PILLAI COLLEGE OF ENGINEERING

JOURNAL OF ELECTRONICS ENGINEERING

JULY 2020

COMMUNITY TALK

The technical journal team of July 2020 would like to congratulate students and staff members for their contribution of sincere efforts and hard work in departmental journal. We would like to thank our Principal Dr. S. M. Joshi and HoD of Electronics Department Prof. R. H. Khade for giving us this opportunity and freedom to express our views and ideas on departmental journal. We would like to extend our gratitude to the journal team who have worked tremendously hard to put everything together which made it possible for us to print the July 2020 issue.

This journal comprises of research papers and technical articles. The journal includes "Automatic seed sowing Machine" which focuses on contribution to improve the existing agricultural methods , "Home Automation using Voice Control (Google Assistant) and Blynk App" which presents a proposal for home automation using voice through Google Assistant and the Blynk application, "GPS Navigated Carry Bot" in which an autonomous Robot prototype is designed using Node MCU, "Design and Prototyping of Compact, Portable, Cost effective Ventilator" where development and validation of a simple, portable and low-cost ventilator that may be rapidly manufactured with minimal susceptibility to supply chain disruptions is discussed, "Infant Incubator using Fuzzy Logic Control" where a micro-controller based system which keeps premature infants safe until they are able to regulate their own body temperature and can cope up with the external environment is designed, "Toward a Green Campus with the Internet of Things – the Application of Lab Management", where the idea of the project is to inculcate the idea of Green Campus across all campuses with the help of an IoT system and "Underground Cable Fault Detection Using IOT", which automatically displays the phase, distance and time of occurrence of fault with the help of PIC 16F877A and ESP8266 Wi – Fi module in a webpage. This is small briefing of our journal for this issue. We greatly appreciate the contribution from all our writers, without which this would not have been possible.

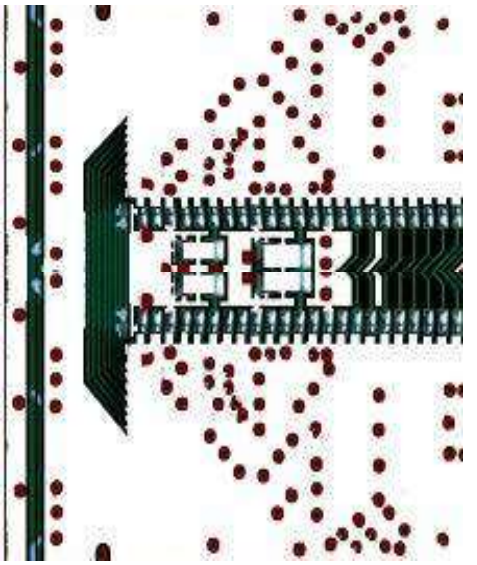
Readers, we really hope you find this worth enough to share it with your friends. Please send us your valuable feedback at pce.etrx.journal@gmail.com and help us for improvement !!!

Best Regards,
Managing Editor Board

MESSAGE FROM PRINCIPAL

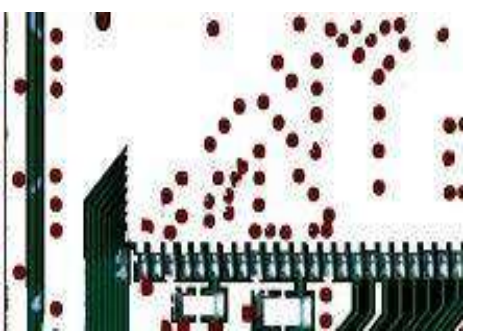
I am happy to know that Department of Electronics Engineering is bringing out its July 2020 issue of Departmental Journal. The journal covers all major technical areas in Electronics and reflects the latest trends in those. The product is a synergetic output of team work involving teachers and students. Students who have given technical papers for departmental journal encompasses innovations and improvisations based on their projects. I express my compliments to Head of the Department of Electronics, editorial / reviewer board and publication team for their commitment and effort for bringing out this journal.

Best Wishes,
Dr. Sandeep M. Joshi



MESSAGE FROM HOD

It is my privilege to present July 2020 issue of our journal of Electronics department. The main endeavor of this journal is to create appropriate environment that stimulates vision, research and growth in the area of Electronics. Engineers today have propelled the world to a new era of technological advancement. Blending curiosity with scientific temperament among students is the need of the hour. Hence we encourage our students to publish papers on their project work. Many students have contributed their ideas by means of papers. In this issue we have accommodated 7 technical papers. I thank my beloved students for writing good quality papers for this journal. Finally, I express my sincere gratitude to our editorial / reviewer board, publication team for their continued support and invaluable contributions and suggestions for the advancement of the journal. I hope you will enjoy reading this issue and we welcome your feedback on any aspect of our journal.



Best Regards,
Prof. R. H. Khade

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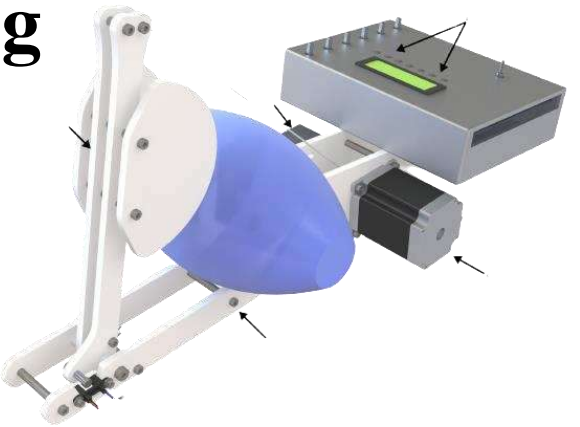

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Automatic seed sowing Machine

Mehul Jayesh Jain, Sharvari Satish Doijode

Anmol Sarit Sharma, Shivshankar Basavraj Mulage

Department of Electronics Engineering, Dr. K.M.Vasudevan Pillai Campus, Plot No.10, Sector 16, New Panvel, Navi Mumbai, Maharashtra 410206, India.

jainmehja17ee@student.mes.ac.in; doijodeshasa17ee@student.mes.ac.in;

sharmaanmsa17ee@student.mes.ac.in; mulageshiba17ee@student.mes.ac.in

Abstract: Whilst the world economy is falling apart due to COVID-19, agriculture - being our main occupation is highly affected. It is the need of the hour to bring improvements in the agricultural methods. With advancements made in the field of science and technology various techniques have already emerged for improving the existing agricultural techniques. The process of implementing the recent technologies to develop crops that are being produced. The use of agro-technology not only helps in improving the efficiency of the crop that is being produced but also helps in developing devices that are suitable for doing mechanical works in the fields. This results in minimization of the total cost of production, saving of time and reduction in the effort involved in the process. The new technology should also be economically feasible and hence the behavior of the technology and its role in society is an important consideration before developing a new product or process. Our project is one such contribution to improve the existing agricultural methods.

Keywords: Agribot, twist drill, calibrate, gap distance, plunger lever mechanism, Adafruit, nozzle, dropper.

I. Introduction

Today's era is marching towards the rapid growth of all sectors including the agricultural sector. To meet the future food demands, the farmers have to implement the new techniques which will not affect the soil texture rather will increase the overall crop production. Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. The seed sowing robot will help to overcome all the problems that the agriculture industry is facing. It has been designed considering the requirements of the process and ways in which it could become simpler. As day by day the labor availability becomes the great concern for the farmers and labor cost is more, this machine reduces the efforts and total cost of sowing the seeds. India has an under-developed agricultural infrastructure and institutions. Conditions of poverty and deprivation and unequal distribution of land resources hamper the evolution of an agricultural entrepreneur class. Traditional equipment like wooden ploughs, sickles and spades are commonly used. Tractors & Combines are not so common in use. Due to the use of these old implements agriculture is backward. Traditional methods of cultivation like manual ploughing, two crop patterns and old systems of irrigation are mainly responsible for low productivity of agriculture. Lack of proper understanding of the need to grow crop sustainability will push farmers into a vicious circle of debts, heavy use of chemicals (fertilizers), water mismanagement, and low productivity and thus more debts for the new cycle. Hence there is a need for using better agricultural equipment and automatic control over such parameters would ease the burden of any individual. This will help in precise and accurate farming thus would help in increasing the productivity. This problem is avoided by making the seed sowing machine, the machine is made with the help of microcontroller, GSM modules, Rotary controller and Sensors.

II. Literature Survey

[1] The code is developed to enable the agribot to move in all directions which can be controlled manually and an option auto run is included to automate the process. The agribot moves a specific distance set according to the seed requirements and then digs a hole through the drilling mechanism and sows the seed into it. A flap is provided behind the Agribot to cover the soil. An ultrasonic sensor is used to

make U-turns based on the obstacles at the farm's end i.e. the agribot is programmed to take a turn of 180 degrees and continue the process again. An Arduino Nano microcontroller is used for automation. The motor driver L293D is used to drive the high current or voltage application. A Wi-Fi module is interfaced to the microcontroller, thus the Arduino through this Wi-Fi module when connected to a network can be controlled through a mobile application named Blynk. For video monitoring, a wireless IP camera V380-Q3 is also installed in the agribot. The agribot does not give precise seed drilling and can make false U-turns due to obstacles on the path.

[2] The machine is solar-operated with core processing using an Arduino nano, it consists of an optical compass sensor to decide the exact 90-degree rotation of the agribot along with a collision avoidance sensor. Controlling commands are provided through the Adafruit server using an android application. All the data is pushed on thing speak.

[3] The core processing of the machine is Wi-Fi ESP 8266 microcontroller and the body is made using mild steel grade. The motor is driven with the help of a 12V battery. The cultivator is used to make furrows to drop the seeds at regular intervals using a seed distributor. The machine is made using mild steel grade (MS). The machine lacks a turning mechanism and is restricted to fixed limits for seed sowing.

[4] The mechanism is hand-driven which works on the rotation of gears. Upon rotation, holes are dug into the soil using a plunger lever mechanism, and seeds are dropped in the holes using a special disk designed for seed dropping. It has a low cost but requires manual labor. It does not give flexibility in seed sowing.

III. System requirement and Analysis

SR.NO	COMPONENT NAME	NO.OF COMPONENTS
1	ESP32	1
2	Stepper motor NEMA 17 1.6kg-cm	1
3	18650 Li-ion Battery 6000mAh 12V	1
4	A4988 Driver stepper motor	3
5	TowerPro SG90 Mini Servo Motor	1
6	12V DC motor with drill chuck	1
7	HC-SR04 Ultrasonic sensor	2
8	Infrared IR Receiver and IR wireless remote	1
9	SIM900a GSM module	1
10	Stepper motor NEMA 174.2kg-cm	2
11	Castor wheel	1
12	Side wheel	2

IV. METHODOLOGY

[A] User interface

Using [1], [2] we concluded that the interfaces of existing machines lack database storage and multiple profiles management systems. In our proposed model, we have made a dynamic website that consists of multiple user logins. It consists of different parameters stored in the database for every user reference/ future use like seed gap, seed depth, farm width, farm length, seed type, etc. The UI will also enable farmers to monitor the progress of their field. These parameters will in turn be used for precise farming. The data selected on the UI is sent to ESP32 for further processing. Besides that, in case of no internet connection, the data can be manually entered using a keypad.

[B] Machine movement

Once the parameters are received from the UI, the machine starts, considering that it is kept at the initial point (i.e. at one vertex of the field). The rotation of the wheels is controlled by stepper motors along with drivers. Based on the parameters and considering the circumference of the wheel, the step size is calculated accordingly to cover the specified distance on the field i.e. Seed gap distance (distance between two consecutive seeds).

[C] Drilling mechanism

With reference to [5], a drilling mechanism have been incorporated in the machine and hence it substitutes the ploughing stage of farming. The mechanism consists of a stepper motor, twist drill, a high RPM DC attached to a soil drill bit using a chuck. The drill size are calibrated to know the depth at which the seed is to be sown

[D] Seed dropping mechanism

Once a hole is dug, a special kind of disc [3] is designed to drop the required amount of seeds into the hole dug by the driller using a servo motor. This is achieved precisely by keeping the nozzle of the deep dropper exactly adjacent to the seed drill. In this way desired effective results can be achieved. It also notifies the user using GSM in case the seed volume is low based on readings from the IR sensor. The machine even consist of a roller at its back which will cover the hole back with the soil.

[E] Obstacle detection

The ultrasonic sensor is used to detect the obstacles in the path if any and notify the user using the GSM module about the interruption of the process.

[F] Power supply

A 12V battery acts as a power supply, so as to fulfill the power requirement for the system.

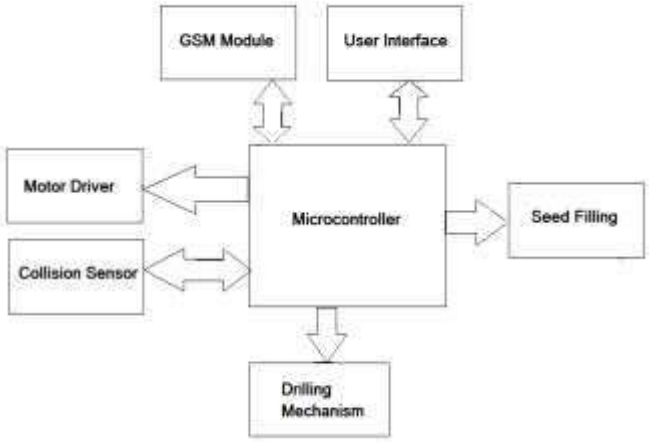

Fig. 1 Proposed system architecture

V. IMPLEMENTATION OF HARDWARE AND SOFTWARE

The hardware will be controlled as per the following conditions-

1. The distance entered from the user (DISTANCE) will be matched with the distance covered by the machine (GAP DISTANCE) and if it's equal then the motor would stop and the drilling mechanism would start.

2. Seeds will be dropped and again the motor would be started to move forward.

3. The First step will be continued until the machine covers the distance equivalent to the entire breadth of the ground.

4. Once the column is covered the machine will rotate left or right and again start following the first step and this will continue until the full field distance is covered and planted.

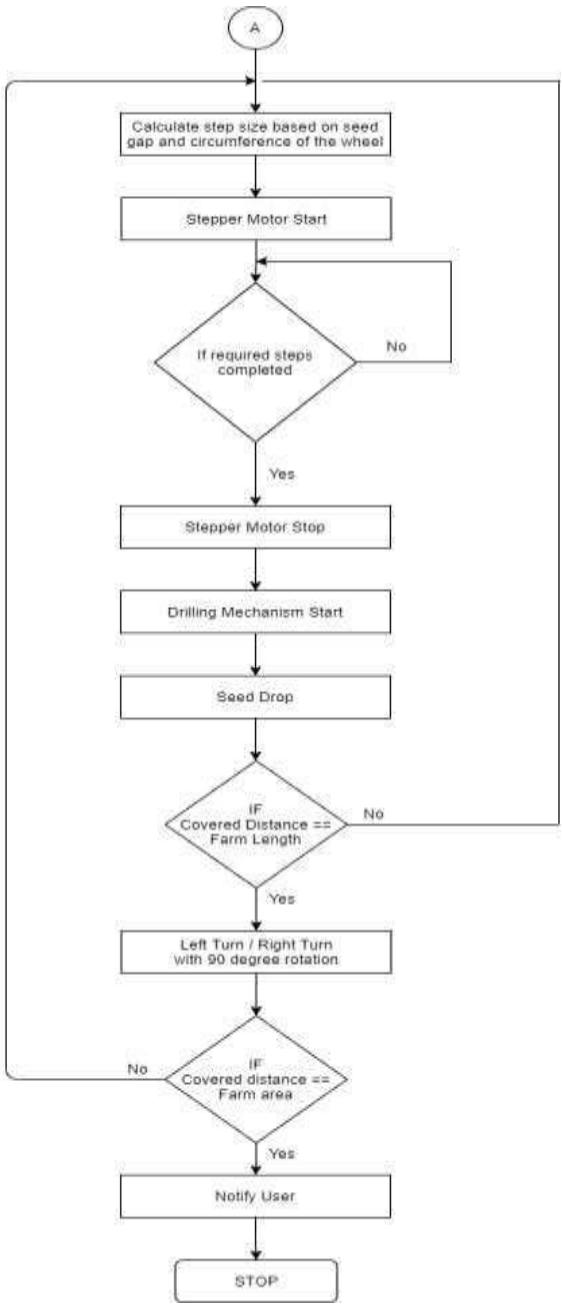

Fig. 2 Hardware flowchart

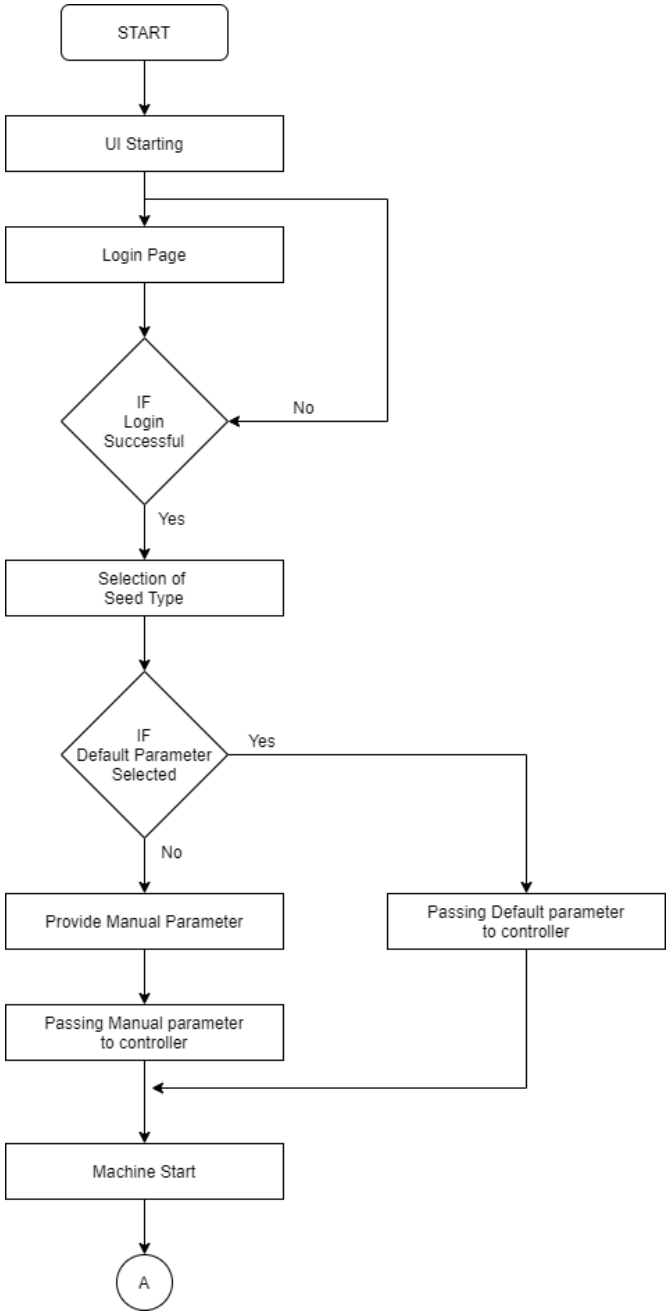

Fig. 2 Software flowchart

The working of the machine can be divided into two parts- the software part handled through the user interface and the hardware part which is controlled by the ESP32 module

The flowchart represents the working of the user interface.

1. After opening the webpage the login page appears in which the user has to login with an authentic login ID and password provided to the user. If the user has successfully logged in then the user will be taken to the next step otherwise the user will have to register first and the login till then the user will remain on the login page.

2. After successful login, the user will be given a choice of either selecting the seeds from the given data along with the distance at which they need to be planted or the user can enter manually the details of seeds and the measurements.

3. The data provided by the user will be matched with the predefined conditions and accordingly the parameters will be passed to the controller and according to the function assigned the machine will start.

VI. Conclusion

Our model is fully automatic machine, it would just need the farmers to enter the details i.e. seeds gap (distance between two consecutive seeds), seed depth (depth at which seed needs to be sown), and farm dimensions through the user interface provided using a dynamic website. The website consists of databases to store multiple profiles and seed sowing parameters. With the help of internet connectivity, the website and the actual machine that is on the field are connected. After successful login, the user needs to enter the required parameters which are sent to the ESP32 microcontroller, and then the seed sowing process begins.
The machine consists of a plougher at the front which creates a furrow in the field. The machine moves to the required distance with the help of a stepper motor which is connected to the wheels. The controller calculates the required steps based on the distance and circumference of the wheel. Once it travels the required distance the drilling mechanism will start. It will drill the soil at the appropriate depth provided by the user and seed will be dropped into the soil from the seed tank using a funnel-like structure provided at the bottom of the machine.
Once the seed is placed into the soil machine will again move ahead to the next point as the machine moves the roller at the back-side covers the hole dug. After completion of one column of the field machine will take left or right turn depending on the field initial position. In case of no internet connectivity, the parameter can also be manually entered using an IR Remote. Also if the seed volume in the seed storage tank goes low during the process it notifies the user using the GSM module.

VII. Acknowledgement

It gives us great pleasure and immense satisfaction to present this report on our project "Automatic seed sowing machine", which became possible due to the unstinted guidance and focused direction of Prof. Ravi K. Biradar, Electronics Department. We express our sincere gratitude to Dr. R.K Khade , HOD, Electronics Department without whom it would not have been possible to successfully accomplish our project. Furthermore, we are indebted to the Principal Dr. Sandeep Joshi whose constant encouragement and motivation inspired us to do our best. Last, but not the least, we sincerely thank our family members, colleagues and all the others who directly or indirectly contributed in making our task easier.

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Home Automation using Voice Control (Google Assistant) and Blynk App

Kirti Chaurasia, Sonali Chavan, Nidhi Falak, Shivam More

Department of Electronics Engineering, University of Mumbai

Pillai College of Engineering, New Panvel,

Navi Mumbai, Maharashtra-410206, India

kirtichaurasia113@gmail.com

chavansonali993@gmail.com

nidhifalaksn@gmail.com

shivammore323@gmail.com

***Abstract*— A proposal for home automation using voice through Google Assistant and the Blynk application is presented in this paper. From Zigbee automation to Amazon Echo, Google Home, and Apple Home, we have seen many home automation innovations launched over the years. The notion behind Google Assistant - controlled Home Automation is to use voice commands to monitor home devices. The Webhook is a way for an app to provide other applications with real-time information and is connected to the IFTTT website, which is used to produce if-else conditional statements. Through the IFTTT service and Blynk application, voice commands for Google Assistant are added that are decoded and sent to the microcontroller, which in turn controls the relays connected to it. As per the user's request to the Google Assistant, the system connected to the respective relay can be switched On/Off and home appliances such as bulb, fan, and engine, etc., can be operated accordingly. The NodeMCU (ESP8266) is the microcontroller used and contact between the microcontroller and the application is formed via Wi-Fi (Internet). Specific sensors are used to determine various devices on a home security level.**

***Keywords*— Google Assistant, Blynk App, IoT, Sensors, Intrusion detection, gas/smoke detection, temperature/humidity sensing, smart appliance, lighting control, fire-detection system.**

I. INTRODUCTION

"Home automation" refers to the automatic and electronic control of household features, activities, and appliances. Smart homes, wherein appliances respond automatically to changing environmental conditions and can be regulated easily via a single device, are becoming increasingly popular. We can use boards like Raspberry Pi, NodeMCU, Beagle Bone, etc. There are three main elements of a home automation system: sensors, controllers, and actuators. The IoT is a key concept in Google Assistant-controlled Home Automation. It links different types of objects to the internet, such as mobile phones, computers, and tablets, allowing for new types of communication between objects and individuals.

The Internet of Things is being used to come up with creative ideas and a vast construction area for smart homes to boost people's living standards. The Internet of Things will transform a variety of industries, including healthcare, automation, electricity, transportation, and more. In this case, cloud computing can be used to build an IoT infrastructure with sensors and actuators that can be used to track and manage "data" from anywhere. Users can access and control different aspects of their homes remotely using home monitoring software. Motion detection, water leak detection, temperature tracking against burglary and fire, and control of lights, locks, fans, and other devices can all be managed from a laptop, tablet, or smartphone.

In both rural and urban areas, smart devices can be effective. It is also used in robotics, where it is used to monitor how a line-following robot responds to speech commands. The line following robot uses sensors and a motor driver board to step forward and backwards. Various types of devices, such as cameras, musical sounds, intercom devices, and voice recorders, have become available in recent years. A smart computer with a microcontroller and a voice recorder can be used in a variety of applications.

This paper aims to indicate a cost-effective Voice Controlled home automation (Google Assistant) to monitor general appliances. It mainly targets the physically disabled and elderly persons. The foremost aim of our technology is to increase efficiency and to decrease effort. Several factors need to be optimized to make Google Assistant-powered Home Automation highly reliable, effective, clever, scalable, and better overall.

After an exhausting and long day of hard work, people arrive home tired. As a result, any small device/technology that allows them to turn on/off their lights, play their favorite music, etc., using only their voice and their smartphones will make their home more comfortable. Furthermore, it would be preferable if they could simply give a voice order to steam

the bathwater and change the room temperature before they arrive at their house. Therefore, when they return home, the room temperature and bathwater had been adjusted to their tastes, and they could immediately relax, feel cozier, and at ease.

II. Literature Review

Home automation really started in a physical sense with the formation of mechanization items, starting with home apparatuses. The centralization and automation of private exercises has its underlying foundations in the principal electrically wired private structures toward the finish of the nineteenth century. The home TV in the 1950s and the infrared remote control innovations were helpful for point-to-control correspondence between gadgets however did not have a two-route trade of data. X10 was discharged in the 1970's as a standard convention for wiring houses for home automation.

1901-1920: The invention of home appliances- like refrigerators, washing machine, dishwashers, irons, toaster and garments dryers.

1966-1967: The invention of ECHO IV and Kitchen Computer was the first brilliant device that could register shopping records, control the home's temperature, and turn apparatuses on and off. The cutting edge came as the Internet, which made an overall system of PCs in the 1990s. Before long, remote Internet as Wi-Fi turned into a typical apparatus in American homes.

2000's: The early 2,000's saw a further ascent in brilliant home innovation, including local tech, home systems administration, and different devices showing up available. A combination of short-range technologies created by Zen-Sys in 2005, this wireless technology creates a mesh network at the user's home and sends signals at the 900 MHz spectrum. The Z-Wave technology is capable of connecting a variety of devices to control appliances, door locks and even flood monitors.

The present smart homes are more about security. Current patterns in home mechanization incorporate remote versatile control, computerized lights, robotized indoor regulator modification; booking machines, portable/email/content warnings, and remote video observation sensors are the eyes and ears of the home system. There are sensors for an extensive variety of uses, for example, measuring temperature, dampness, light, fluid, and gas and recognizing development or commotion. The various technologies used in home automation are Bluetooth, Wi-Fi, ZigBee, X10, Z-Wave, etc.

Tan, Lee, and Soh (2002) proposed the development of an Internet-based system to allow monitoring of important process variables from a distributed control system (DCS). Potamitis, Georgila, Fakotakis, Kokkinoss, and G (2003) approach was inclined to not only ordinary people but also people with disabilities to perform real-life operations at home by directing appliances through speech. S. M. Anamul Haque, S. M. Kamruzzaman & Md. Ashraful Islam (2006) proposed that it control the home appliances using the personal computer by using the visual basic 6.0 programming language and voice engine tools for speech recognition purposes.

Jawarkar, Ahmed, Ladhake, and Thakare (2008) proposed remote monitoring through mobile phone involving the use of spoken commands. The spoken commands are generated and sent in the form of text SMS to the control system and then the microcontroller based on SMS takes a decision of a particular task. H. Kanwa, N. Wakabayashi, R. Kanazawa (2003) introduced the design and implementation of a low-cost, flexible, and wireless solution to home automation. Shivani V Devoor, Syed Sha Qutub, and Mallikarjuna Swamy (2015) proposed the design of a sensor network for home automation system using five sensors in the network namely RFID used for controlling the access of the door, light-dependent resistor (LDR) for automatic control of curtains, LM35 for fire detection system, Passive infrared (PIR) for lighting system and ultrasonic level sensor for continuous monitoring of water level in a tank.

Kyung Chang Lee and Hong-Hee Lee (2004) presented a network-based fire detection system via the controller area network (CAN). Rajesh Singh, Amit Kumar Thakur, Anita Gehlot, Akhilesh (2019) presented a paper which includes integration to be carried out with other home appliance, detailed event display and logging, computerized notification , panic buttons, and a centralized monitoring station. This research work focuses its attention on the proper utilization of hand gestures for controlling remote devices. Karishma Yadav, Rajat Johri (2016) proposed a project to develop a system that will provide remote control of home appliances and provide security against intrusion when the home host is not at home. This paper is mainly concerned with the automatic control of light or any other home appliances using internet. The major technologies used to implement these systems include gas sensors, conduct metric gas sensors, potentiometric gas sensors, and smoke alarm.

III. Methodology

A. BLOCK DIAGRAM

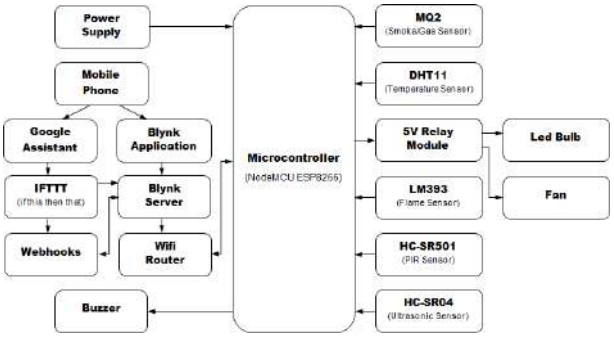


Fig. 1 Block Diagram of the system

The design is implemented using ordinary household appliances and sensors. The process begins with configuring the Webhook (also called a web callback or HTTP push API). The NodeMCU ESP8266 is connected to Google Assistant through the IFTTT service, which is a platform that allows users to formulate simple chains of conditional statements such as if-else statements.

Google Assistant works seamlessly with Android and is a virtual assistant powered by artificial intelligence that is mainly available on smartphones and smart home devices. If This Then That (IFTTT) is a software interface that links apps, devices, and services from various developers to cause one or more automation involving those apps, devices, and services. Webhook allows you to make or receive a web request with IFTTT. All is achieved via the Internet. The relay serves as a switch, allowing the linked home appliances to be switched on/off. The number of relays determines the number of wired home appliances.

The relay module is a 5V four-channel relay interface board with a 15-20mA driver current for each channel. With high-current relays that operate under AC250V 10A or with a broad current, it can monitor a variety of appliances and equipment. The performance supports a variety of loads (Fan, Lights, etc.).

Blynk is an IoT platform that allows you to monitor Arduino, ESP8266, Raspberry Pi, and other devices over the Internet using iOS and Android apps. Drag and drop widgets to build graphical interfaces by downloading the Blynk app and constructing a project, then specifying the microcontroller that will assign the Auth code to your email address. Allocate a digital pin to each button and title it as per Widget Box's relay connections. After entering the Wi-Fi id and password, copy / paste the Auth Token from the email into your Arduino code, then select the ports and module in the Arduino tools section, then compile and upload the Arduino code.

B. CIRCUIT DIAGRAM

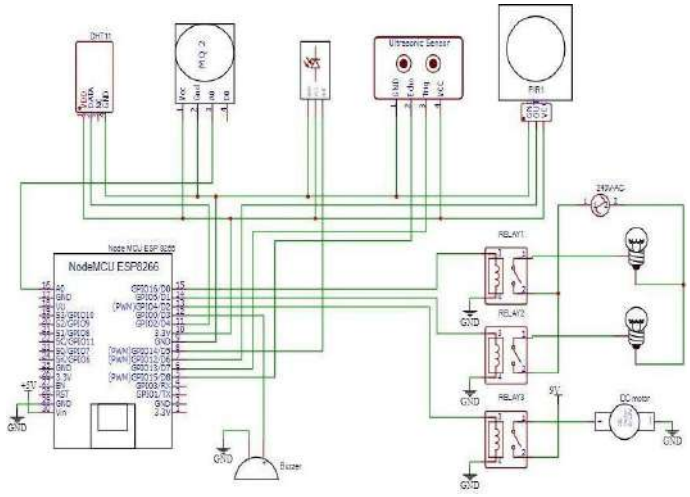


Fig. 2 Circuit Diagram of Sensor network interface to Microcontroller

A sensor network is designed for home automation system consisting of the following modules:

- Flame Sensor
- Gas/Smoke Sensor
- Temperature and Humidity Sensor
- PIR Sensor
- Ultrasonic Sensor

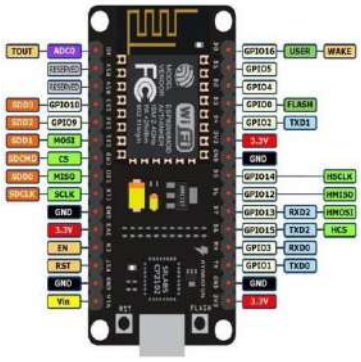
The Flame Sensor LM393 detects a flame or a light source of a wavelength in the range of 760nm1100 nm. A Metal Oxide Semiconductor (MOS) type Gas Sensor detects change of resistance of the sensing material when the Gas/smoke comes in contact with the material.

The DHT11 sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. A PIR sensor can detect changes in the amount of infrared radiation, which varies depending on the temperature and surface characteristics of the objects in front of it.

An Ultrasonic sensor is a device that can measure distance by sending out a sound wave at a specific frequency and waits for that sound wave to bounce back. The buzzer is used by connecting it to a DC power supply between 4 and 9 volts. The buzzer is connected to a switching circuit that turns it on/off at the specified time and interval.

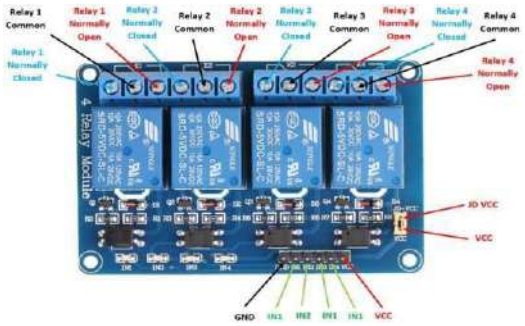
IV. HARDWARE DEVELOPMENT

A. Microcontroller – NodeMCU ESP8266:



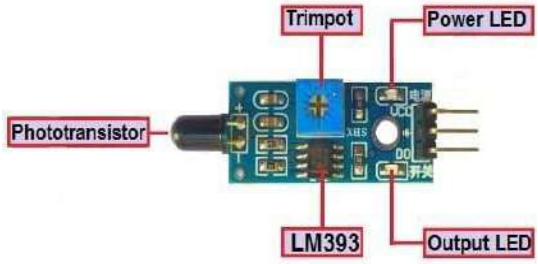
It is an open-source Lua based firmware and development board specially targeted for IoT based applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that is based on the ESP-12 module. It has 30 pins. It can be powered through the USB port and has three 3.3V voltage supply pins. Regulated 3.3V can be supplied to this pin to power the board. It has 4 Ground pins and 1 External Power Supply (Vin). EN and RST are two control pins, which resets the NodeMCU. It has one analog pin A0 that is used to measure analog voltage in the range of 0-3.3V. It has 16 general-purpose input-output pins on its board (GPIO1 to GPIO16). It has four pins available for SPI communication (SD1, CMD, SD0, CLK). It has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.

B. 5V Four-Channel Relay Module:



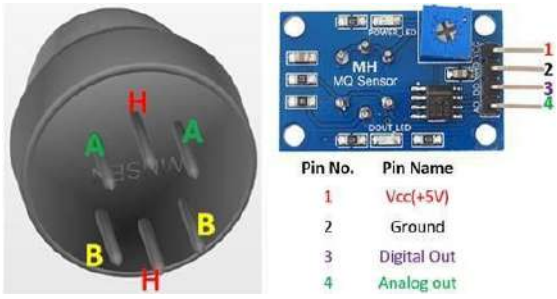
It is every channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with high current relays that work under AC250V 10A or with a large current. It is equipped with DC30V 10A. It has a standard interface that can be controlled directly by a microcontroller. The supply voltage Vcc is given from the 3.3V pin of NodeMCU. The GND pin is grounded. IN1--IN4 are Relay control port, which is connected to digital pins of NodeMCU.

C. Flame Sensor LM393:



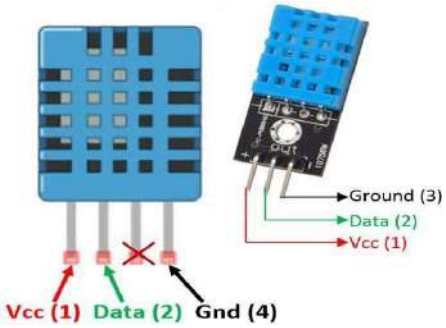
It detects a flame or a light source of a wavelength in the range of 760nm1100 nm. The detection angle is about 60 degrees; it is sensitive to the flame spectrum. It works on an Operating voltage of 3.3V ~ 5V and has 3 pins as Vcc, GND, Dout. The Dout pin is connected to the D5 pin of NodeMCU, the Vcc pin is connected to 3.3V, and the GND pin is grounded. We are using a flame sensor to detect a fire, and if it does, the buzzer turns On, data from the flame sensor's D0 pin is sent to the microcontrollers D5 pin, and we get an alert via the Blynk application that there is a fire at home.

D. MQ2 Gas/Smoke Sensor:



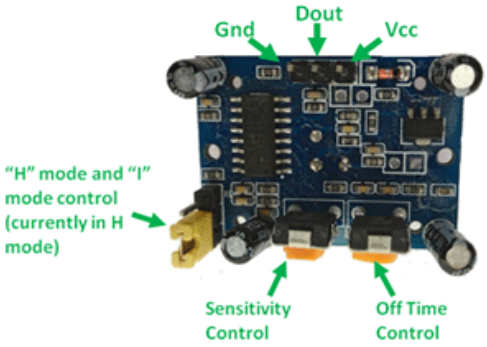
It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon the change of resistance of the sensing material when the Gas/smoke comes in contact with the material. MQ2 Gas/smoke sensor works on 5V DC and draws around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane, and Carbon Monoxide concentrations anywhere from 200 to 10000ppm. It has 4 pins as Vcc, GND, Dout, Aout. The Aout pin is connected to the analog pin (A0) of NodeMCU, the Vcc pin is connected to 3.3V, and the GND pin is grounded. When the MQ2 gas sensor detects smoke or gas leakage at home, a buzzer strikes, data from the Gas sensor's A0 pin is sent to the microcontrollers A0 pin, and accordingly, we receive a notification through the Blynk application.

E. DHT11 Temperature and Humidity Sensor:



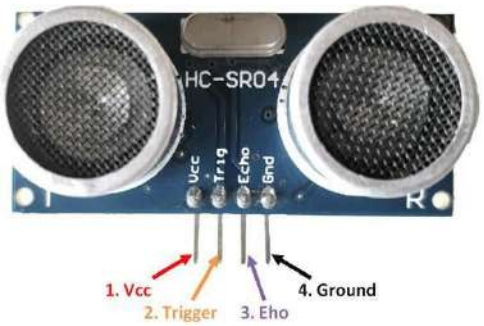
The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. It has 3 pins as Vcc, GND, Data. The Data pin is connected to the D4 pin of NodeMCU, the Vcc pin is connected to 3.3V, and the GND pin is grounded. If the temperature in the room exceeds 25 Degree Celsius, the fan automatically turns on. It senses the temperature and humidity and the statistics are displayed on the Blynk App notification window.

F. PIR Sensor:



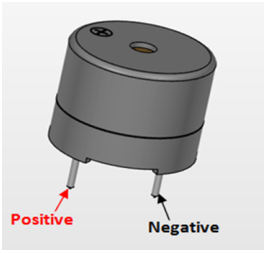
A passive infrared sensor is an electronic sensor that measures IR radiations from objects in its field of view. PIR sensors are commonly used in PIR-based motion detectors, security alarms, and automatic lighting applications. When an object passes, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature and vice versa. The sensor converts the resulting change as the incoming infrared radiation into a change in the output voltage, which triggers the detection. It has 3 pins as Vcc, GND, Dout. The Dout pin is connected to the D6 pin of NodeMCU, the Vcc pin is connected to 3.3V, and the GND pin is grounded.

G. HC-SR04 Ultrasonic Sensor:



It is a device that measures distance by sending out a sound wave at a specific frequency and waits for it to bounce back. By recording the time taken between the sound wave being generated and bouncing back, it is possible to calculate the distance between the sensor and the object. The Ultrasonic sensor's VCC pin is connected to the NodeMCU's VU pin, while the sensor's GND pin is connected to the NodeMCU's GND pin. The Ultrasonic sensor's TRIG pin is connected to the NodeMCU's D7 pin, and its ECHO pin is connected to the NodeMCU's D8 pin. 33 When the tank is filled, the level component on the Blynk app displays it, which activates the buzzer and sends a notification to the user.

H. Buzzer:



A compact 2-pin structure that can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. It is normally associated with a switching circuit to turn ON/OFF the buzzer at the required time and interval. Buzzer's positive terminal is paired to NodeMCU's D3 pin, while the negative terminal is grounded.

V. SOFTWARE DEVELOPMENT

A. Google Assistant:

It is an artificial intelligence-powered virtual assistant developed by Google that is primarily available on mobile and smart home devices. Google Assistant is Google's virtual helper that allows getting stuff done faster. Just by tapping the finger on the smart screen a gazillion times, the job is done by using voice commands. Google Assistant is smart and very well integrated with Android. You can use it to open apps, send messages, make calls, play a specific song on YouTube Music, check the weather, and many other things.

Systematic instructions on how to enable Google Assistant:

- Launch the Google app.
- Tap the More option in the bottom-right corner.
- Head to Settings > Google Assistant.
- Move to the Assistant tab.
- Tap the Phone option at the bottom.
- Enable the Google Assistant option.
- Enable the Hey Google option.

Now that the Assistant is turned on, it is time to take it for a spin. Initialization can be done by saying "Ok, Google" or "Hey Google", and then stating your command. An example of this would be, "Ok, Google. Play a funny cat video on YouTube".

B. IFTTT (If This Then That):

It is a software platform that connects apps, devices and services from different developers to trigger one or more automation involving those apps, devices and services. The Applet creation tool is designed to help you build valuable Applets and publish them for the world to use. Your Applets can have multiple actions and custom filter code to go beyond the basic "if this then that" paradigm.

Creating an Applet on the IFTTT website:

- Visit the IFTTT website or the IFTTT App and tap 'New Applet'
- Tap '+ This' displayed in blue
- Choose a trigger channel. Search for the 'Google assistant' channel.
- Write the command that you want to perform the particular action (turn light/fan On or Off).
- Tap '+ That'.
- Choose Action Channel. Search for the 'Webhooks' channel.
- Specify the appropriate URL which will be in the given format
- http://blynk-cloud IP address/your blynk auth ID/update/digitalin
- Select Method as PUT Content-Type as application/JSON.
- Select body as ["1"] or ["0"] to turn on or off the light/fan.
- Click on create action and thus applet is created.

C. Arduino IDE:

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards. It supports the languages C and C++ using special rules of code structuring. It supplies a software library from the Wiring project, which provides many common input and output procedures.

D. Blynk Application:

It can control hardware remotely, display sensor data, store data, visualize, etc. There are three major components in the platform:

i. Blynk App - allows creating amazing interfaces for projects using various widgets.
ii. Blynk Server - responsible for all the communications between the smartphone and hardware. You can also use Blynk Cloud or run your private Blynk server locally. It is open-source, could easily handle thousands of devices, and can even be launched on a Raspberry Pi.
iii. Blynk Libraries - enables communication with the server and process all the incoming and outcoming commands for all the popular hardware platforms.

Blynk Application set up:

- After downloading the Blynk app, first login with your Gmail address and in the New Project window, write the name of the project.
- Select the hardware (microcontroller), after which the app assigns the Auth code to the Gmail address registered.
- Select the buttons as per the relay connections from the Widget Box.
- Assign a digital pin to each button and name it.
- Copy and paste the Auth Token from the mail to Arduino code, and enter your Wi-Fi name and password likewise.
- In Arduino tools, select the ports, the module, and then compile and upload the code.

VI. Results and Discussions

The main aim of this paper was to provide the safety and minimize the human effort and electrical power by designing the sensor network. The system worked satisfactorily and produced desired outputs and results. The result of using smart devices and getting home technology is that it will assist in creating a comfortable atmosphere at home, which will include convenience, lightness, and an enhanced quality of life. The connection will be secure and reliable in all instances. The network serves as the home's central nervous system, offering a solid foundation for current and future technology.

In a smart home, a complete network solution that meets all of the needs, including TV, music, security, phone, control system, and mobile devices, can be delivered. A high-speed, credible network provides the security that users need. Alert messages can be sent to family members to help them protect the house if an intruder is detected, and live streaming from surveillance cameras can be viewed at any time on a smartphone or an iPad, ensuring complete home security. If there is a hazy path due to smoke, the lighting system can be controlled. As a result, IoT-based technologies provide more than just a solution.

VII. Conclusions and Future Scope

Home automation is an aid for digitizing the home environment. These technologies will have a lot of commercial power for a long time. Home appliances such as bulbs, fans, and motors can be operated according to the user's commands to the Google assistant. The Google Assistant commands are decoded and sent to the microcontroller, which controls the relays connected to it.

The sensor network for the home automation system was successfully developed and tested. With the available advanced mechanisms and the integration of the entire system into one network, a stress-free living environment can be developed. The property is absolutely safe from fire accidents and burglary, and there is also an overhead tank level control feature. The PIR-based circuit for home security triggers alarms if motion is detected. Reduced maintenance costs, fast rollout, installation, and coverage, system scalability and easy expansion, aesthetic benefits, and integration of mobile devices are just a few of the benefits of using wireless technology over wired networks.

Big associations like Philips, Siemens, and Schneider will as time goes on bring out truly mass-market mechanization things with interfacing with UI in any case at lower esteem point as a contrast with today, and more people will be able to bear the cost of things. The household activities such as food preservation and preparation can be automated with the movement of pre-packaged food or pre-made food. A smart garage that can determine the length of a car and evaluate which block to park it in as it navigates the vehicle through the garage, making parking easier for the homeowner. More energy can be conserved by ensuring the occupation of the house before turning on devices and checking the brightness and turning off the light if not necessary.

Acknowledgment

It gives us great pleasure and immense satisfaction to present this paper on “Home Automation using Voice Control (Google Assistant) and Blynk App”, which became possible due to the unstinted guidance and focused direction of Prof. Ajit Saraf. We express our sincere gratitude to Dr. R. H. Khade, Head of Electronics Department, without whom it would not have been possible to successfully accomplish our paper. We also thank our senior faculty members of the Electronics department for their time-to-time suggestions. Furthermore, we are indebted to Principal Dr. Sandeep Joshi whose constant encouragement and motivation inspired us to do our best. Finally yet importantly, we sincerely thank our family members, colleagues and all the others who directly or indirectly contributed to making our task easier.

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GPS Navigated Carry Bot

Anisha Vemula[1], Pratibha Verma[2], Sujith Nair[3], Rohan Sharma[4]

Department of Electronics

Pillai College of Engineering, University of Mumbai

Mumbai, Maharashtra, India

vemulaanibh17ee@student.mes.ac.in, vermapraha17ee@student.mes.ac.in,

nairsrel16e@student.mes.ac.in , sharmarcel16e@student.mes.ac.in

Abstract: The project is to build an autonomous Robot prototype using Node MCU as a processing chip. Navigation of a mobile robot in an unknown and uncertain environment requires knowledge about the robot's current position. A natural approach to manage the task is using GPS (Global Positioning System). The GPS controlled autonomous BOT is a rover that can be used for delivering goods without human intervention. The bot has a cart for carrying goods for delivery purpose and can also be used to walk-through places which are harmful for humans. The proposed work consists of two working modes - GPS streaming and GPS waypoint. In the streaming mode, the robot follows the user by streaming the co-ordinates from the android application using Bluetooth connectivity. The waypoint method allows the user to enter starting and destination location and give start command using mobile application. Once, the command is received from the server, the BOT starts heading towards the selected destination. Magnetometer is used to update coordinates which makes sure the robot is in right path towards the destination. The cart that carries the goods is protected using a lock that can be controlled only using the mobile application. Autonomous guided vehicles have found numerous applications in the industries, hospitals, army, etc. This robot is an approach towards world of self-driving vehicles. The BOT would replace the conventional way of transferring materials within an allocated space. It will ensure faster, safer and dependable way of for delivering materials.

***Keywords*- Global Positioning System, Magnetometer, Navigation, Bluetooth, Autonomous**

1. INTRODUCTION

A robot is an electromechanical machine that is controlled by PC program to perform different operations. Modern robots have intended to decrease human exertion and time to enhance profitability and to diminish fabricating cost. Today human-machine collaboration is moving far from mouse and pen and ending up significantly more inescapable and considerably better with the physical world. Android application can control the robot movement from a long separation utilizing Bluetooth correspondence to interface controller and Node MCU is interfaced with Bluetooth module. According to the summons got from android application the robot movement can be controlled. Navigation of a mobile robot in an unknown and uncertain environment requires knowledge about the robot's current position. A natural approach to manage the task is using GPS (Global Positioning System).

The GPS controlled autonomous BOT is a rover that can be used for delivering goods without human intervention. The bot has a cart for carrying goods for delivery purpose and can also be used to walk-through places which are harmful for humans. With the drastic increase in demand in the fields of Sports, Medicine and e-Commerce, our aim is to minimize human efforts and make the process efficient and structured. The goal is to deliver miscellaneous materials for short distances in an autonomous way. The scope for Carry-Bot diversifies in various sectors which are as follows. Carry-Bot would be used for transporting first-aid and refreshments during sports activities (Olympics, Tournaments). Secondly, in hospitals where patients with transmittable diseases will be provided medicine with zero physical contact. This will indeed help in safeguarding the health of doctors and nurses. Carry-Bot would also be used for delivering materials and groceries for shorter distances which will result in reduction of manpower utilization.

1.1 Literature survey

The implementation of GPS into the system will result into two modes of navigation i.e., Manual mode and GPS Waypoint. The co-ordinates are obtained by parsing the GPGGA string, hence the parsing and feeding of coordinates will be done by the Tiny GPS Library. For providing a sense of direction, a magnetometer will be used which indeed would act like a compass. The magnetometer (HMC58331 Compass) is used for measuring the direction and magnitude of the earth's magnetic field This technique has been implemented in "GPS controlled autonomous bot for unmanned

Delivery" by S.S. Prabhu and Dr G. Kannan in 2018. The main purpose of the technique involves delivering good without human intervention. The destination point is entered in the mobile application and the bot is navigated accordingly. A Cost-Effective GPS Guided Autonomous Object Transporter Robot for Disaster Management and Industrial Automation by D.J. Paul and A.I. Khan in 2017 also includes the implementation of GPS for navigation purpose. A P-controller has also been used for providing a heading angle to the robot. Robot can set its moving direction using compass by taking feedback from the GPS receiver.

1.2 Hardware

Description	Quantity
Node MCU ESP 32	1
GPS Module Ublox Neo-6M	1
Magnetometer HMC5853L	1
Motor Driver L298	1
DC Motor	2
Wheels	2

Microcontroller ESP32:

Fig No.1 ESP32

ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. At the core of this module is the ESP32-D0WDQ6 chip*. The chip embedded is designed to be scalable and adaptive. There are two CPU cores that can be individually controlled, and the CPU clock frequency is adjustable from 80 MHz to 240 MHz The chip also has a low-power co-processor that can be used instead of the CPU to save power while performing tasks that do not require much computing power, such as monitoring of peripherals. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speed SPI, UART, I²S and I²C.

Magnetometer:

Magnetometer HMC5883L is used for measuring the direction and magnitude of the Earth's magnetic field. It is used for low-cost compassing and magnetometry. It measures the Earth's magnetic field value along the X, Y and Z axes from milli-gauss to 8 gausses. It can be used to find the direction of heading of the device and uses I2C protocol for communication with microcontroller.

GPS module:

Fig. No. 2 GPS Module

GPS receivers are generally used in smartphones, fleet management system, military etc. for tracking or finding location. Global Positioning System (GPS) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth. GPS is also known as Navigation System with Time and Ranging GPS. GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites. This GPS receiver is used in many applications like smartphones, Cabs, Fleet management etc. GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located. These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time. GPS receiver module gives output in standard (National Marine Electronics Association) NMEA string format. It provides output serially on Tx pin with default 9600 Baud rate.

VCC: Power Supply 3.3 – 6 V

GND: Ground

TX: Transmit data serially which gives information about location, time etc.

RX: Receive Data serially. It is required when we want to configure GPS module.

Motor driver**:**

The motor driver connects to the Node MCU, which would supply both power and data signals that will tell the motor when to run using PWM (pulse width modulation). A separate power

gets passed directly to the motor. The reason for using separate power supply for the motor is because motors act as inductors, therefore there can be a reverse current flow which may cause instability in the system.

II. Block Diagram and Working

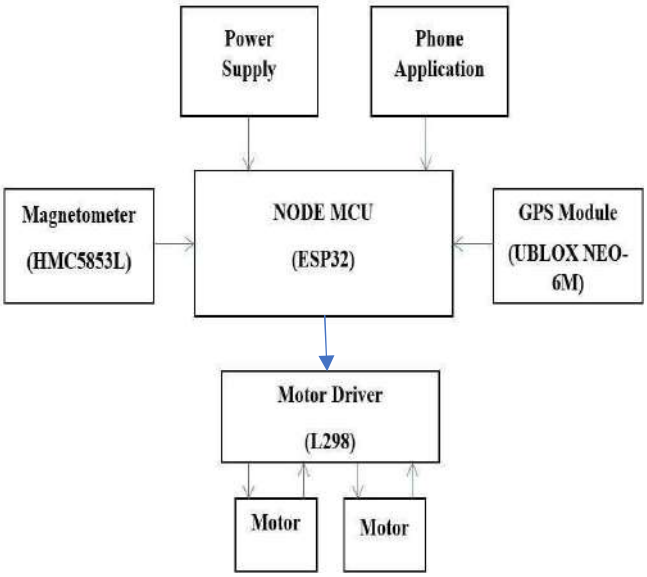

Fig. No. 3 Block Diagram

Working

The above flow chart explains the operation of the algorithm designed for the robot. Starting from the top is the initialization section for motor pins, GPS module pins and the declaration of some variables that are used in the later part of the algorithm. Initially, when the ESP32 starts the GPS module, compass and monster moto shield is powered ON. The GPS module locates the current position of the robot. The current location is stored in two variables as latitudes and longitudes. The destination coordinates are defined in the algorithm. Now the algorithm calculates the distance between the current location and destination using the distance formula. Further, the current heading of the robot is located using the compass module and also the heading from a current location to the destination is calculated using heading formula. In order to drive the robot in the desired direction, the difference of the current heading and the formula heading is calculated. Once these calculations are done the robot starts to move towards the first location given in the algorithm. While traveling towards the destination location the GPS module continuously updates the location and also the overall process is done till the robot reaches close to the destination. In the algorithm, the minimum distance condition of 5 meters is defined which is checked every time a new location is found. If this condition is satisfied it means that the robot has reached its first destination location. Now the counter is incremented and again the same process is repeated. Once the counter reaches the predefined value it means that the robot has reached to its final destination and it slowly stops. The advantage of this algorithm is that it calculates the accurate distance between ant two coordinates. As per the working of the robot, it is observed that the accuracy of the robot is 5 to 6 meters which is acceptable for this project.

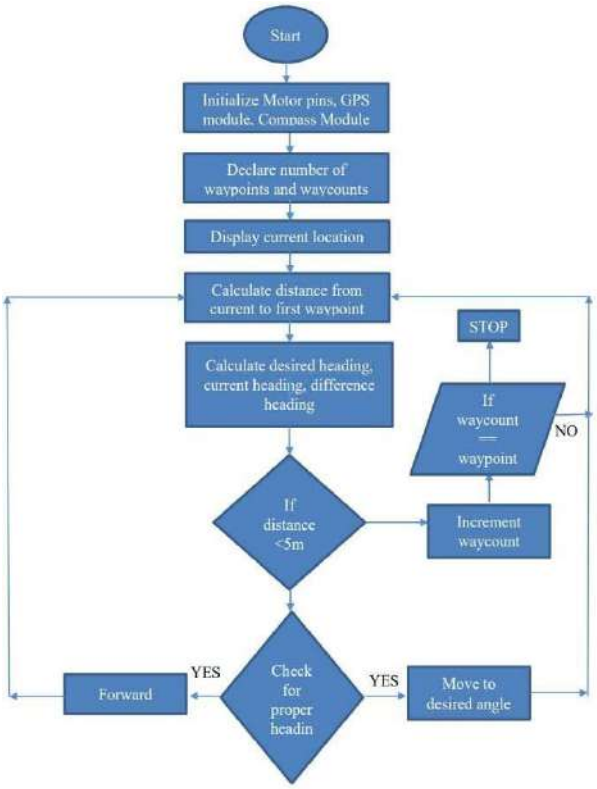

Fig. No. 4 Flow Chart

App Implementation:

MIT App Inventor is an online platform designed to teach computational thinking concepts through development of mobile applications. Students create applications by dragging and dropping components into a design view and using a visual blocks language to program application behaviour. In this chapter, we discuss (1) the history of the development of MIT App Inventor, (2) the project objectives of the project and how they shape the design

of the system, and (3) the processes MIT uses to develop the platform and how they are informed by computational thinking literature. Key takeaways include use of components as abstractions, alignment of blocks with student mental models, and the benefits of fast, iterative design on learning.

III. Conclusion

Carry-Bot is an autonomous robot which intelligently detects the obstacle in its path and navigates according to the GPS modes directed by the user, thus delivering the miscellaneous material or package to the required destination. The primary goal of this project was to build an autonomous robot that can move from one location to another with the help of GPS coordinates. Therefore, this system provides an alternate way to the existing system by replacing skilled labour with robotic machinery, which in turn will handle assigned tasks with better accuracy and a lower per capital cost. Different factors are various methodologies have been analysed and reviewed with their merits and demerits under various operational and functional strategies are taken into consideration for building the Carry-Bot. It is used make the delivery process convenient and ship to the desired location and also minimize human efforts in various sectors.

Acknowledgement

It gives us great pleasure and immense satisfaction to present this report on our project “GPS Navigated Carry Bot”, which became possible due to the unstinted guidance and focused direction of, Prof. Ujwal Harode, Electronics Department. We express our sincere gratitude to Prof. Rajendra khade, HOD, Electronics Department without whom it would not have been possible to successfully accomplish our project. We also thank to our senior faculty members of Electronics department, Prof. Ajit Saraf and Prof Ujwal Harode for their time-to-time suggestions to develop the project. Furthermore, we are indebted to the Principal Dr. Sandeep Joshi whose constant encouragement and motivation inspired us to do our best. Last, but not the least, we sincerely thank our family members, colleagues and all the others who directly or indirectly contributed in making our taskeasier.

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Design and Prototyping of Compact, Portable, Cost effective Ventilator

Prof. Tusharika S. Banerjee
Yash Shirke, Khushal Sule, Shivangi Singh, Diksha Negi

Department of Electronics, Pillai College of Engineering, New Panvel, Mumbai University, India

***Abstract*— The worldwide medical community currently faces a critical shortage of Ventilators to address the COVID-19 pandemic. As the respiratory illness due to COVID-19 pandemic spreads worldwide, health care systems are facing the tough challenges of acquiring ventilators to support patients. Companies are scaling up their production, but this will not be sufficient to meet the demand according to the current forecasts. There is an unmet need for rapidly deployable, emergency-use ventilators with sufficient functionality to manage COVID-19 patients with severe acute respiratory distress syndrome. Here, we show the development and validation of a simple, portable and low-cost ventilator that may be rapidly manufactured with minimal susceptibility to supply chain disruptions. The proposed low-cost ventilator delivers breaths by compressing a conventional bag-valve-mask (BVM) with a motor-arm mechanism attached with a wire of higher tensile strength, eliminating the need for a human operator. The respiratory rate (10-30 breaths/minute) or air flow (volume in ml) will be displayed accordingly. The control of air flow inside the air bag (capacity of 2600 ml max.) can be achieved by changing the rotation speed of the motor which in turn will pump (100ml-650ml) the corresponding amount of air. Also, a Buzzer which acts as a safety measure gets triggered when power supply gets off. There are other techniques too such as sliding mechanism using servo motor and the pivoting motor arm mechanism but it makes the overall mechanism very bulky. But the mechanism illustrated in the paper reduces the overall bulk.**

***Keywords*— COVID-19, Ventilator, Bag Valve Mask (BVM), Low-Cost, Low-Power, Portable and Automatic.**

I. INTRODUCTION

This paper will propose all features and procedures to develop a Compact, Portable, Cost effective Ventilator. This paper specially contains details about objectives followed by design concept then Methodology, primary requirements, Control Implementation, Software Implementation and finally the conclusion.

Health experts and authorities maintain that only about 15 percent of Covid-19 patients actually need hospitalization, treatment in ICU, oxygen supply for breathing or ventilator support. In Covid-19 patients, the coronavirus blocks haemoglobin from exchanging carbon-dioxide for oxygen. Patients simply begin desaturating. That is, they are losing oxygen content in their bloodstream. Normal saturation level shows oxygen level in the body at 95 per cent. A report by The Lancet [7] said the oxygen level can drop to 60 or 50 per cent in some of Covid-19 patients. In such a situation, oxygen supply to different organs starts drying up, and eventually organ failures happen [8].

As the respiratory illness due to COVID-19 pandemic spreads worldwide, health care systems are facing the tough challenges of acquiring ventilators to support patients. All steps involved in the supply chain management of ventilators are being escalated to produce more ventilators for the coronavirus frontline [6]. The seriously ill patients suffering from COVID-19 need respiratory support, as their lungs get damaged by the coronavirus leading to breathing difficulties. Ventilators are needed in such cases for supplying adequate oxygen (O2) into their lungs and also removing the carbon dioxide (CO2), as a lifesaving supportive measure. The ventilators are one of the most vital medical devices needed to keep these critically ill COVID-19 patients alive.

Medical ventilation is basically of two types: a) invasive mechanical ventilation and b) non-invasive ventilation. The invasive mechanical ventilation uses an Endotracheal Tube or a Tracheostomy Tube which is inserted into the trachea for the flow of oxygen into the lungs of the patient, whereas the non-invasive ventilation does not employ any internal tube. The non-invasive ventilation devices such as continuous positive airway pressure (CPAP) devices and Oxygen Hoods or Nasal Masks are also used in the management of less severe COVID-19 patients, so as to avoid the need of mechanical ventilators which are invasive in nature [6].

One of the main reasons for the shortage of ventilators is the issues related to their global supply chain. Due to the worldwide spread of infection, the exports of medical equipment including ventilators have come to a halt. The situation has become so alarming that as many as fifty-four countries have stopped exporting the goods related to the medical field including ventilators. The production of medical machines such as ventilators demands more intensive capital and expertise.

The ventilators are often fragile and vulnerable during continued use, requiring costly service contracts from the manufacturers [3]. Hence there is a need to build a portable ventilator which will be used to deliver breathing support during emergency situations. As these ventilators are inexpensive, easy to produce and non-metallic, they can be used in remotely located areas for longer runs without major

wear and tear of components. So, the proposed ventilator is a device operated by a microcontroller which calibrates the motor according to the breathing requirements of the patients with the assistance of BVM.

The Comparison between the Modern and Portable ventilator is shown in Table I.

TABLE I
COMPARISON OF VENTILATORS

Sr.No.	*Parameters*	*Modern Ventilator*	*Portable Ventilator*
1.	Cost	High costing due to complex & metallic components	Low costing due to readily available, easily manufactured & non-metallic components
2.	Portability	Difficult to transport	Easy to transport
3.	Size	Bulky	Compact
4.	Power Consumption	10-30V DC	12-15V DC
5.	Efficiency	High	Low

The objective of this work is as follows:

1. A portable ventilator should be lightweight, robust, and able to function in demanding environments with little maintenance.
2. It must use available gas or electrical supplies sparingly. It should be inexpensive, simple to operate, and provide a range of effective ventilatory modes.
3. It is made using readily available components that can be manufactured quickly and easily in small quantities or on mass at low cost.
4. Portable ventilators may not provide identical support to the ICU machine in use despite apparently similar settings; a trial period should always be allowed before moving the patient.
5. To work reliably and with the lowest risk to the patient (partly to help speed up the medical product approval process, if this project gets that far).

The ventilators are needed to provide support to lungs in case of attack on lungs, the severity of which has become an open challenge during the current pandemic times. There is a need to develop handy, compact and cost-effective portable ventilators. These will be able to be used in large numbers making best possible utilization of space and available resources, much useful in remotely located areas.

II. DESIGN CONCEPT

The design of the prototype is very much similar to Fig. 1. The Air delivery technique [8] is based on Motor-arm mechanism. There are two sets of compression arms namely top compression arm and bottom compression arm. The Ambu-Bag is placed between these compression arms as shown in Fig. 1. The Servo-motor is attached to a spool, aligning the center of the servo arm with the center hole on the spool, and the furthest hole on the servo arm with the singular hole near the rim of the spool as shown Fig. 4.

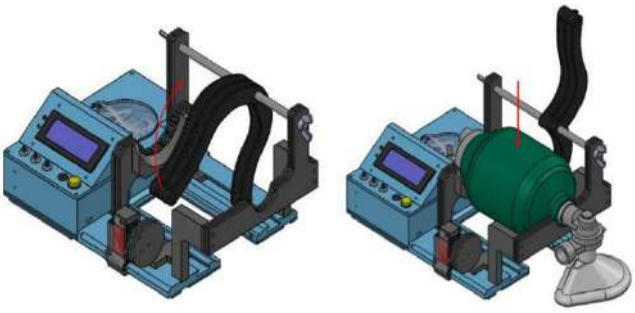

Fig. 1 Prototype Model

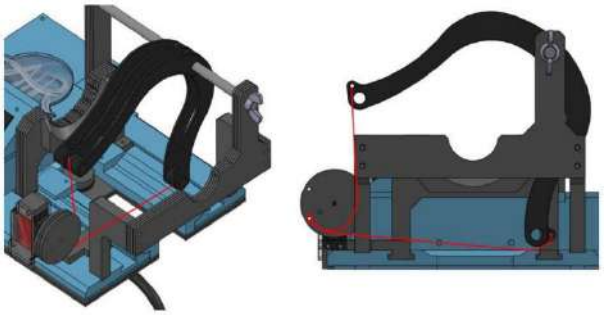

Fig. 2 Motor-Arm Mechanism

The servo spool is attached to the servo-motor using the servo arm. Align the large center hole on the servo arm with the shaft of the servo as shown in Fig. 3. The compression arms are attached to a servo spool using a wire of higher tensile strength (for example: Nylon). One end of a piece of nylon wire is tied around the connector on the lower compression arm set and the other end of wire is tied around the outermost screw on the servo spool, with the spool in the approximate orientation as shown in Fig. 2. Same attachments are done for the upper compression arm, except instead of tying the wire directly to the arm connector, tie it to one end of the hook. Remove the hook, lift and rotate the top compression arms out of the way. Place the Bag Valve Mask inside the device as shown in Fig. 2. The upper arms can then be lowered, and the hook can be re-attached.

Fig. 3 Servo-arm and Spool connections

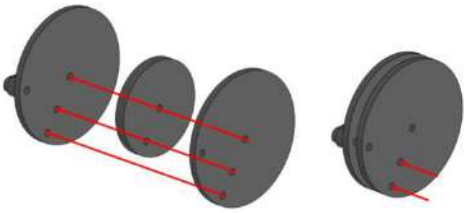

Fig. 4 Spool

It is important the wires connecting the compression arms to the servo spool are taught when the bag is fully uncompressed and the servo is in its start position. Some trial and error by the user will be required during setup to achieve proper results. It is recommended that the device be turned on and run through one compression to see the start/stop location of the servo. Then, with the device off, the servo spool should be carefully removed using the center screw and rotated to ensure the wires are taught in this position before reattachment. When the device is turned on the motor will rotate the spool in clockwise direction and pull both the compression arms. Because of which the ambu-bag placed between is compressed and the corresponding Volume of air is supplied to the patient.

III. METHODOLOGY

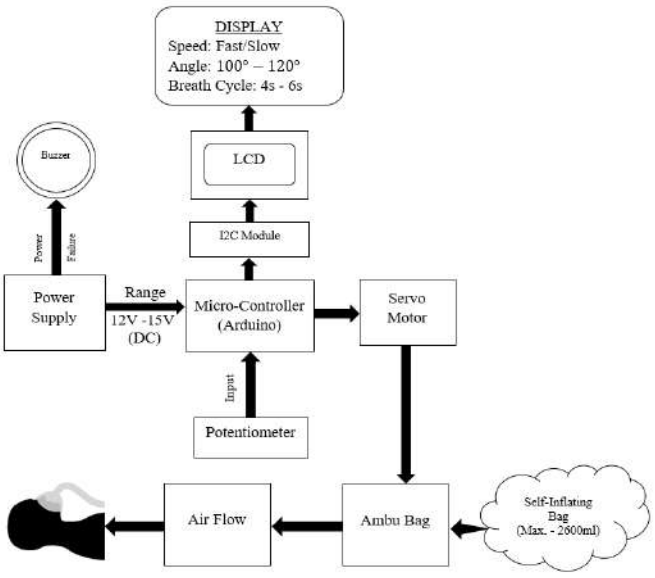

Fig. 5 Block Diagram of Portable Ventilator

The Block diagram of the ventilator is shown in the Fig. 5. Starting with the power supply, which is of 12-15 volts DC, is given as input to the microcontroller. The microcontroller used is Arduino Uno and it is programmed to drive the motor arrangement. This arrangement is called the motor-arm mechanism [3]. This mechanism consists of an arm whose one end is attached to the motor with a wire of higher tensile strength [4]. The LCD is interfaced using an I2C module which uses the PCF8574T IC chip which converts I2C serial data to parallel data for the LCD display. It also displays the values that are given as an input such as Angle (in degrees), Speed(min/max) and Breath Cycle (in seconds) to the motor. There are a total of six instances(modes) in the code which can be changed by adjusting the potentiometer and accordingly the servo motor will run. The instances differ from person to person depending upon their respiratory rate or breath cycles. A Push button is used to start and stop the ventilator. Once an appropriate instance is selected, the motor will rotate accordingly which pulls the connected arm. The instance can be changed with the help of a potentiometer. The arm is used to apply pressure to the Ambu-bag which gives out airflow. This volume of air is proportional to the speed and pressure applied by the arm. The rotation or frequency of the motor is programmed to achieve the desired output. The control of air flow inside the air bags (capacity of 2600 ml) can be achieved by changing the rotation speed of the motor which in turn will pump (100ml-650ml) the corresponding amount of air. During this process, if the Arduino loses power supply the buzzer is automatically triggered indicating power failure has occurred. The buzzer [2] will keep on ringing till either the power supply resumes in the ventilator or the buzzer switch is turned off manually. Buttons are used to start and stop the ventilator. The buzzer is connected to the circuit through relay. The relay has two different types of electrical contacts inside – normally open (NO) and normally closed (NC). The buzzer is connected to the normally closed side and the normally open side is connected to the Arduino pin. Once the start button is pressed a 5 volts supply is given to the relay through Arduino which will charge the electromagnet and attracts the contact from normally closed to normally open which will break the buzzer circuit. So, when the ventilator will start there will be no sound coming from the buzzer. When the power failure occurs, there is no supply to the Arduino because of which the voltage across the electromagnet drops and the contact goes to its original position completing the buzzer circuit and the buzzer gets activated.

IV. SYSTEM REQUIREMENT

As the term suggests the final prototype will be handy, rugged, easy to handle and accessible. It can be easily transported as compared to traditional ventilator due to its compact size. Also, it can be battery operated which makes it more flexible. Also, the overall structure is non-metallic which makes it easy to transport. Components used to build the prototype are easy to manufacture, readily available and low-cost which in turn reduces the overall costing. Since it is non-metallic, the manufacturing cost is also reduced.

A. Controller:

An Arduino Uno is used to control our device. The microcontroller runs a simple control loop to achieve user-prescribed performance. Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists of other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in Arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 Kilo-ohms which are disconnected by default. Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e., 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using an AREF pin with analog Reference() function. Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx).

B. Motor:

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. If a motor is powered by a DC power supply, then it is called a DC servo motor, and if it is an AC-powered motor then it is called an AC servo motor. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Servo motors works on the PWM (Pulse Width Modulation) principle, which means its angle of rotation is controlled by the duration of pulse applied to its control PIN. Basically, a servo motor is made up of a DC motor which is controlled by a variable resistor (potentiometer) and some gears. The main reason behind using a servo is that it provides angular precision, i.e., it will only rotate as much we want and then stop and wait for the next signal to take further action. The servo motor is unlike a standard electric motor which starts turning as when we apply power to it, and the rotation continues until we switch off the power. We cannot control the rotational progress of an electrical motor, but we can only control the speed of rotation and can turn it ON and OFF. Servo motor applications are also commonly seen in remote-controlled toy cars for controlling the direction of motion, and it is also very widely used as the motor which moves the tray of a CD or DVD player. Besides these, there are hundreds of servo motor applications we see in our daily life. Servo motors are rated in kg/cm (kilogram per centi-meter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance.

TABLE II
HARDWARE REQUIREMENTS

Sr. No.	***Components***	***Descriptions***
1.	Arduino Uno	ATmega 320P, Operating Voltage: 5V, Input voltage: 7-20V.
2.	Servo Motor	Operating Voltage: 4.8V - 6V Stall Torque: 13kg/cm - 15kg/cm
3.	LCD Display	Display Format: 20x4 Operating Voltage: 5V
4.	Ambu-Bag	Max. Capacity: 2600 ml (for adults)
5.	I2C Module	Operating Voltage: 5V
6.	Buzzer	Operating Voltage: 4V - 8V Sound Type: Continuous Beep
7.	Potentiometer	Resistance value: 10K
8.	Push Buttons	Action type: Momentary contact type
9.	Relay	Trigger Voltage: 5V Trigger Current: 70mA Max. Switching: 300 operating/min
10.	LED	Forward Voltage: 3.0V - 3.5V Colour: Red, Green & Yellow
11.	Battery	Voltage: 9V DC
12.	Resistors	Resistance value: 10KΩ (1 piece) 220Ω (3 pieces)

C. Liquid Crystal Display:

A Liquid Crystal Display (LCD) is a flat panel display, electronic visual display or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. Here, in this we are going to use a monochromatic 20x4 alphanumeric LCD. 20x4 means that 20

characters can be displayed in each of the 4 rows of the 20x4 LCD, thus a total of 80 characters can be displayed at any instance of time. LCD display is used to show the inputs given to the motor as well as the respiratory rate, speed and angle of the servo motor which is to be displayed.

D. Bag Valve Mask:

The Artificial Manual Breathing Unit (Ambu-bag) also known as BVM (Bag Valve Mask) which is a “self-inflating bag" and is a hand-held device commonly used to provide positive pressure ventilation to patients who are not breathing or not breathing adequately. It is made of silicon and has a maximum capacity of 2600ml.A bag valve mask (BVM), sometimes referred to as an Ambu-bag, is a handheld tool that is used to deliver positive pressure ventilation to any subject with insufficient or ineffective breaths. An Ambu-bag consists of seven parts: a mask, a main ventilation and backup bags, medical valve systems and a nipple. A distinctive feature of the AMBU breathing bag is a non-reversible medical valve system with input and output ports. In the process of inhalation one of them opens letting the respiratory mixture to the patient. Through the exhalation port the exhaust gas is released into the atmosphere. Compared with artificial mouth-to-mouth breathing, it is more hygienic, simple and effective. When the ventilation bag is squeezed, the air enters the lungs of the patient, while the non-reversible breathing valve prevents backfiring of the exhaled air. Then the AMBU self-dispenses by sucking air from the valve from its back side. An ambient air can be used as a "fuel", or an oxygen cylinder can be connected. In the latter case, it is possible to connect a tank to collect excess oxygen, which was not used by the patient.

E. I2C Module:

The I2C Module has an inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version, you have checked the black I2C adaptor board on the underside of the module. If there are 3 sets of pads labelled A0, A1, & A2 then the default address will be 0x3F. If there are no pads the default address will be 0x27.The module has a contrast adjustment pot on the underside of the display. This may require adjusting for the screen to display text correctly.

F. Buzzer:

A buzzer is a small yet efficient component to add sound features to our project/system. It is a very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications. There are two types of buzzers that are commonly available. One is a simple buzzer which when powered will make a continuous beeping sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beeps at specific intervals. Sound due to the internal oscillating circuit present inside it. This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

G. Relay:

A relay can be defined as a switch. Switches are generally used to close or open the circuit manually. Relay is also a switch that connects or disconnects two circuits. But instead of manual operation a relay is applied with an electrical signal, which in turn connects or disconnects another circuit. To drive the relay we have to consider two important parameters of the relay. Once is the Trigger Voltage; this is the voltage required to turn on the relay that is to change the contact from Common->NC to Common->NO. Our relay here has 5V trigger voltage, but you can also find relays of values 3V, 6V and even 12V so select one based on the available voltage in your project. The other parameter is your Load Voltage & Current, this is the amount of voltage or current that the NC, NO or Common terminal of the relay could withstand, in our case for DC it is maximum of 30V and 10A. Make sure the load you are using falls into this range.

V. Control Implementation

The control loop diagram for the system is shown in the Fig.6 below.

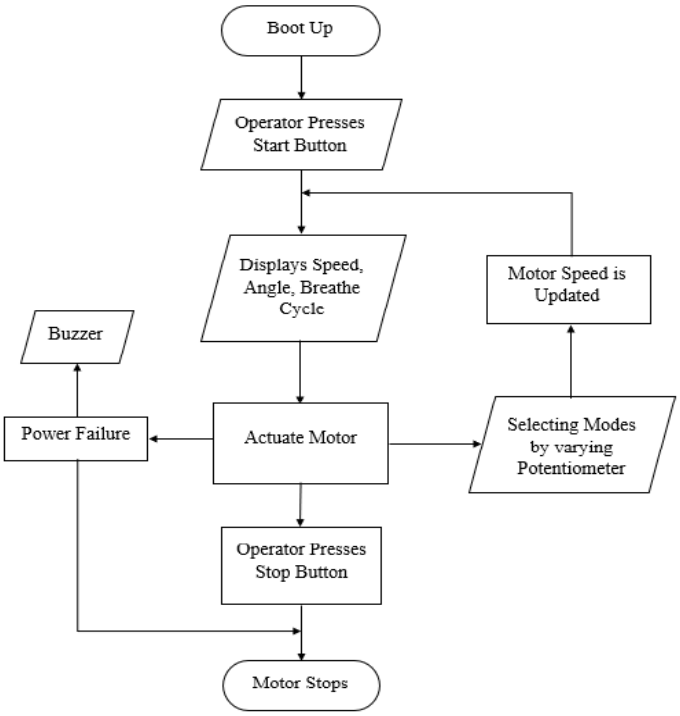

Fig. 6 Ventilator Control Loop

VI. Software Implementation

For the prototyping of this system, Arduino Uno is used as microcontroller which is less expensive and easily available in market. The microcontroller runs a simple control loop to achieve the mode selected by the user. For the Motor arm mechanism, the controller triggers the motor and depending upon the mode selected the motor compresses the BVM. The mode can be adjusted depending upon the patient's need and accordingly all the parameters are displayed. Once the BVM is pressed it deliver the breath to the patient. Once the breath was delivered, the controller will wait for the next exhale cycle before delivering the next breath to the patient. The loop then repeats to deliver intermittent breaths. Also, in order to make the system secure for the patient, a buzzer is added to indicate power failure. The control loop diagram for the system is shown in Figure 5.0

The Code of the project is built in Arduino IDE and written in C++ Language. As studying the research paper, designing the block diagram and circuit diagram was convenient which helped us designing it using the proteus software to check the implementation of the project. We developed an algorithm for the software as it plays a vital role so that we can analyze the complete system and understand the entire working of the software. After developing the algorithm, we write the code for each and every individual part of the project. After successful compilation of code using the Arduino IDE. As the open-source Arduino software makes it easy to write the code and upload it to the board. This software can be used with any Arduino board. After the compilation of the code, we started designing the circuit in proteus software. The hex file, which is obtained after the compilation of code in Arduino IDE, is necessary for the simulation of the portable ventilator. It is then loaded on the microcontroller in the proteus which helps to run the simulation of the entire system successfully as shown in Fig. 7.

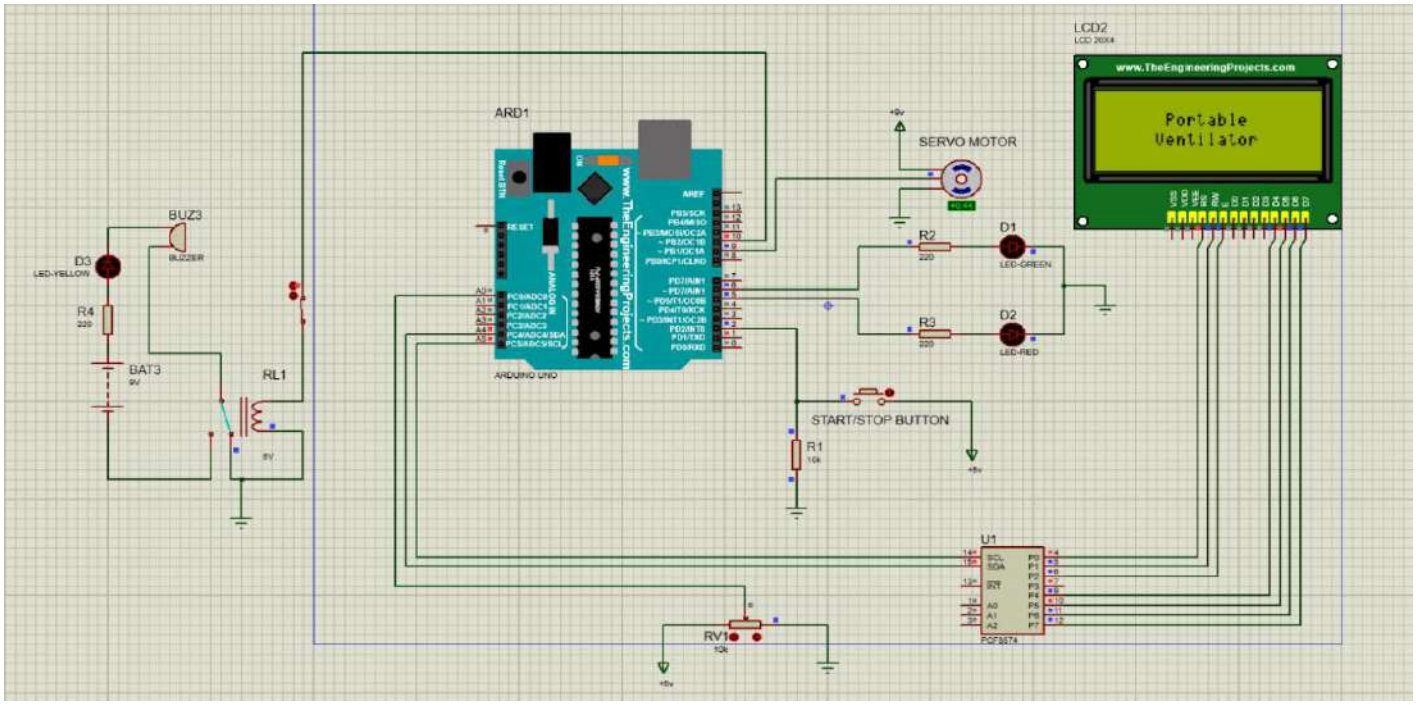

Fig. 7 Circuit Diagram for Portable Ventilator in Proteus

VII. Conclusion

In this paper, the study of motor-arm mechanism technique is presented. Knowing about the practice of ventilation management in patients with COVID-19, we aimed to describe the practice of ventilation management and to establish outcomes in ventilated patients with COVID-19. The system was developed for in house and for emergency use in remote areas outside the grid. Various research papers have helped us to find a way in building a portable ventilator. The key points from numerous research papers were studied to have a relative understanding about our system. Different techniques were cited from different articles but they had their own drawbacks. Hence, we figured that the motor-arm mechanism is more reliable as compared to the other techniques. The parameter factors such as cost and portability are mentioned in this paper. Different inputs and outputs that may be used in this experiment are defined in this system. Various applications of this system

are being identified and presented. It should be noted that our design is not comparable to commercial ventilators in many ways. We are hoping to give our best to help meet the requirements arising out of current health crises because of COVID 19.

ACKNOWLEDGEMENT

It gives us great pleasure and immense satisfaction to present this paper on our project "Design and Prototyping of Compact, Portable, cost effective Ventilator", which became possible due to the unstinted guidance and focused direction of Prof. Tusharika Banerjee, Electronics and Telecommunication Department. We express our sincere gratitude to Prof. R.H. Khade, HOD, Electronics Department without whom it would not have been possible to successfully accomplish our project. We also thank our senior faculty members of the Electronics Department, Prof. Ujjwal Harode and Prof. Tusharika Banerjee for their time suggestions to develop the project. Furthermore, we are indebted to the Principal Dr. Sandeep Joshi whose constant encouragement and motivation inspired us to do our best. Last, but not the least, we sincerely thank our family members, colleagues and all the others who directly or indirectly contributed in making our task easier.

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Infant Incubator using Fuzzy Logic Control

Gurpreet Singh Saini, Prachi Balasaheb Karande,
Pallavi Krishnaji Kothavale, Nithya Muraleedharan Panicker
Department of Electronics Engineering, Dr. K.M.Vasudevan Pillai Campus,
Plot No.10, Sector 16, New Panvel, Navi Mumbai, Maharashtra 410206,
India.
sainigursi17ee@student.mes.ac.in
prachi17@student.mes.ac.in
kothavalepalkr17ee@student.mes.ac.in
nithyamur17ee@student.mes.ac.in

***Abstract*— Premature birth is a worldwide problem. Neonates, who are born premature, often don't have enough maturity to regulate their temperature. These infants have low metabolic heat production rate and may have high heat loss from the skin. Premature infants are kept in infant incubators which provide convective heating. There are two kinds of techniques available to control the incubator temperature. Currently either the incubator air temperature is sensed and used to control the heat flow, or infant's skin temperature is sensed and used in the close loop control. Skin control often leads to large fluctuations in the incubator air temperature. Air control also leads to skin temperature fluctuations. The question remains if both the skin temperature and the air temperature can be simultaneously used in the control. The purpose of the present study was to address this question by developing a fuzzy logic control which incorporates both incubator air temperature and infant's skin temperature. The temperature space was divided into a number of sub-domains. The crisp values of skin and air temperature were first fuzzified to obtain membership values which were then input to a rule base to obtain the output. This output was defuzzified to obtain a crisp value for the heat flow parameter. This fuzzy logic control system was evaluated for an infant incubator system by Gurpreet Singh, Nithya Panicker, Pallavi Kothavale, Prachi Karande under the guidance of Prof. Ravi. K. Biradar.**

***Keywords*— Skin servo control, Air servo control, Fuzzification, Crisp values, Defuzzification**

I. Introduction

Preterm birth is a major problem all over the world. Most babies are fully developed and ready for birth within one or two weeks of their estimated due date. A full-term pregnancy is defined as anything between 38-42 weeks of gestation. Babies born before 38 weeks gestation - about 10% of the total - are considered premature. The shorter the term of pregnancy is, the greater the risks of complications. Infants born prematurely have an increased risk of death in the first few weeks of their life. Thermo regulation is a major problem in premature infants. The core temperature of the human body needs to be kept at a constant temperature of 37 degrees Celsius. If the temperature goes too high or too low, then the organs can be damaged and illness or death can result. Neurological damage can be caused by slight to significant increase in brain temperature. Premature babies and other high risk infants, have low ability to regulate temperature and produce heat. Because of low gestation these infants do not have developed thermal regulatory control to maintain their body temperature. They have a large surface area to volume ratio and very low metabolic rate. On one hand, they cannot produce enough heat and on the other hand they have higher heat loss from the skin due to a large surface area to volume ratio. The chances of survival of these premature babies are very low in the first few weeks of their life. Therefore, they should be carefully protected against heat loss. This can greatly increase their chances of survival after birth.

Therefore, we need to keep the infant warm and provide thermal neutrality. This can be achieved by simply swaddling in case of a full term infant. In case of preterm infants only swaddling is not sufficient therefore they are often needed to be kept in an artificial thermal environment of infant incubators. Thermo regulation in the incubator depends on many factors. These factors may depend on infant related parameters or incubator related parameters. Infant related parameters include variables such as size, maturity level, gestational age, metabolic factor, maturity of skin and body development etc. Smaller size infants need different thermal care when compared to full term infants. The incubator related parameters include incubator size, geometry, thickness of walls, material of the incubator, mattress, incubator heating type (convective heating), and control mechanisms.

One of the most important parameters of these entire incubator related parameters is the temperature control mechanism. Two control mechanisms have been proposed which use either skin temperature of infant or air temperature of incubator air space to control the heating of incubators. Skin servo control often leads to large fluctuations in air temperature. Air control leads to skin temperature fluctuations. Moreover, in the air control, it is often difficult to maintain the core temperature of the infant in the desired range. In the current incubator designs, the clinician has to select either the air control or the skin control. These incubators do not permit simultaneous air and skin control.

The question remains if both the skin temperature and the air temperature can be simultaneously used 3 to control the heating of the incubator. The purpose of the present study was to address this question by developing a fuzzy logic control system, which incorporates both the infant's skin temperature and the incubator's air temperature to control the heating. The fuzzy logic control was evaluated by using a mathematical model developed by Simon, Reddy and Kantak, 1994.

Different infant related conditions such as different sizes of infants and different metabolic rates were simulated. Many incubator related conditions were also simulated for example if the door is open for some time or skin probe is somehow detached, using fuzzy logic control.

II. Literature Survey

The present techniques available for temperature control are 1) Air servo control 2) Skin servo control. The current commercial devices use either incubator air temperature or the skin temperature to control the hot air flow inside the incubator. The clinician has to choose either the set skin temperature mode or the set air temperature mode. Skin control leads to significant fluctuations in the air temperature and air control leads to fluctuations in the skin temperature and sometimes even in the core temperature. It is very often difficult to maintain the core temperature of the infant in the desired range of 37℃-37.5℃. When the skin probe site is changed, large fluctuations occur in the air temperature in both skin and air servo control. These fluctuations have an adverse effect on the neonate. These are the limitations of existing controls

Due to the limitations of existing controls, a new fuzzy logic control is developed which uses both the air temperature and the skin temperature to control the flow of hot air into the incubator. It considers both the temperatures and gives output according to fuzzy rules.

III. System Requirement & Analysis

A. Microcontroller Arduino Nano:

The Arduino Nano is a small, complete and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specifications of the Arduino Uno board in a smaller form factor. The Arduino Nano is equipped with 30 male I/O headers which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-b micro-USB cable or through a 9V battery. Technical specifications of this microcontroller (ATmega328P) include operating voltage of 5 Volts.

Input voltage from 6 to 20 Volts, 14 digital I/O pins (plus 6 can PWM output pins), 8 analog input pins, 40 mA DC current per I/O pin, 32 KB of flash memory of which 0.5 KB used by bootloader, 2 KB SRAM, 1KB EEPROM and 16 MHz clock speed.

B. LCD Display:

Various display device such as seven segment display. LCD display, etc can be interfaced with microcontroller to read the output directly. In our project we use a two-line LCD display with 16 characters each. Liquid crystal Display (LCD) displays temperature of the measured element, which is calculated by the microcontroller. CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption.

C. DHT11 Sensor:

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It is fairly simple to use, but requires careful timing to grab data. You can get new data from it once every 2 seconds, so when using the library from Adafruit, sensor readings can be up to 2 seconds old.

D. LM35 Sensor:

LM35 is a precession Integrated circuit Temperature sensor whose output voltage varies, based on the temperature around it.
It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C. It can easily be interfaced with any Microcontroller that has ADC function or any development platform like Arduino. Power the IC by applying a regulated voltage like +5V (VS) to the input pin and connected the ground pin to the ground of the circuit. Now, you can measure the temperature in form of voltage if the temperature is 0°C, then the output voltage will also be 0V. There will be rise of 0.01V (10mV) for every degree Celsius rise in temperature.

E. Brushless DC fan

These 80x80mm 12V fans are typically found in ATX Computer cases, servers, and other enclosed equipment – but they can also be used in a variety of other projects requiring moderate airflow. The fan spins at ~2600 RPM and can move approximately 30CFM. It is fairly quiet – just 30.7dBA.

F. Peltier Module:

The TEC1-12706 40x40mm thermoelectric cooler 6A Peltier Module is the simple application of the Peltier Thermoelectric effect. The module features 127 semiconductor couples in the area of 40x40mm which very effectively cools and heats up to 90o C. The thermoelectric cooler is also known as TEC or Peltier Module creates a temperature differential on each side. One side gets hot and the other side gets cool.

G. Voltage Regulator:

The LM2596HV series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator capable of driving a 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V, and an adjustable output version. Available in a standard 5-lead TO-220 package, 5- lead TO-263 surface mount package and SOP-8 package. External shutdown is included, featuring typically 30 µA standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown, and protection from output short for full protection under fault conditions.

H. Buzzer:

Buzzer or beeper is a signalling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound.

I. Fuzzy Logic:

Fuzzy Logic (FL) is a method of reasoning that resembles human reasoning. The approach of FL imitates the way of decision making in humans that involves all intermediate possibilities between digital values YES and NO. The conventional logic block that a computer can understand takes precise input and produces a definite output as TRUE or FALSE, which is equivalent to human's YES or NO.

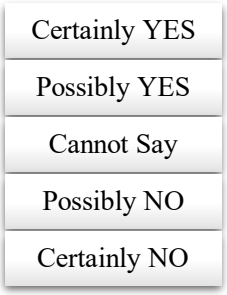

Fig. 1 Human decision-making

The fuzzy logic system architecture has 4 main parts as shown:

1) Fuzzification: It is used to convert inputs i.e. crisp numbers into fuzzy sets. Crisp inputs are basically the exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm's, etc.

2) Knowledge base: It contains the set of rules and the IF-THEN conditions provided by the experts to govern the decision-making system, on the basis of linguistic information. Recent developments in fuzzy theory offer several effective methods for the design and tuning of fuzzy controllers. Most of these developments reduce the number of fuzzy rules.

3) Inference engine: It determines the matching degree of the current fuzzy input with respect to each rule and decides which rules are to be fired according to the input field. Next, the fired rules are combined to form the control actions.

4) Defuzzification: It is used to convert the fuzzy sets obtained by inference engine into a crisp value. There are several defuzzification methods available and the best suited one is used with a specific expert system to reduce the error.

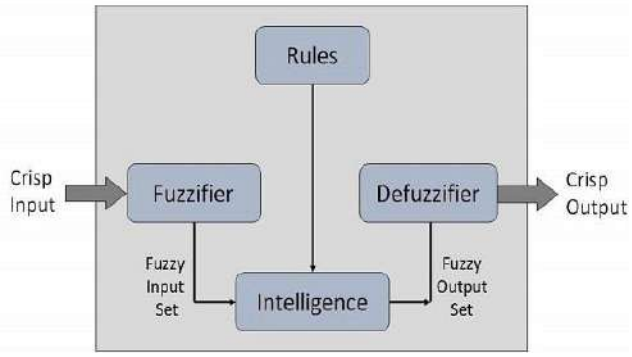

Fig.2 Fuzzy logic block diagram

IV. HARDWARE IMPLEMENTATIONS

A. Power Supply:

There is power supply of 230V. It is stepped down to 12V using transformer. The circuit contains a bridge rectifier circuit which rectifies this 12V AC supply. Further, LM2596 DC to DC buck converter is used to obtain required regulated voltage. The output from one of the voltage regulators is given to RAW pin of Arduino Nano (which runs into on board regulator), LCD, DHT11, LM35 and buzzer. Also, output of second voltage regulator is given to the relays.

B. Microcontroller Arduino Nano:

Arduino Nano is used in this project based on ATmega328P. Pin number D8 of microcontroller is given to buzzer. We have used 5 relays, first is used to drive cooling fan, second for heating fan, third one is for exhaust fan and last two for Peltier module for cooling and heating. So, pin number D3-D7 is provided to those 5 relays respectively. Pin number D2 is connected to pin number 2 of DHT11 sensor to collect its readings.

RAW pin gets its input from one of the voltage regulators, which is the input voltage to the on-board regulator. Then pin number A0 is connected to output pin number 2 of LM35 sensor to collect temperature reading, pin number A1 is connected to the reset pin RS of 16x2 LCD display to reset the LCD display, A2 is connected to E, also pin numbers A3-A6 of microcontroller are connected to pin number DB4-DB7 of LCD display respectively.

C. *LCD Display:*

16x2 LCD Display has been used in this project to display temperature and humidity. LCD is 16x2 which can store 16 characters. LCD is powered by output of one of the voltage regulators. Next is the Vo pin on which a potentiometer is attached for controlling the contrast of the display. Also, the read/write pin is connected to ground so as to write data to LCD. Other pins like Register Select (RS), Enable and data pins are connected to analog pins of Arduino Nano.

D. *Temperature sensor LM35:*

LM35 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of lm35 over thermistor is it does not require any external calibration. Since it gives analog output, its output pin is connected to analog pin A0 of Arduino Nano.

E. *Humidity and temperature sensor DHT11:*

DHT11 is a temperature and humidity sensor, the sensor comes with a dedicated NTC to measure temperature. Pin number 1 is connected to output obtained from voltage regulator, pin number 3 is grounded and pin number 2 is connected to pin number D2 of microcontroller to produce digital output readings of temperature and humidity.

F. *Relay:*

In this project, five relays are used namely to drive cooling Fan, heating fan, exhaust fan and the Peltier module (for cooling and heating). so instead of using five individual relays, one relay module is used which is having five relays on it. These relays are powered using output of second voltage regulator. The input pins of relays are connected to digital pins of Arduino so that fans can be switched on/off based on data interpreted by controller.

G. *Buzzer:*

Buzzer is powered by one of the voltage regulators and its controlling pin is connected to D8 pin of Arduino. Buzzer is used to indicate that temperature and humidity values of incubator are not in desired range.

V. Software Implementations

The code is written in C language in Arduino Integrated Development Environment (IDE). The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information.

A. *Arduino Libraries:*

The Arduino environment can be extended through the use of libraries, just like most programming platforms. Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. In our project, we have used DHT11 sensor so we downloaded required library for the same. Also, library for LCD is one of the standard libraries in Arduino.

B. *Code structure:*

1. *void setup( ){ }:*

Void setup is technically a function that is created at the top of each program. Inside the curly brackets is the code that that is to be run one time as soon as the program starts running. Things like pinMode are set in this section

.

2. *void loop( ){ }:*

The loop is another function that Arduino uses as a part of its structure. The code inside the loop function runs over and over as long as the Maker Board is turned on.

dht.readHumidity() and dht.readTemperature() are the two methods used to obtain humidity and temperature readings from DHT11 sensor. Also, analogRead() Reads the value from the specified analog pin which, in our model, is connected to output pin of LM35 sensor.

millis() function Returns the number of milliseconds passed since the Arduino board began running the current program. This function is used to set timer for Peltier module so that it will be ON for 5 seconds and OFF for 20 seconds.

VI. METHODOLOGY

A. Block Diagram:

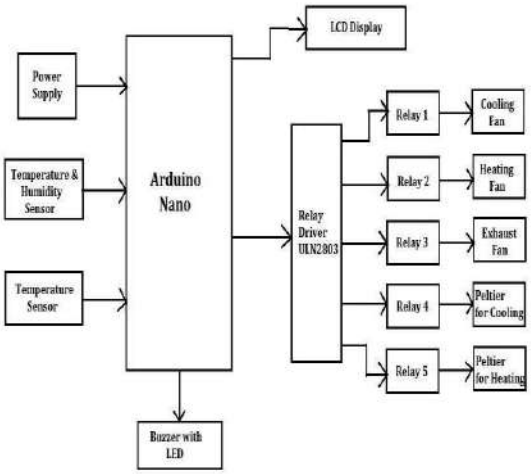

Fig. 3 Block diagram

B. Circuit Diagram:

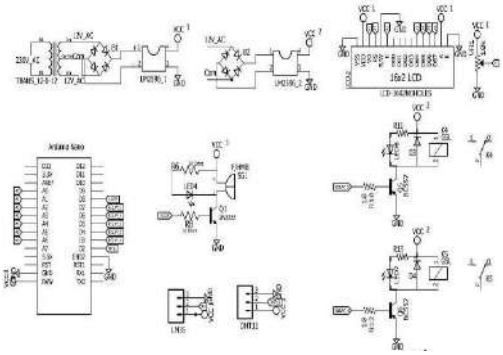

Fig. 4 Circuit Diagram

C. Working:

In this model of our project, we use an Arduino Nano as main controller. Along with the micro-controller, two sensors are used out of which one is LM35 temperature sensor, for sensing the body temperature of infant. LM35 is a precession integrated circuit temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C. Once the IC is powered by applying a regulated voltage to the input pin and the ground pin is connected to the ground of the circuit, temperature can be measured in form of voltage. If the temperature is 0°C, then the output voltage will also be 0V. There is rise of 0.01V (10mV) for every degree Celsius rise in temperature. The voltage can then be converted into temperature.

The other sensor is DHT11 temperature and humidity sensor, for continuous monitoring of the temperature and humidity inside the incubator. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. The DHT11 calculates relative humidity by measuring the electrical resistance between two electrodes. And then it converts the resistance measurement to relative humidity on a chip mounted to the back of the unit and transmits the humidity and temperature readings directly to the Arduino Nano. The temperature and humidity sensor, DHT11 has three pins i.e. one is +VCC, second is output which is connected to the digital pin of Arduino Nano D2 since it gives digital output and third pin is GND. The LM35 temperature sensor also has three pins, first pin is connected to the +VCC, second pin gives analog output, which is connected to the analog pin of Arduino Nano A0 pin. Also, to increase or decrease the temperature inside the incubator, we have used brushless DC fans and Peltier module. The main application of the Peltier effect is cooling. However, the Peltier effect can also be used for heating or control of temperature. The hot side of Peltier module always requires heat sink. Also, in this model, we use five relays, first one is used to drive the cooling fan, second one for driving the heating fan, third one is for exhaust fan, then fourth one is for Peltier for cooling and last one is for Peltier for heating. So instead of using five individual relays, we have used one relay module which is having five relays on it. Arduino Nano, temperature sensor, humidity sensor, heating and cooling fans work together to maintain temperature and humidity in desired range inside the incubator. The body temperature of infant and air temperature and humidity inside incubator is continuously monitored and the same is displayed on LCD. Based on the skin temperature of infant (Ts) and air temperature of incubator (Ta), the decision is made by the controller using fuzzy logic to switch on/off the heating/cooling fan. In this model, we have included 4 conditions and their results as follows:

1. If Ta is greater than 40°C and humidity is greater than 90%, then LCD will display a message as “High humidity detected: taking humidity down” and hence it will switch on heating fan, cooling fan as well as the exhaust.

2. If Ts is greater than 60°C and Ta is greater than 50°C, then LCD will display a message as “High temp detected: cooling down” and hence it will switch on exhaust and cooling fan.

3. If Ts is less than 25°C and Ta is less than 30°C, then it will be displayed on LCD that “Low temp detected: heating environment” and heating fan will be switched on.

4. Also, if Ts is greater than 70°C and Ta is greater than 40°C, then message saying “High body temp, Contact Doctor” will be displayed on LCD since it is inferred that though the environment temperature is less, the skin temperature of infant is comparatively very high which means the infant’s body is producing heat. So, buzzer will beep indicating that the caretaker needs to pay attention to the infant.

When the measured parameters are encountered to be deviating from standard values provided to micro controller, fuzzy logic as programmed in micro controller is used to take necessary actions such as switching to hot/cool side of Peltier module, switching on respective fan using relays and cold or hot air passes into the incubator till desired range of values for the given parameters is met. In this way the air temperature and humidity are maintained at required values proportional to the body temperature of the infant. Also, we have connected a buzzer in the circuit which will beep if the temperature or humidity values are out of desired range.

This function works in a loop and continuously monitors as well as maintains required parameters in suitable range using fuzzy logic and works as a more reliable system for survival of premature infants.

VII. Conclusion

This project produces a micro-controller based system which keeps premature infants safe until they are able to regulate their own body temperature and can cope up with the external environment. This project can be used as a more reliable and accurate system for providing warm environment to premature infants since it incorporates both the skin temperature of infant and air temperature of incubator using fuzzy logic and gives suitable output accordingly. this system can be made to monitor other vital body functions like heart rate, oxygen saturation, blood pressure, etc in the future.

Images of infant incubator:

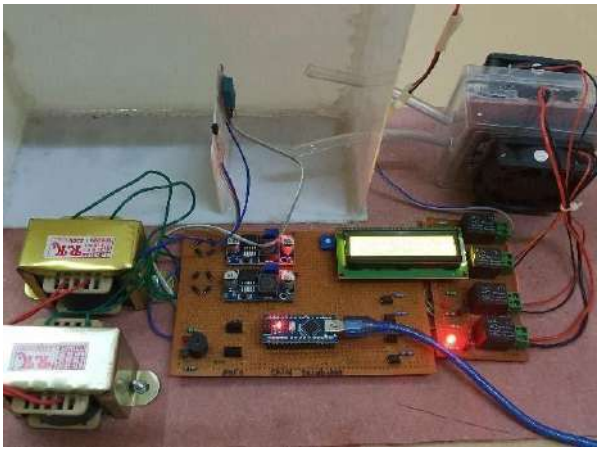

Fig. 5 Interior components

Fig. 6 DHT11 and LM35 sensors

Fig. 7 LCD display output

Acknowledgement

It gives us great pleasure to present this paper on our project “Infant Incubator using Fuzzy Logic Control”. It became possible due to the unstinted guidance of Prof. Ravi Biradar, Electronics Department. We express our sincere gratitude to Prof. R. H. Khade, HOD, Electronics department without whom it would not have been possible to accomplish our project. We also thank to our senior faculty members of Electronics department, Prof. Manisha Singh, Prof. Ujwal Harode, Prof. Ajit Saraf, Prof. Seema Mishra for their time-to-time suggestions to develop the project. Furthermore, we are indebted to the Principal Dr. Sandeep Joshi whose constant encouragement inspired us to do our best. Also, we sincerely thank our family members, colleagues and all the others who directly or indirectly contributed in making our task easier.

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Toward a Green Campus with the Internet of Things – the Application of Lab Management

Shibnarayan Ghosh, Bhavesh Agnihotri, Rashi Jha, Harshad Kedar, Prof. Uma. K

#B.E Student, Dept. of Computer Engineering, Pillai College of Engineering, Navi Mumbai, India – 410206 Faculty, Dept. of Computer Engineering, Pillai College of Engineering, Navi Mumbai, India – 410206

Abstract— **As the global population grows, the resources on earthare depleted quickly. In order to have a sustainable earth, governments around the world put a lot of efforts to advocate the reduction of carbon production as well** as to **emphasize the benefits of reducing the consumption of energy.** The proposition has been **promoted on campus of educational institutions as well. The idea of the project is to inculcate the idea of Green Campus across all campuses with the help of an IoT system which will realize the idea of energy-saving by properly managing the computers and air conditioners.**

Keywords— **Green Campus, IoT System, TemperatureMonitoring, Lab Management, Energy Saving**

I. INTRODUCTION

Green building on college campuses is the purposeful construction ofbuildings on college campuses that decreases resource usage in both the building process and also the future use of the building. The goal is to reduce CO emissions, energy use, and water use, while creating an atmosphere where students can be healthy and learn. Universities across the country are building to green standards set forth by the USGBC, United States Green Building Council. The USGBC is a non-profit organization that promotes sustainability in how buildings are designed and built. This organization created the Leadership in Energy and Environmental Design (LEED) rating system, which is a certification process that provides verification that a building is environmentally sustainable. In the United States, commercial and residential buildings account for 70 percent of the electricity use and over 38 percent of CO. Because of these huge statistics regarding resource usage and emissions, the room for more efficient building practices is dramatic. Since college campuses are where the world's future leaders are being taught, colleges are choosing to construct new buildings to green standards in order to promote environmental stewardship to their students. Colleges across the United States have taken leading roles in the construction of green buildings in order to reduce resource consumption, save money in the long run, and instill the importance of environmental sustainability on their students. It is a better way to motivate a new generation to live a sustainable life.

II. LITERATURE REVIEW

2.1 HISTORY

It was started towards the end of 2007 by Susan Botha, who had been working for the Namaqualand Restoration Initiative (NRI) at UCT. The initiative has its origins in the Botany Department, where Susan's work was based, but the organization quickly grew to a campus-wide initiative. Susan is responsible for the formalization of the GCI, including the naming of the organization, the formation of a group on Vula (UCT's internal online network), the articulation of a specific aim for the organization, as well as the founding and co-execution of many of the first projects. These first projects included the implementation of campus-wide recycling; the organization of UCT's first Green Week; the Building-to-Building Roadshow initiative and the promotion and implementation of carpooling. Each year a new GCI committee is elected, which includes portfolios that run the different projects. As of September 2010, the GCI has over 1500 members on Vula, of which approximately 100 are actively participating in projects.

2.2 COMPARISON WITH EXISTING IMPLEMENTATIONS

As the global population grows, the resources of earth are depleted quickly. To possess a sustainable earth, governments aroundthe world put tons of efforts to advocate the importance of the reduction of carbon production and also to emphasize the benefits of reducing the consumption of energy. The proposition has been promoted on campuses of educational institutions as well. Smartcampus may be a trendy application within the paradigm of the IoT. The concept of constructing a "Smart campus" implies that the institution will adopt advanced ICTs (Information Communication Technologies) to automatically monitor and control every facility on campus. To use the facilities more efficiently and to minimize the energy consumed are believed the most important advantages of building a smart campus. Such efforts are also recognized as constructing a "Green Campus." By using the green campus IOT based technology we can automatically shut down the computersinstead of doing it manually. This mechanism will decrease the number of idle power-on computers.

2.3 PROBLEM DEFINITION

To construct a green campus environment which helps in saving the energy by managing the heavy power consumption devices like air conditioners and workstation computers. RFIDs and ZigBee modules along with temperature sensors act as the wireless sensor network. The computer's idle time is monitored and based on the temperature, the air conditioners are turned on or off.

Since the IoT radically changes the view of the "Internet" by embracing every physical object into a network. With the combination of the Internet, the cloud services, the near-field communications, real time localization, and embedded sensors, we can transform all objects into smart objects, so that all components can understand and react to their environment. In 2009, The EU Commission realized the importance of the revolution of the Internet and initiated an IoT action plan.it is suggested that an IoT must be Internet Oriented (middleware), things oriented (sensors), andsemantic oriented (knowledge). Based on the assertions, it is proposed that the architecture of an IoT actually contains three segments which are the hardware segment, the middleware segment, and the presentation segment. In the hardware segment, wirelesssensor networks are expected to be a key technology for various IoT applications such as home automation and energy saving. The sensor devices in the wireless sensor network work as the communication node and will communicate with other devices wirelessly. Sensors can be deployed randomly and densely with much fewer costs in a wireless sensor network environment. All the conditions are monitored at all times. Therefore, it is believed that the construction of a green campus based on the IoT concept is more advanced than merely purchasing the energy-saving facilities. ZigBee is the name ofa standard that specifies the application layer of a wireless network ina small area with a low communications rate. Previous research and projects have shown that ZigBee sensor networks are suitable for applications in many areas.

Wireless sensor network provides real time monitoring opportunities. As a result, more space is required to store the data andsmart tools are mandatory in order to analyzed the data. Cloud computing is recognized as the best solution. The major function of cloud computing is the delivery of services. It is not new to consider the pursuit of "service" as the entire and sole philosophy in theadoption of new technology.

Cloud services are classified into four categories.

- Infrastructure as a service (IaaS): main services include theprovision of virtual hardware, network, storage, computing power, and so forth.
- Software as a service (SaaS): SaaS represents a new concept of "software on demand." The software refers to application systems that can be activated directly on the internet.
- Platform as a service (PaaS): PaaS delivers a service-oriented platform. The whole process in the software development life cycle would be provisioned as an integrated service over the Internet.
- Database as a service (DaaS): DaaS, such as the SSDS of Amazon, moves the traditional database features, including the definition of data and the storage and retrieving of data, over to the network.

Cloud computing usually plays important role since wireless sensor networks are limited in their processing power, battery life, and communication speed, while cloud computing is known for having powerful computational and processing capacity and the communication speed is much faster as well Previous researches have proved that the merits and the performances of wireless sensor network will be doubled when the architecture is combined withcloud environment. Cloud environment is also more flexible to be migrated once the university wants to expand the object network and move toward building a smart campus with more smart applications.

Expected Output: -

- The computer labs can be managed efficiently. More labs will be open only when the demand is increasing.
- The use of the computers will be monitored at all times. This mechanism decreases the number of idle power-on computers.
- The air conditioners will be turned on only when the temperatures reach a preset level. As a result, more energy will be saved.

III. CONSTRUCTION OF GREEN CAMPUS WITH IOT ARCHITECTURE

A. Proposed Architecture

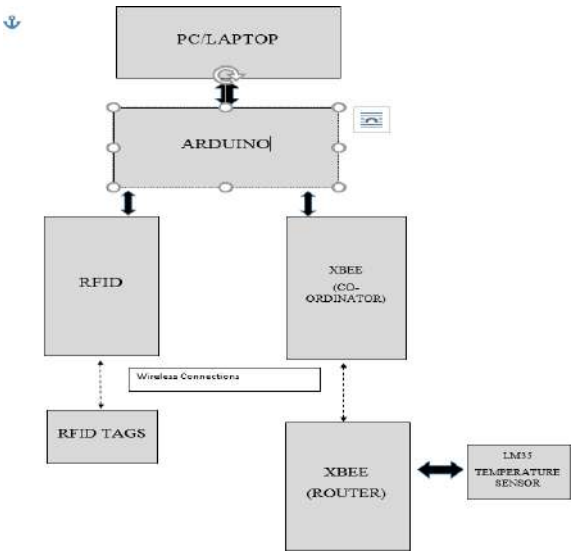

Figure 1 Proposed Architecture

TABLE I

B. Required Hardware Components.

Arduino	8-Bit Microcontroller
XBEE	RF module for wireless communication
RFID Module	Digital storage device
LM 35	Temperature Sensor
Desktop / Laptop	For Presentation

Based on the definition and the required elements defined in the architecture, shows the proposed architecture of the green campus within IoT. The architecture consists of three major segments which are the hardware segment, the middleware segment and the presentation segment. The hardware segment mainly uses RFID to induce the students who are going to enter the computer labs. The IoT is set up to connect the computers and the air conditioners in the lab. Not only do the computers own an IP, but also each air conditioner is assigned an IP. The temperature sensor module of ZigBee is used to monitor the temperatures in the lab. In our work, a ZigBee network is constructed with Xbee Module S2C 802.15.4 devices. The specifications of the devices are as follows:

1) Radio frequency: 2.4 GHz band.

2) Data rate: 38400bit/s (max to 115200).

3) Distances: 60 meters indoor/ Outdoor (LOS) 1200 m

4) Number of channels: the device is able to search up to 16 satellite channels.

5) 10 I/O ports.

3.2 Implementation Details

The setup of the project is very economical and portable. The Arduino which is the connection point between the Xbee module is connected to the Host Computer which starts the whole project. Zigbee and the arduino act as the main Components for the project. 2 zigbee - 1 acts a co- ordinater - Co -ordinator zigbee is the main node of the network and it constantly relays its information to the arduino which is then used by the admin hence it never sleeps. It is wirelessly connected to a second zigbee which acts as the router.Router zigbee handles all sensors or endpoint zigbee if any. It can also communicate with the other routers in the network if we ever need to expand it. Zigbee network helps us to create a grid to relay information fast without any delay.

The Arduino acts as a serial bus controller to connect the zigbee to an Admin Computer since the zigbee can't communicate with the Admin PC on its own. Also We can utilize the Arduino Functionality to add more features to the zigbee.1

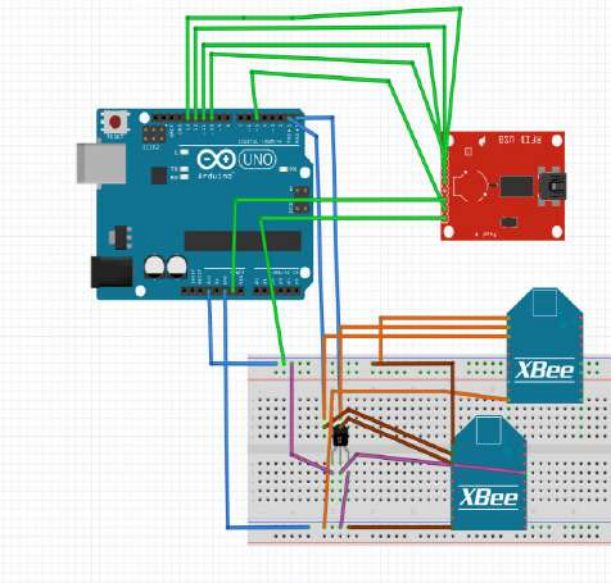

Figure 2 - Circuit diagram of the IoT system

The Arduino and Co coordinator zigbee communicate with each other constantly at equal intervals which is given by us so that It can relay and prompt the admin to take action. Here The message will be sent by the Router to the Coordinator zigbee which will use the message according to the provided parameters.

Router handles all the sensors which are connected to it via a digital or an analog pin. RFID is used across all devices in a lab such as Computers and Air Conditioners to know their Power status. A student when switching the Computer On RFID is triggered which relays the sensor to the router which passes on to the Admin. Since RFID is connected wirelessly to the router, a passive UHF RFID is used here which has a maximum range of 10 to 20 m. If the Computer is left idle for more than 1 hour, RFID alerts the Admin who can switch it off remotely. For temperature sensing, LM35 is used which has a range of -55 C to 150 C with an accuracy of -/+ 0.5degree C. Temperature is recorded every 30 mins. and if the recorded temperature is more than 25degree Celsius, The Admin is notified who can switch on the Air Conditioning.

IV. CONCLUSIONS

With the IoT System, Educational Campuses can achieve independence from traditional resources and exhaustive labor.It can direct their resources to better improving the facilities for its teachers and students and making it a global place of learning.

ACKNOWLEDGEMENT

It gives us great pleasure and immense satisfaction to present this report on our project "Toward a Green Campus with the IoT – the Application of Lab Management" which became possible due to the unstinted guidance and focussed direction of Prof. Uma K.S, Electronics Department. We express our sincere gratitude to Prof. R.H Khade , HOD of Electronics Department without whom it would not have been possible to successfully accomplish our project.

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Underground Cable Fault Detection Using IOT

Sumedh Nerleker, Aditya Garde, Himanshu Joshi, Vishal Thorat
Department of Electronics Engineering, University of Mumbai
Pillai College of Engineering, New Panvel,
Navi Mumbai, Maharashtra-410206, India

***Abstract*— In the cities underground cables used more often than the overhead cables. When a fault occurs in an underground cable it is hard to pin point the fault as we cannot see the cable with eyes. To detect the faults the cable must be tested for different conditions. This prototype uses a simple concept of ohm's law to detect the fault. The prototype has set of resistors which are used to model as a wire. These are divided in three phases which are RED, YELLOW, BLUE. To model the fault set of switches are used. In case of the fault the voltage across the series resistor changes accordingly and then it is fed to the ADC pin of IC PIC18F452. These results are uploaded to a webpage using IOT so that conditioned of the wire can be monitored from anywhere.**

I. Introduction

Power supply networks are growing continuously and their reliability getting more important than ever. The complexity of the whole network comprises numerous components that can fail and interrupt the power supply for end user. For most of the worldwide operated low voltage and medium voltage distribution lines, underground cables have been used for many decades. Underground high voltage cables are used more and more because they are not influenced by weather conditions, heavy rain, storm, snow and pollution. Even though the cable manufacturing technology is improving steadily; there are still influences which may cause cable to fail during test and operation. A cable in good condition and installed correctly can last a lifetime of about 30 years. However, cables can be easily be damaged by installation or poorly executed jointing, while subsequent third-party damage by civil works such as trenching or curb edging.

II. Types Of Faults In Cables

Open Circuit Fault: - Whenever there is a break in conductor, it is called as the open circuit fault of the conduction wire. The open circuit fault can be found by use of megger. In the megger all the three cables are shortened at the far end and resistance is measured between conductor and earth cable by a megger. If there is no fault, then the megger will indicate zeroresistance. But if there is a fault and conductor is broken then the megger will indicate infinite resistance.

Short Circuit Fault: - When two cables of multicore conductor come in contact of each other due to insulation failure, it is called as Short Circuit Fault. Whenever there is a break in conductor, it is called as the open circuit fault of the conduction wire. The megger is connected with two terminals of the conductor and if the megger gives the reading zero then there isshort circuit fault between these two conductors.

Earth Fault: - When the conductor of the cable comes in contact of the earth it is called as earth fault or ground fault. To detect this fault, the conductor is connectedto one terminal of the megger and another terminal is connected to ground.

III. Proposed System

The system uses IOT to remotely monitor the health of the conducting cables. The project is based on the principle of Ohm's Law. When the fault occurs, there is difference in the voltage which is used to calculate the fault distance. The power supply is provided using step- down transformer, rectifier, and regulator. The current sensing circuit of the cable provides the magnitude of voltage drop across the resistors to the microcontroller and based on the voltage the fault distance is located.

IV. Flow Chart

The input/output port of Microcontroller, LCD display, RTC, and Wi-Fi Module of the system are configured and initialized.

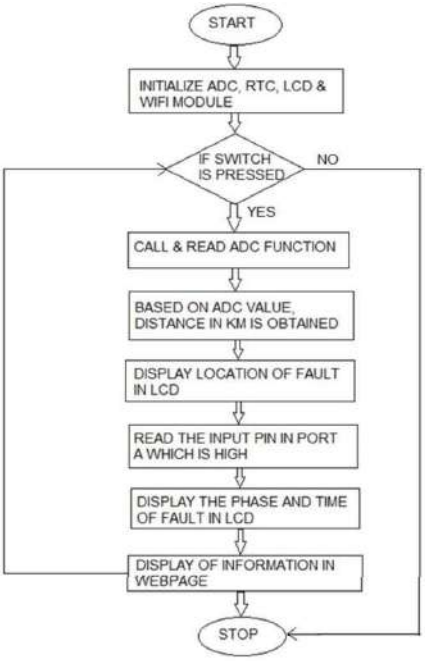

Fig. No.1 Flow Chart

V. Block Diagram Of Proposed System

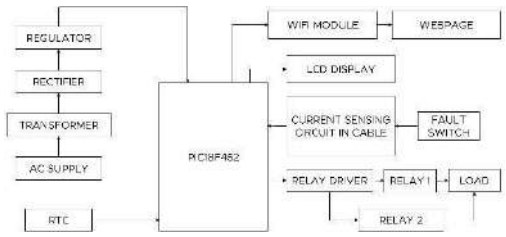

Fig. No. 2 Block Diagram

The proposed system is an IoT enabled underground cable fault detection system. The basic principle behind the system is Ohms law. When fault occurs in the cable, the voltage varies which is used to calculate the fault distance. The system consists of Wi-Fi module, Microcontroller, and Real- Time Clock. The block diagram of the faultdetection system is shown in the Figure 2. The power supply is provided using step- down transformer, rectifier, and regulator. The current sensing circuit of the cable provides the magnitude of voltage drop across the resistors to the microcontroller and based on the voltage the fault distance is located.

VI. Circuit Description

The prototype uses resistors to represent thecable length. The resistors R_{R1} to R_{R5} represents R phase of the cable. Similarly, R_{Y1} to R_{Y5} and R_{B1} to R_{B5} represent Y andB phase of the cable. R_{N1} to R_{N12} are used torepresent the neutral lines. To represent the occurrence of fault in underground cables switches are used. Each phase is connectedwith a relay which in turn is connected to Port C of Microcontroller. When there is no fault, the LEDs connected to each relayglows. When a switch connected to a particular phase is closed, the LED connected to the particular phase alone glows. The resistance connected to that particular phase adds up and the voltage drop thus generated is given to Port A of the Microcontroller. The voltage drop is converted to distance as per Table 1 and is displayed in the LCD. Additionally, the pin of Port C connected to that particular LED goes high and the name of the faulted phaseis displayed in the LCD. The cable side circuit diagram is shown in the Figure 3.

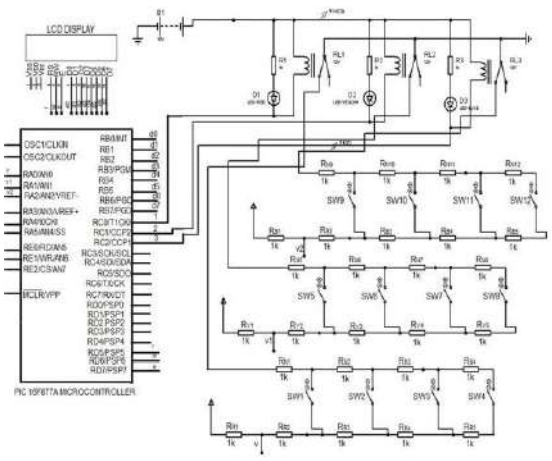

Fig. No. 3 Circuit Diagram

. Table 1: - Mapping Table for FaultIdentification

S. No.	Switch	Analog	Fault	ADC
1.	SW 1	3.33 V	2 km	682
2.	SW 2	3.99 V	4 km	818
3.	SW 3	4.28 V	6 km	876
4.	SW 4	4.4 V	8 km	909

VII. Observation And Result

The fault detection system is simulated using Proteus 8.5 professional software andthe fault information is displayed in theLCD. The simulation and hardware setup ofthe fault detection system are shown in the Figure 4. The Fault display message is shown in the table 2. The work "IoT BasedUnderground Cable Fault Detector" is an efficient system as it reduces the time to detect the exact location of fault.

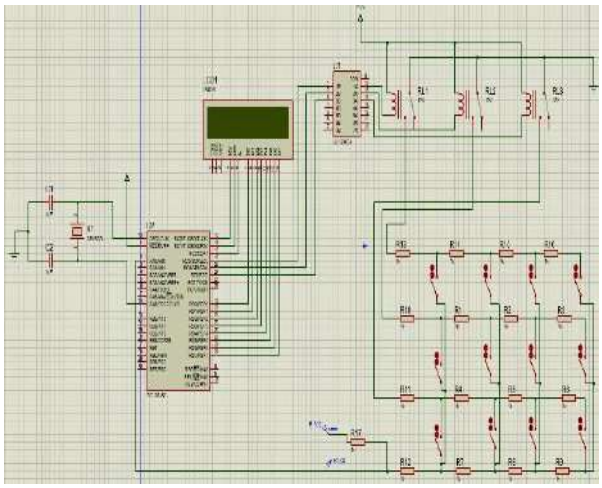

Fig. No. 4 Result

VIII. Conclusion

The short circuit fault at a particular distance in the underground cable is locatedto rectify the fault efficiently using simple concepts of Ohms law. The work automatically displays the phase, distance and time of occurrence of fault with the help of PIC 16F877A and ESP8266 Wi – Fi module in a webpage. The benefits of accurate location of fault are fast repair to revive back the power system, it improves the system performance, it reduces the operating expense and the time to locate the faults in the field.

Future Scope

The work can be extended for open circuit fault, short circuit Line to Line Fault (LL) and double Line to Ground Fault (LLG). The open circuit fault can be detected usinga capacitor in ac circuit which measures the change in impedance and calculate the distance of fault

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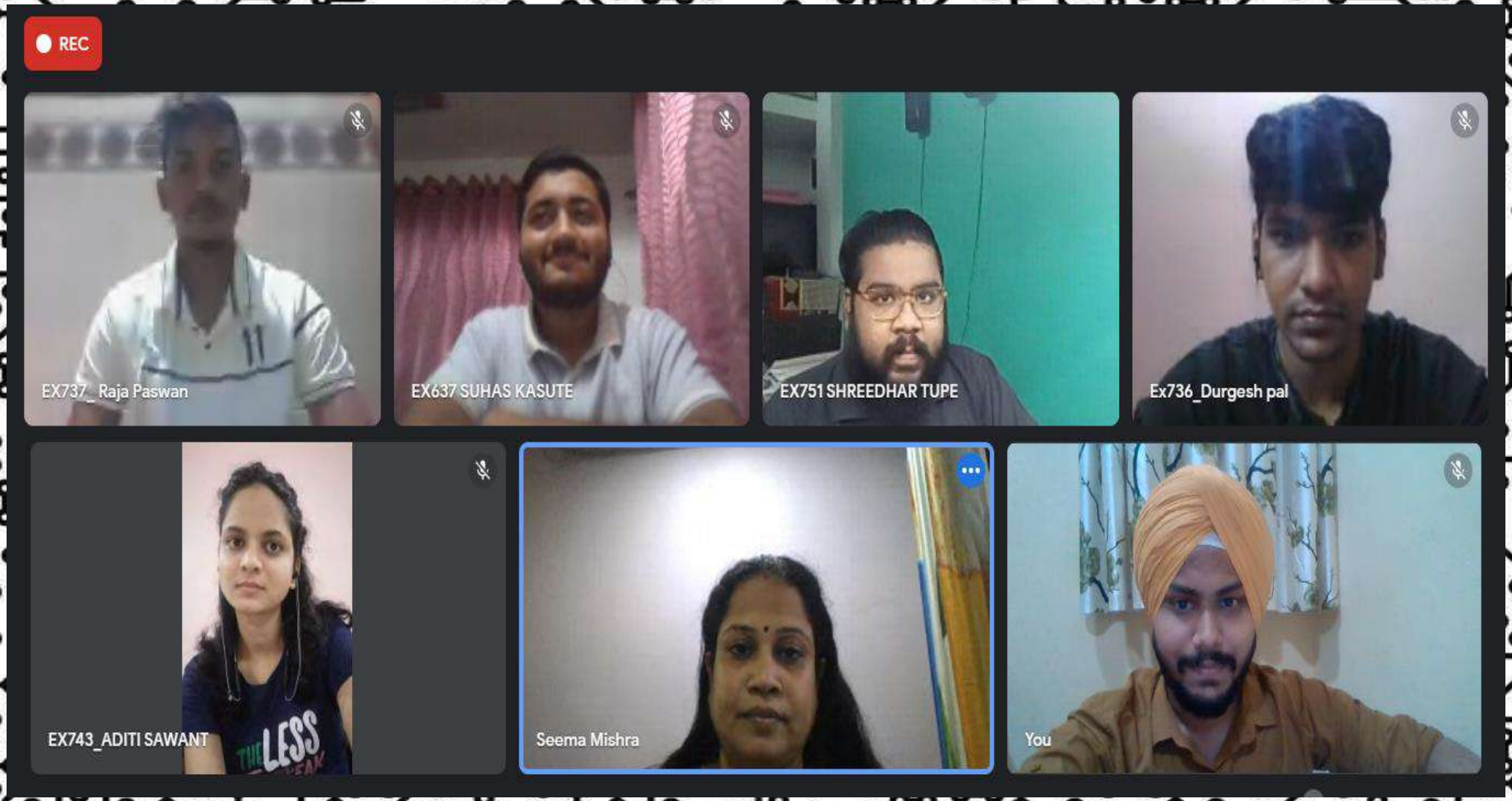

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