophisticated imaging techniques, preventive treatment is becoming increasingly important. Oncological treatments are not being overlooked, and promising trials focusing on avoiding unneeded procedures are gaining traction. Radiomic analysis and the development of new surgical planning techniques demands accurate segmentation of kidney cancers. Radiologists perform segmentation based on visual evaluation of images obtained through a computed tomography (CT) scan in clinical analysis. This is a time-consuming procedure, and its success is highly dependent on prior expertise. In this study we will be using U-NET architecture.

A. Literature Survey

Daw-Tung Lin et al [6]. proposed a segmentation method with average correlation coefficient up to 88 % on reduced dataset i.e, 258 images from 30 patients. R. Cuingnet et al. [3] reported that 80 percent of the kidneys were accurately detected and segmented with a Dice coefficient less than 0.90 in a few seconds per volume using random regression and classification forests. This method had been validated on a highly heterogeneous database of 233 CT scans from 89 patients. Guanyu Yang et al. [12] proposed a 3D fully convolutional network (FCN) which combines a pyramid pooling module (PPM) using a dataset of 140 patients. The target structures were segmented with high accuracy. The average dice coefficients obtained for kidney and renal tumors were equal to 0.931 and 0.802 respectively. HUI ZHANG et al. [13] developed a four IOU threshold cascade RCNN to achieve high precision detection with AP of 0.840 and AUC of 0.871. The drawbacks were low precision and false detections. Couteaux et al. [2] developed a 2D U-Net model based on computed tomography images with good precision, reaching a Dice score of 0.867. They emphasized to apply the process in 3D to reduce the effort to train deep networks. Chen Li et al. [5] contemplated a network model that had a deeply

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This paper is a research contribution of students of Batch (2021-2022)
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controlled encoder–decoder architecture and redesigned dense skip connection using ANU-Net. This model achieved four types of medical image segmentation tasks with a Dice similarity coefficient of 90.10%. Nithya et al. [7] proposed a method for the detection and segmentation of kidney diseases using artificial neural networks and segmented stones and tumors separately, with a success rate of 99.61%. Ronneberger [9] presented a method to segment neuronal structures in electron microscopic stacks and transmitted light microscopy images. He achieved an average IOU of 77.5% which is significantly better than the second-best algorithm with 46%. Hai Su [10] proposes pixel-wise region segmentation with 92 pictures from 20 patients in the Cancer Genome Atlas (TCGA) breast cancer data set which has better segmentation accuracy and can be used as a tool for biomedical image analysis. Wenshuai Zhao et al. [14] developed a 3D U-Net-based architecture for kidney and tumor segmentation. They used MSS U-Net architecture in the dataset of KiTS19 challenge to find kidney and tumor Dice coefficients of 0.969 and 0.805, respectively. Fuat Türk [11] proposed a hybrid V-net model and compared it with other V-Net models and achieved more successful results for kidney and renal tumor segmentation with rates of 0.977 and 0.865 DSC. Robin et al. [8] proposed a breast tumor classification with 94.2% accuracy using histopathological images with reduced set of training images. Badawy et al. [1] developed a system for semantic segmentation of breast tumour with fuzzy logic as a preprocessing technique and CNN for segmentation. They achieved 95.45% global accuracy with 78.7 % mean IoU with 400 ultrasound cancerous images. Hai Su proposes pixel-wise region segmentation with 92 pictures from 20 patients in the Cancer Genome Atlas (TCGA) breast cancer data set which has better segmentation accuracy and can be used as a tool for biomedical image analysis [10].

II. METHODOLOGY

The presented work in this paper is the segmentation of Renal Carcinoma Cell (RCC) using the U-Net deep learning Network. The supervised learning of the network is used in this work. The block schematic of the segmentation of RCC is shown in fig2.

1) *Dataset*: For segmentation of RCC, two different datasets were used for testing our model. The first dataset from a medical centre of 15 patients consisted of 1117 CT scan images that were used to test the algorithm. This dataset was divided into two parts- 870 CT scan image- Training Dataset, 164 CT scan image - Validation and 83 CT scan - Testing. The second dataset was the benchmark dataset (Manifest) consisting of 2220 CT scan images of 119 patients.

TABLE I
PROPERTIES OF MEDICAL CENTER DATASET

Property	Value
Number Of Patients	15
Modality	CT(late-arterial phase)
Training dataset size	870
Validation dataset size	164
Test dataset size	83

TABLE II
PROPERTIES OF KiTS-1

Property	Value
Number Of Patients	119
Modality	CT(late-arterial phase)
Training dataset size	
Validation dataset size	
Test dataset size	

2) *Pre-Processing*: Removal of annotations from all the images of 15 patients reduced the error and increased the accuracy. The images from Manifest Dataset carry a lot of background noise which makes it difficult for segmentation of the RCC. Filters like median and gaussian were used to reduce this random noise. Median filter was used to preserve the edges in an image while the gaussian filter was used for smoothing the image. This helps in proper identification of kidney and cancer cells around it.

3) *Data Augmentation*: The U-Net model trained on an inadequate dataset would result in overfitting problems. For decent improvement in this smaller dataset, the Data Augmentation technique becomes a crucial step to avoid overfitting and to increase the quantity of data. Data Augmentation techniques used are rotation, width shift, height shift, shear, zoom, horizontal flip, fill mode, etc are used in this step.

4) *U-Net*: The U-Net model is selected for this work presented on RCC segmentation. The framework of this CNN model is shown in fig1. This model consists of two sides- Contracting and Expansive path. Each side has five blocks which are made of 16 convolution layers for feature extraction. The contraction path has ReLU and 3x3 max pooling with a stride of 1 for downsampling. At each downsampling step we double the number of feature channels. For the expansive path with five blocks of up-convolution, each block consists of upsampling of the feature map followed by 2x2 convolution, each followed by ReLU. In the last layer a 1x1 convolution is used to map each 128-component feature vector to the desired number of classes. In total the network has 23 convolutional layers. The network is extensive and has about 4,913,473 (approx.) parameters. [9]

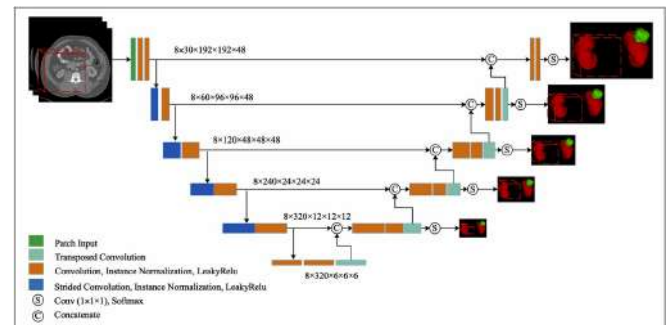


Fig. 1. U-Net Architecture [14]

III. RESULTS AND DISCUSSION

Original input CT images and kidney segmentation output images. (img table)

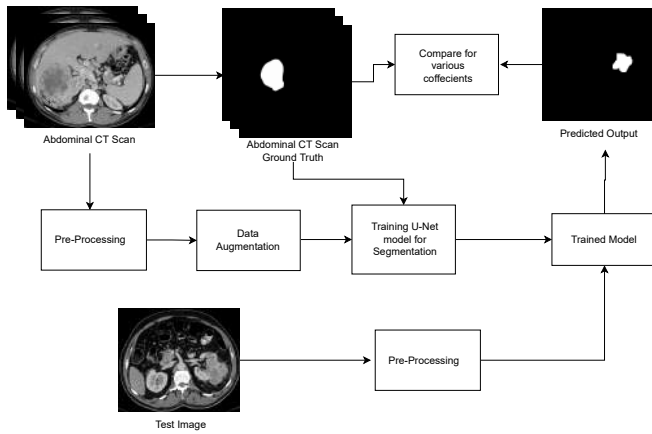


Fig. 2. Flowchart

TABLE III
COMPARISON OF MSS-UNET, CLASSIC 3D-UNET AND U-NET

Metric	MSS U-Net	Classic 3D U-Net	U-Net
Dice	0.969	0.962	
Jaccard	0.941	0.93	
Accuracy	0.999	0.999	
Precision	0.971	0.961	
Recall	0.968	0.965	
Hausdorff	19.188	38.945	

IV. CONCLUSION

The RCC(Kidney) cancer segmentation in CT scan images using U-NET architecture is presented. The model identifies the location of tumour. The methodology includes data augmentation and predicting the mask of new data provide to the trained model. We have trained the Unet model and achieved the result of Jaccard coefficient (0.9989) and Dice Coefficient (0.8272) for Breast cancer (—dataset). We have trained, validated and tested our current model with Kits-19 and have achieved precision (—). It will be helpful to radiologists for prioritizing the CT scan for abnormality during the screening programs. In the future work, we expect to extend the application of our architecture towards segmentation of other organs and modalities.

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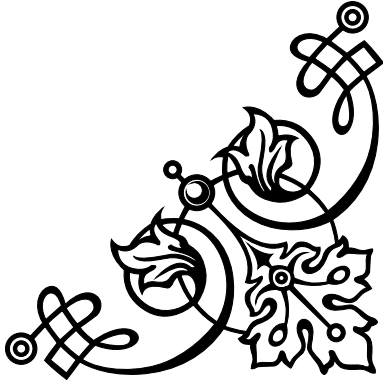
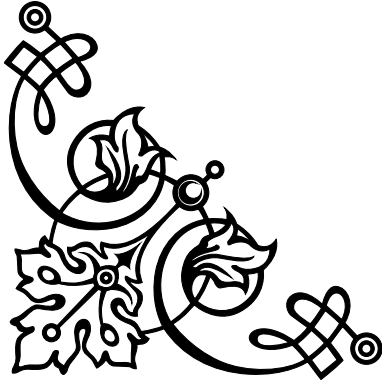
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Papers accepted for publication

Design of a Dual Band Monolayer Metasurface Based Bandpass Filter

Design and Analysis of a Compact Metasurface Based Filter for Broadband Performance.

Both these papers are accepted for publication in The IEEE Region 10 Symposium (TENSymp 2022)



Design of a Dual Band Monolayer Metasurface Based Bandpass Filter

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Abstract— In this paper, a planar metasurface-based bandpass spatial filter has been proposed for C-band and Kuband applications. The unit cell of the proposed metasurface is consisting of four slots bearing two combinations of geometrical patterns etched from the top copper surface mounted on the FR4 substrate. The geometrical dimensions of the slotted patterns have been varied to study their impact on the reflection and transmission characteristics. The structure provides insertion losses of less than 0.5 dB at both the operating bands at 4.79 GHz (C-band) and 15.17 GHz (Ku-band), respectively. The proposed metasurface-based filter can be useful for weather forecasting, earth exploration services, airport surface detection equipment (ASDE) systems, etc.

Keywords— Metasurface, insertion loss, bandpass filter, unit cell.

I. INTRODUCTION

Metasurfaces have been used to improve the electromagnetic (EM) phenomena of the devices operating over a broad range of frequencies [1]-[3]. They have been accepted as an interesting topic to the scientific community because of their flexibility for the manipulation of the EM wave covering a wide range of applications viz., filters, cloaking, polarization converters, absorbers, antenna, etc. [4]-[8]. Metasurface filters are preferred over the conventional ones due to the low profile and for this reason they can be easily mountable to any EM system. Over the years, several metasurface designs have been studied and proposed in the microwave frequency range. Gil et al. [9] presented a study of several metasurface filters using resonating transmission lines. Planar self-complementary metasurfaces have been also used as bandstop or bandpass filters depending upon their structural orientation to the polarization state of the incident EM wave [10]. Qu et al. [11] discussed a frequency selective surface (FSS) to provide bandpass response at 2.4 GHz. FSSs using transmission line approach have also been investigated as narrowband bandpass filter [12]. Planar slotted metallic metasurfaces with strip loading have been studied as bandpass filters [13]. Stacked metallic metasurface configurations have also been examined as spatial

bandpass filters by exploiting the coupled mode theory [14].

The reflection and transmission response of a metasurface is fixed and cannot be altered. However metasurfaces are desired due to their reconfigurable nature. Metasurfaces utilize the interaction of surface waves across gaps and dielectric spaces[15]. The currents on the surface can lead (or lag) depending on the individual resonant element since elements on a metasurface can be spatially changed. This specialized phenomenon allows us to tune wavefronts as they pass through a metasurface, which opens up a wide range of solutions[16]. Because of their potential application, a large amount of research has been done in the recent decade to construct bandpass filters in the gigahertz domain using metasurface designs[17]-[18].

Split ring resonator (SRR) Bandpass Filter (BPF) proposed in [19] offers Fractional Bandwidth (FBW) of 1.97% in the X band with a tenability across 8.62-9.46GHz. In the work presented in [20] a single layered metasurface band pass and band stop filter with 14% FBW is proposed for scanning angles as wide as $\pm 30^\circ$. Multi band metasurface filters integrated with antenna is utilized for multiband antenna characteristic with low interferences for eg. in work proposed in [21] antenna aperture is shared for S and K band, this is made possible by integration of metasurface filters.

In this paper, a simpler planar single layer metastructure containing slotted metallic patterns is proposed as a dual band bandpass filter for C-band and Ku-band applications simultaneously. It provides a FBW of 44.8% and 21.9% in C and Ku-band respectively. Such a filter can be employed to perform the critical function of passing frequencies within a specific range and attenuate out-of-band frequencies in radar systems; thereby, having applications in radio monitoring systems, fixed and mobile military communication, weather forecast, automotive

systems, earth exploration services, airport surface detection equipment (ASDE) system, military and other law enforcement systems.

II. DESIGN METHODOLOGY

The proposed metasurface design has been evolved into two stages. The unit cell of the proposed metasurface contains two identical conventional plus (CP)-shaped-slots placed along the left-diagonal position as well as two identical modified plus (MP)-shaped-slots placed along the right diagonal of the square-shaped metallic layer on the substrate as shown in Fig. 1. This design configuration exhibits single band filtering response in the Ku band only. The resonant frequency and transmission characteristics of the filter can be effortlessly nurtured through the changes in the structural dimensions of the metasurface unit cell.

There exists a linear relation between resonating length 'l' and frequency 'f'. This becomes highly prominent in microwave bands [23].

$$l \propto 1/f \quad (1)$$

$$\Theta = \beta \cdot l \quad (2)$$

where Θ is the phase, β is the phase constant of the wave propagating on the surface, l is the length of the line, Tuning 'l' enables a change in resonant frequency of the filter. The dimension 'r1' and 'g' introduces capacitive loading to the resonant length thereby shifting the frequency higher these two parameters enable fine tuning of filter resonant frequency. The substrate thickness 'h' is maintained constant for the analysis.

The dimensions of the design of the unit cell have been optimized as mentioned in the caption of Fig. 1. The unit cell of the unit cell consists of 2×2 sub-cells of slots where each of them has an area of the order less than

$0.125 \lambda_g \times 0.125 \lambda_g$. Ansys HFSS [14] has been used for the electromagnetic analysis of the proposed structure under periodic boundary conditions. The reflection and transmission coefficient spectra of the initial design are shown in Fig. 2 from where it is seen that the structure offers passband at 19 GHz.

The structure has been further modified incorporating metallic slots in the unit cell making the periodicity of the unit cell unaltered. The top view of the modified design is shown in Fig. 3.

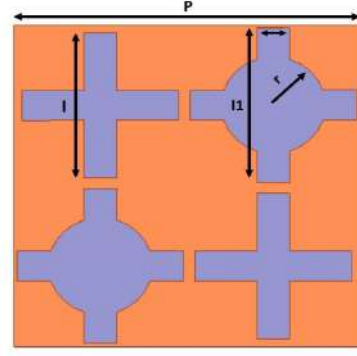


Fig 1: Top view of initial unit cell

Fig. 1. Initial design of the unit cell with periodicity, $P = 10.611$ mm, $l = 4.8$ mm, $l_1 = 5.1$ mm, $r = 1.4$ mm. is $35 \mu\text{m}$ Cu (t), 1 mm glassreinforced epoxy laminate material, FR-4 substrate (h).

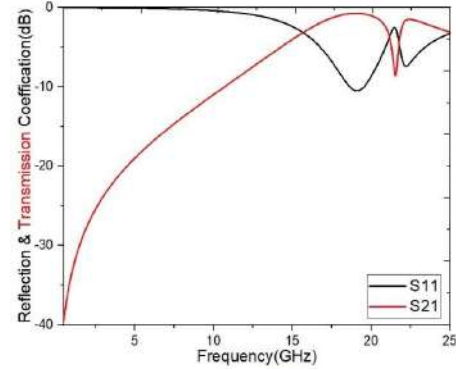


Fig 2: Spectral responses of the reflection and transmission coefficients for the initial design of the metasurface-based dual bandpass filter.

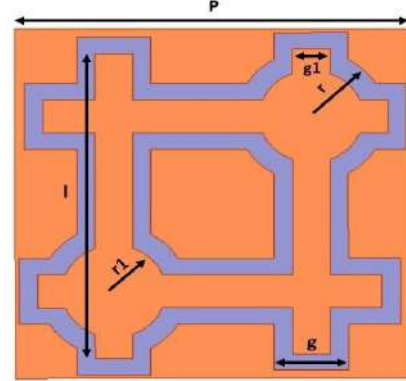


Fig 3: Top view of final design

Fig. 3. Proposed metasurface-based dual bandpass filter with periodicity, $P = 10.611$ mm, length, $l = 9.26$ mm, inner radius, $r_1 = 1.4$ mm, outer radius, $r = 2$ mm, outer gap, $g = 2$ mm, inner gap, $g_1 = 1$ mm.

III. RESULT AND DISCUSSION

The results of our research are not restricted to a single band, but also to two other bands, namely C-band and Kuband, with 44.8 percent and 21.9 percent FBW, respectively, and insertion losses of roughly 0.36dB and 0.8dB.

The optimized responses of the reflection and transmission coefficients of the filter whose unit cell is shown in Fig. 3 have been illustrated in Fig 4. It can be seen that the design exhibits dual passband characteristics at 4.79 GHz and 15.17 GHz lying in C-band and Ku-band respectively. The resonant length along with the capacitive loading in the unit cell of the metasurface has been enhanced in lowering the frequency bands to 4.7 GHz and 15.17 GHz. It is further noted that the insertion losses at these two frequencies are less than 0.5 dB. At both these bands, the 3 dB transmission bandwidths have been evaluated as 1.675 GHz and 1.695 GHz, respectively.

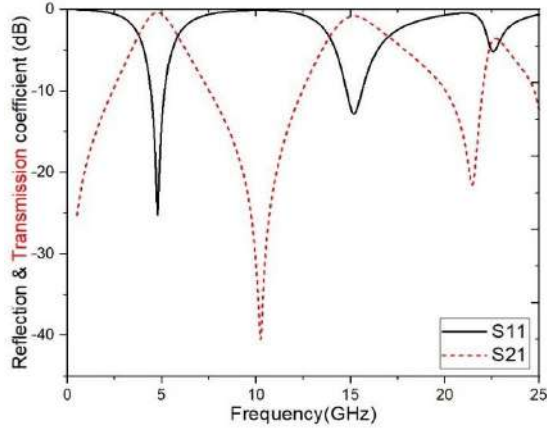


Fig. 4. Spectral responses of the reflection and transmission coefficients for the proposed metasurface-based filter.

The surface current distribution on the proposed metasurface based dual bandpass filter have been illustrated in Fig. 5 and Fig. 6, respectively at 4.7 GHz and 15.17 GHz respectively. It can be depicted from Fig. 5 that at the corners of the slotted region of the unit cell structure, the surface current intensity is denser at 4.7 GHz. On the contrary, at 15.17 GHz, the middle portion of the slotted region in the unit cell is responsible as evident from the surface current distribution as shown in Fig. 6. The optimized response of the current distribution plot informs us about the contribution of various edges and portions to the filter's final output. In the present distribution plot, the reddish colored portion contributes the most to the resonance.

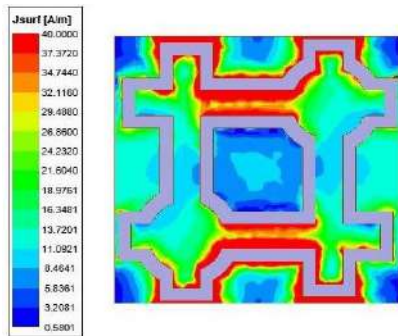


Fig 5: Current Distribution on the unit cell of the proposed spatial filter at 4.7 GHz

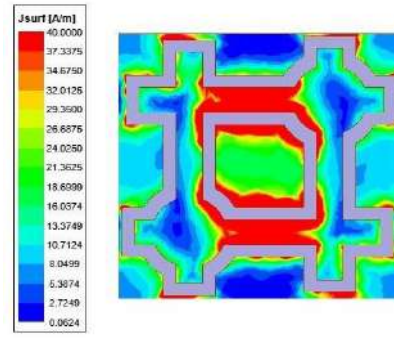


Fig 6: Current distribution on the unit cell of the proposed spatial filter at 15.2 GHz.

To check the angular stability, the structure has been studied under various incident angle, θ . The variation in θ has insignificant effect on the reflection coefficient in the Cband and Ku-band till 45° angular incidence as depicted from Fig.7

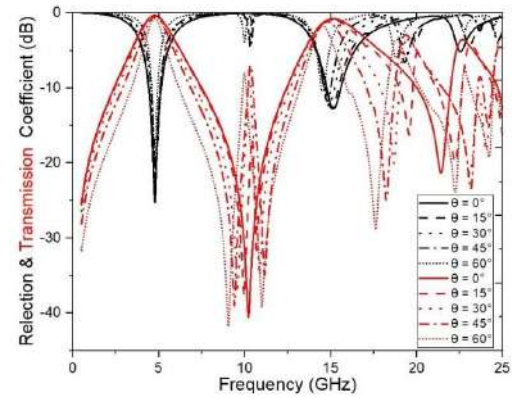


Fig 7: Response of the Reflection & Transmission coefficient of the proposed spatial filter under various incident angle, θ .

IV. CONCLUSION

A low-profile band pass filter based on the concept of metasurfaces is designed and simulated for C-band and Kuband applications. The structure has been evolved from a single band design by incorporation of metallic slots in the unit cell to enhance the electrical length. The surface current distributions at the slotted region of the unit cell implies the utility of the design shape. The structure is claimed to be angularly stable till 45° incident angle. The preliminary studies have been found to be encouraging and can be modified to design a broadband multi resonance filter with improved stop band rejection.

V. FUTURE SCOPE

The filter proposed in our work can be integrated to communication systems operating at C and Ku band, while

rejecting the intermittent bands due to its sharp cut off. This filter presents a low profile robust solution for satellite and radar communication. The filter proposed in our work presents a low deviation in reflection and transmission coefficients when scanning angles are varied from 0° to 45° , this presents a good scope of such metasurface filters being stacked with antenna arrays to operate in dual band with little interference.

ACKNOWLEDGMENT

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Design and Analysis of a Compact Metasurface Based Filter for Broadband Performance

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Abstract - In this paper, a planar metasurface based broadband low pass filter has been proposed for up to X-band. The unit cell of the proposed metasurface consists of a lattice made of Omega shaped geometric patterns etched on an FR4 substrate. The geometrical dimensions of the Omega structure have been varied to study their impact on the reflection and transmission characteristics of the filter. The structure provides insertion losses of less than 3 dB up to 12.5 GHz for a linear phase shift and constant minimum group delay throughout the passband. The proposed metasurface-based filter can be useful for weather forecasting, earth exploration services, airport surface detection equipment (ASDE) systems, etc.

Keywords - Metasurface, Filter, Microwave.

I. INTRODUCTION

Metasurfaces have gained a lot of research attention owing to their ability to orchestrate electromagnetic waves. They are array of subwavelength inclusions that can be densely arranged and allow the fields to be engineered with much better spatial resolution, it has recently become widely understood, thanks to the development of the concept of metamaterials, that a design of subwavelength inclusions can grant a more profound control of electromagnetic waves by planer structures. Such inclusions, in general, have both electric and magnetic polarizations, and thus provide complete control over reflected and transmitted waves, opening up new possibilities for microwave and optical systems. Until recently, all such planar metamaterial structures were referred to as metasurfaces[1]. They cater to a range of applications such as antennas, cloaking, absorbers, filters, polarization converters, phase shifters, etc. [2],[3],[4]. Planar slotted metallic metasurfaces with strip loading have been studied as bandpass filters (BPF) [5].

Some interesting work is presented for the development of metasurface based filters, one such is that of a metasurface based waveguide filter that utilizes metal bars to form metasurface[6]. This filter has its passband till the Ku band; however, such filters are non-planar and

integration with planar arrays is difficult. Another work is that of a split ring resonator (SRR) metasurface type BPF with a bandwidth of 180MHz, the tunability it presents is from a range of 8.62-9.46GHz[7]. In a work presented by Teng Li *et al.* metasurfaces with filtering characteristics are integrated with common aperture antennas to enable dual band operations without interferences[8]. These filters show great prospects even in terahertz band with excellent cutoff and broadband performance[9]. Metasurface filters within X – band are reported as seen in the literatures, they involve one or more layer of substrate or PECs to obtain a large bandwidth [6],[7].

In this paper, a simpler planar single layer metastructure containing an Omega structure is proposed as a broad band lowpass filter for up to X-band applications. Such a filter can be employed to perform the critical function of passing frequencies up to a specific cut-off frequency with steep roll-off and attenuates spurious signals in the stopband. An electrical equivalent circuit model of the proposed low pass filter is derived. The basic design methodology of the proposed metasurface filter is described in Section II. The results are discussed in Section III followed by the circuit model analysis in Section IV. A detailed parametric analysis of the significant contributors in the Omega structure is included in Section V.

II. DESIGN STRUCTURE

A meandered structure forming an “Omega” is designed to form a metasurface unit cell referred to as Metasurface based Omega (MSO) in this communication. It is designed as a metasurface based low pass filter at a cut-off frequency of 12.5 GHz and an insertion loss less than 0.5dB.

The lattice of the proposed metasurface unit cell filter consisting of the Omega is implemented on an FR4 substrate of 1.0 mm thickness.

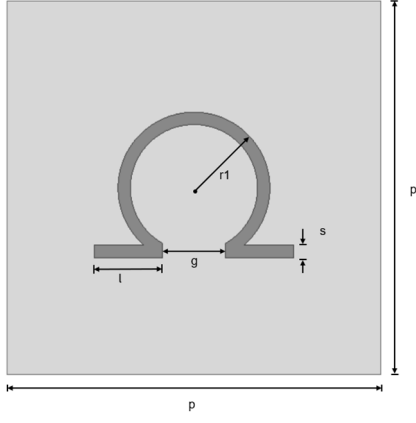


Fig. 1(a): Top view of the proposed MSO ($r_1 = 1.2198$ mm, $s = 0.2$ mm, $g = 1$ mm, $l = 1.10$ mm, $p = 6$ mm).

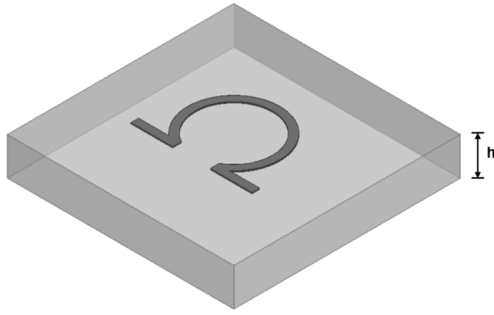


Fig. 1(b): Isometric view of the proposed MSO ($h = 1$ mm).

The meandered length of Omega can be modeled by the resistance and inductance while the intermediate varying gap forms the equivalent capacitance. The MSO resonates at the design frequency, when electromagnetic waves are incident on the proposed metasurface unit cell. The varying gap between the meandered line can be modeled as a varying capacitor that effectively contributes to the wide resonant behavior of the proposed unit cell. The length, width and gap of the unit cell are optimized for wideband transmission characteristics up to X band for a cut-off frequency of 12.5 GHz. The dimensions of the unit cell are included in the caption of Fig. 1(a). The metasurface lattice is $0.25\lambda_g \times 0.25\lambda_g$ (6mm $\times$ 6mm). The proposed metasurface unit cell is simulated using ANSYS HFSS 19 [10]. The reflection and transmission coefficients are observed and a detailed parametric analysis is conducted to study its characteristics.

III. RESULTS & DISCUSSION

The optimized responses of the reflection and transmission coefficients are shown in Fig 2. The Omega is observed to exhibit broadband low pass filter characteristics with a cut-off frequency at 12.5 GHz.

The phase shift in the passband is seen to be linear with reference to the frequency as shown in Fig. 3. This linear phase shift implies that all frequencies are equally delayed by the filter, thus mitigating phase distortion. This is also

verified by the flat group delay response observed in the passband of the Omega filter as illustrated in Fig. 4.

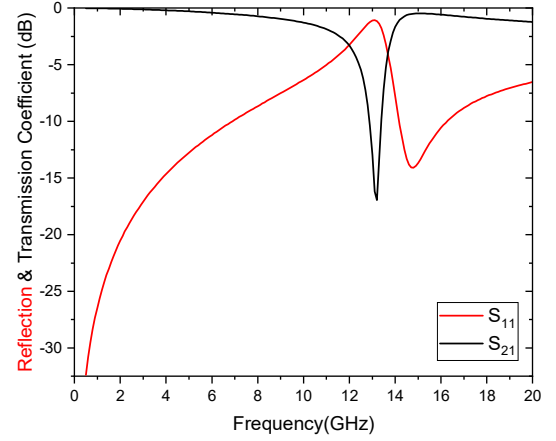


Fig. 2: Insertion & Return loss of the MSO non scaled

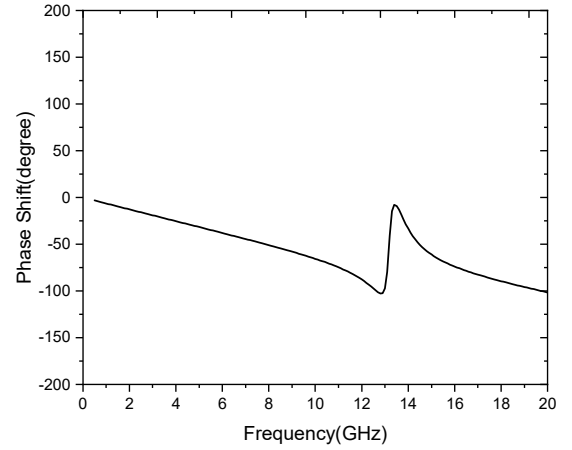


Fig. 3: Phase delay through MSO

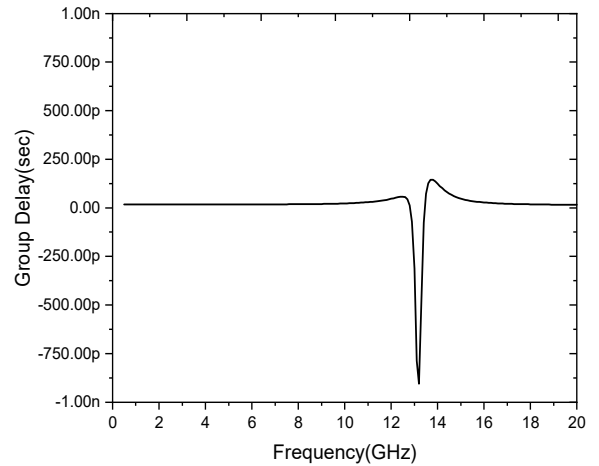


Fig. 4: Group delay of proposed MSO.

The electric field and surface current distributions are illustrated in Fig. 5(a) and Fig 5(b). The field distribution aids the equivalent modeling of the Omega as shown in Fig. 7(b).

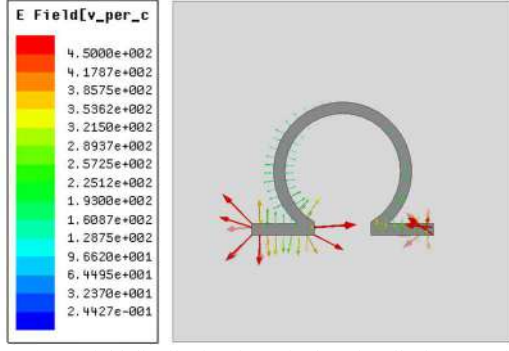


Fig. 5(a): E-Field distribution for a single unit cell of metasurface.

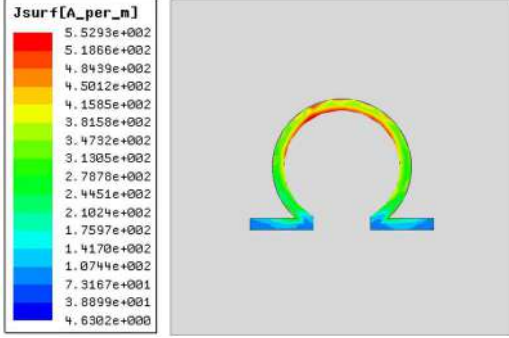


Fig. 5(b): Surface current distribution for a single unit cell of metasurface.

To check the angular stability, the MSO has been studied under various incident angles, θ . The variation in θ has insignificant effect on the reflection coefficient in the X-band till 60° angular incidence as depicted from Fig. 6.

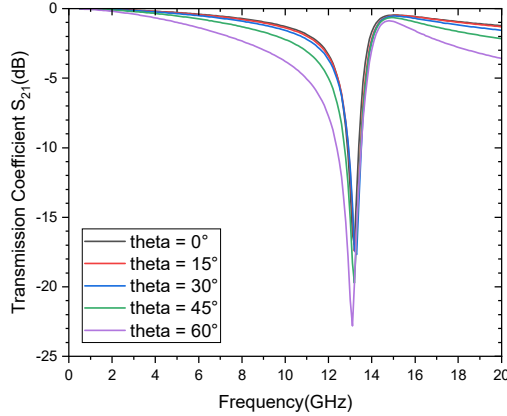


Fig 6: Angular Stability check for different incidences.

IV. CIRCUIT MODEL

The proposed metasurface based low pass filter formed by the MSO is modeled into a simple ladder network as shown in Fig. 7(a) further simplified to the model shown in Fig. 7(b).

The legs of Omega which are marked as 'l' in Fig.1(a) introduce an inductance L_i and the spacing 'g' between them results in a fixed capacitance C_i .

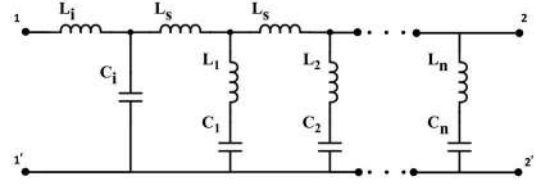


Fig. 7(a): Ladder network model of the proposed spatial filter

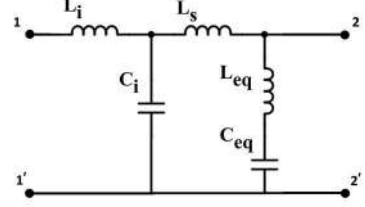


Fig. 7(b): Equivalent circuit model of the proposed spatial metasurface filter

The legs of Omega which are marked as 'l' in Fig.1(a) introduce an inductance L_i and the spacing 'g' between them results in a fixed capacitance C_i . The gap 'g' is bounded by plates of copper having thickness of 0.035mm and width 's' of the proposed MSO, this presents capacitance C_i and similarly, the arc length of Omega offers a varying capacitance all through its length which forms the cascade of series L- C_{eq} in shunt contributing to the broadband performance of the proposed low-pass filter. C_{eq} comprises the total varying capacitance through the arc length of Omega. The equivalent model is simulated using Keysight Genesys[11] and the response is as shown in Fig. 8.

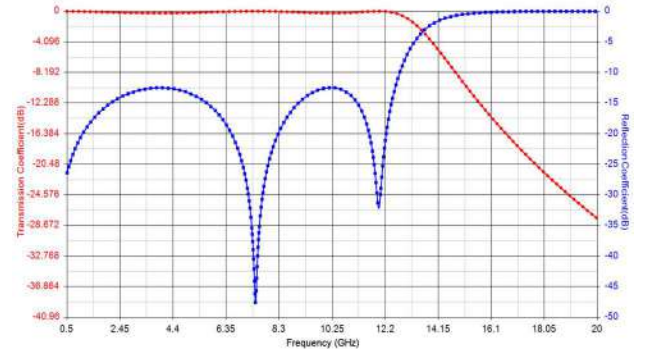


Fig. 8: Transmission coefficient and reflection coefficient response of the equivalent model in Keysight's Genesys.

V. PARAMETRIC ANALYSIS

A parametric analysis is carried out to optimize and also have an in-depth understanding of the effect of the contributory factors; the total length and gap between the legs of the Omega. The effect of the total length on the transmission coefficient of the metasurface based filter can be analyzed in parts. The total length comprises two major sections; the two leg-lengths and the arc length. Effect of up or down scaling of the arc length, results in the upper shift in the cutoff frequency with reduction in arc length and vice-

versa, as shown in Fig. 9. It is also observed that the stop-band rejection improves with up-scaling of the MSO. Similar observations are made in case of increase or decrease in the leg-lengths of the MSO, as shown in Fig. 10

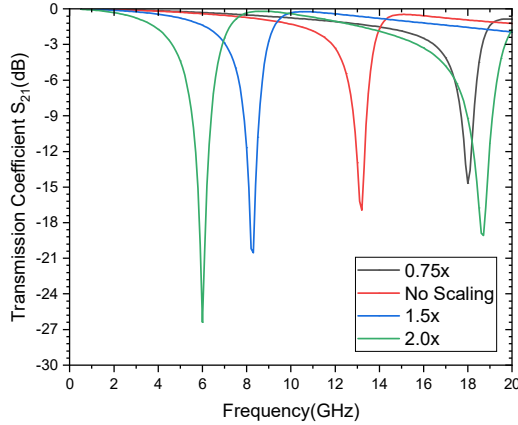


Fig. 9: Comparison of transmission coefficient for varying scaling factors.

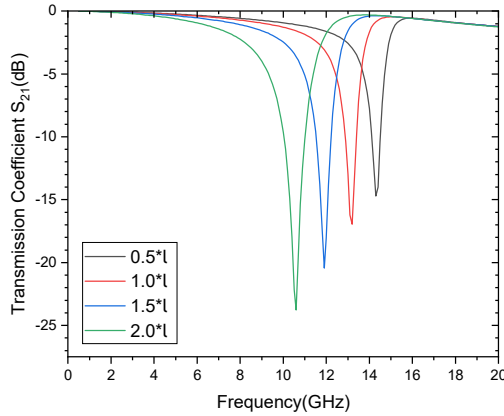


Fig 10: Effect of leg-length variations on transmission coefficient.

The variation in the spacing 'g' between the legs of the MSO results in varied capacitance leading to shift in the resonant frequency as illustrated in Fig. 11.

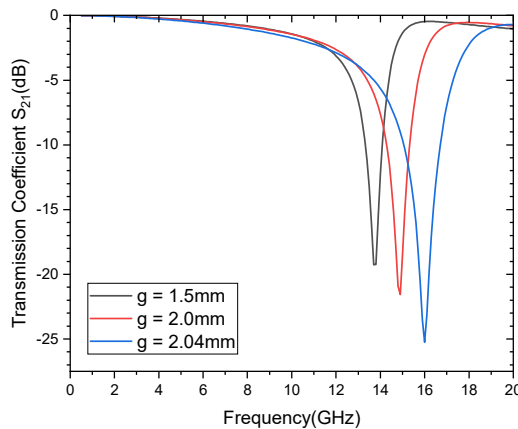


Fig. 11: Effect of gap variations on transmission coefficient.

VI. CONCLUSION

The proposed low profile metasurface based Omega shaped low pass filter is designed, modeled and simulated for broadband low pass characteristics over L, S, C & X bands.

The lowpass filter bandwidth can be tuned by scaling the arc length or leg length while the spacing 'g' is maintained. While scaling down the overall arc length increases the bandwidth, the attenuation peak reduces. It is also observed that increase in the width of the MSO results in increased bandwidth and attenuated peak. The surface current distributions at the arc region of the unit cell implies the utility of the design shape. Preliminary studies have been found to be encouraging and can be modified to design a broadband filter with improved stop band rejection.

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