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Embedded and IoT

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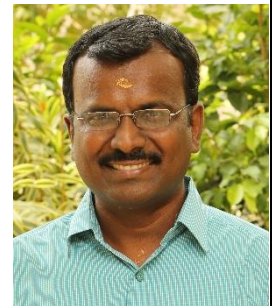


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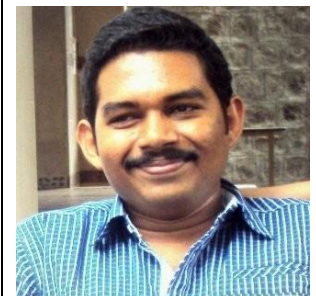
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PREFACE

Embedded system is basically the study of how-to setup a device that is hardware or software or both that is embedded in a larger system and is mostly a real time system. An embedded system usually consists of a microcontroller programmed to do a specific job.

Internet of things is how these devices communicate with each other directly and indirectly to serve a specific purpose. Directly is when two devices or more talk peer to peer. And decide actions based on what the other device says. Indirect is when all of these devices are connected to a single node and the node receives and transmits signals to the devices and intercommunicate is thus established.

The “Internet” side of IOT is about processing the huge amount of data that can be collected by devices and extract the useful bit of information that can improve the way we use many services and devices today. The applications of embedded systems have increased drastically over the past years. Multi-core technologies are being appreciated and are now in great demand across various industry verticals.

AUTOMATION OF LIFT USING MICROCONTROLLER

KALAISELVAN J, PRAVEEN RAJ T

ABSTRACT

Generally, the lift goes to a particular floor as per the floor number is chosen. to that floor and opens the Lift's door and wait for person to enter into the Lift. But Lift doesn't detect whether the person is present or not in front of Lift. If a person pressed Lift's button in a floor and leaves due to some other reasons but the Lift still comes to the floor, stops at that floor and opens the door. Our aim is to eliminate this problem by using Force Sensitive Resistor(FSR) sensor we detect the presence of the person, it produces a low resistance if a pressure is applied to that sensor and it sends information to the microcontroller and Lift starts moving to the specific floor where the FSR detects the pressure. If the person who pressed the button leaves then Lift will stop in the nearest floor using arduino uno microcontroller to stop the Lift and open door at the particular floor if there is a person standing in front of the Lift's door in that particular floor. Our project detects whether the person who pressed the button is still in front of Lift's door waiting for Lift or person left.

INTRODUCTION

Lifts are a vital part of modern life, and they make it possible for people to live and work in tall buildings. Lifts are used to transport people between different floors of a building. This is especially important in tall buildings, where it would be difficult or impossible to climb stairs. Lifts can also be used to transport people with disabilities, as they provide a way for them to move between floors without having to climb stairs. Lifts can also be used to transport goods between different floors of a building. This is useful for moving supplies, equipment, and furniture. Lifts can also be used to transport food and other items to restaurants and other businesses. In the event of an emergency, Lifts can be used to evacuate people from a building. This is especially important in tall buildings, where it can be difficult to evacuate people quickly by using stairs. Lifts can also be used to evacuate people with disabilities, as they provide a way for them to evacuate a building without having to climb stairs.

The aim is to make the Lift more efficient by automating it using microcontroller. In this project, we discuss a method for implementing the automatic Lift system by using FSR sensor and Arduino microcontroller. FSR sensor is a electronic sensor which produces a low resistance when a pressure is applied to the sensor

and detects whether there is a person present in front of the Lift or not. Thereby reducing the unwanted opening of Lift doors and reducing the power and time consumption.

PROBLEM STATEMENT

Normally, it is a common sight to see people waiting for an Lift in a building. Often, individuals press the Lift button and then leave the area without waiting for the Lift to arrive. As a result, the Lift arrives at the floor, opens its doors unnecessarily, and then closes them without anyone entering.

In some instances, a building may have a situation where multiple people are waiting to use the Lift, but there is only one Lift available. In such cases, time becomes a constraint, and some people opt to use the staircase instead. However, as they pass through each floor, they press the Lift button on every floor they encounter. This action causes the Lift to stop at each floor, open its doors, and close them even though there are no passengers waiting to enter or exit. This behavior can be quite irritating to those already inside the Lift.

To address this inconvenience, we decided to develop a project that offers a solution to this problem. Our project aims to create a system that prevents the Lift from stopping on a floor unless there is a person present who intends to use the Lift alone. By implementing this solution, we can eliminate unnecessary stops and enhance the efficiency of Lift operations.

By incorporating sensors and intelligent algorithms, our project detects the presence of a person waiting for the Lift. When the system identifies a person at a particular floor, it ensures that the Lift stops to accommodate them. On the other hand, if the sensors detect no individual waiting for the Lift, the system instructs the Lift to bypass that floor and continue its journey to the desired destination floor.

This innovative approach significantly reduces the inconvenience caused to those already inside the Lift. By eliminating unnecessary stops, the project improves the overall efficiency of Lift operations and enhances the user experience. Additionally, it promotes time-saving and streamlines the flow of individuals in the building.

In conclusion, our project addresses the common problem of unnecessary stops and wasted time in Lift operations. By incorporating sensors and intelligent algorithms, we have developed a system that prevents the Lift from stopping on a floor unless there is a person present who intends to use the Lift alone. This solution optimizes Lift efficiency, reduces inconvenience, and enhances the overall user experience in buildings.

4. PROPOSED METHODOLOGY

4.1 WORKING OF OUR SYSTEM

In the proposed system, we have used Arduino Uno microcontroller that is connected to FSR 402 and DC motor using motor driver.

Normally Lifts works like if a person stands in front of a Lift and presses Lift button Lift will reach that particular floor and that person will get into Lift and go to desired floor. If the person left the place after pressing the button, irrespective of the presence of the person the Lift will reach that floor and open the Lift's door and close it. In buildings with many floor this causes many problems like time wastage, electricity wastage.

Our system detects whether a person is standing in front of a Lift door and understands he wants to use Lift and Lift will move to that particular floor and this will repeatedly detect whether a person is standing in front of Lift's door or not ,if a person who pressed the Lift's button and left that place due to some other work according to our system Lift wont come to that particular floor. So that we can save our time and reduce electricity wastage.

If a person standing on a pressure sensor we can detect the pressure exerted by them on ground , so that if a person stands in front of a door ,using this method we can detect their presence and operate Lifts according to their needs.

If current floor where Lift stays is below the desired floor level Lift should move upwards to reach the desired floor, if current floor where the Lift stays is above the desired floor level the Lift should move downwards inorder to reach the desired floor.

We have used two IR sensors for each floor to detect whether Lift reached the desired floor or not ,if we use one IR sensor for detecting whether Lift arrived the desired floor or not ,like if we say the Lift should stop while IR is detected and we want Lift to stop in 1st floor and currently Lift is in ground floor, when Lift's top portion is detected Lift will stop and if Lift comes from 2nd floor to 1st floor bottom portion will be detected and Lift will stop, in both case Lift wont

stop in 1st floor properly so we have used two IR sensor in each floor detect the position of Lift and operate Lift.

When Lift's position is detected through IR sensors those data will be sent to microcontroller and microcontroller will decide and control DC motor through motor driver L293D to move the Lift to desired position.



FIGURE 4.1 APPLICATION OF FSR IN LIFT

5.HARDWARE REQUIREMENTS

5.1 HARDWARE REQUIREMENTS:

- Arduino Microcontroller
- FSR sensor
- IR sensor
- Motor driver
- DC Motor

4.2 BLOCK DIAGRAM

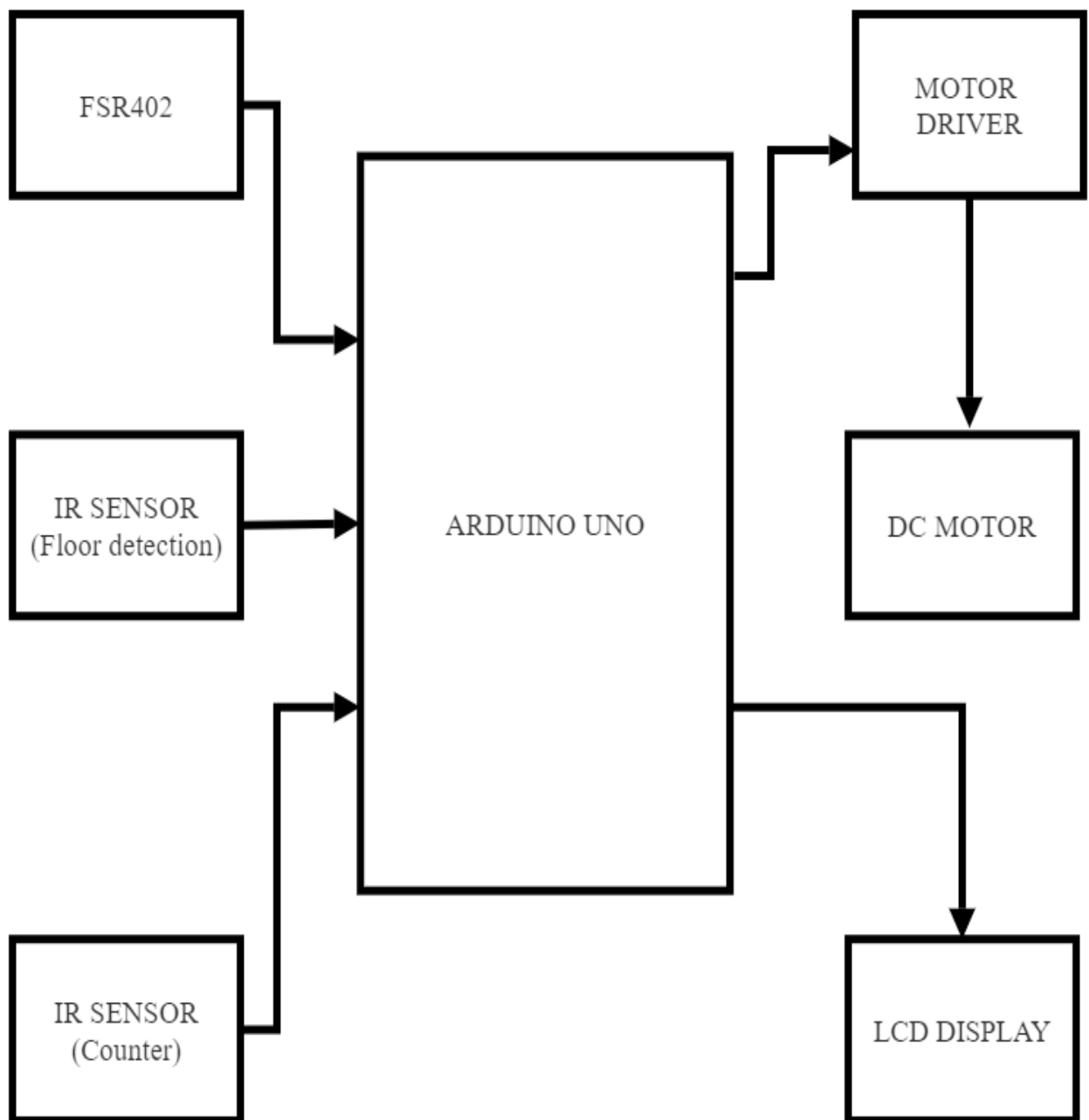


FIGURE 4.2 BLOCK OF THE PROPOSED SYSTEM

4.3 FLOWCHART

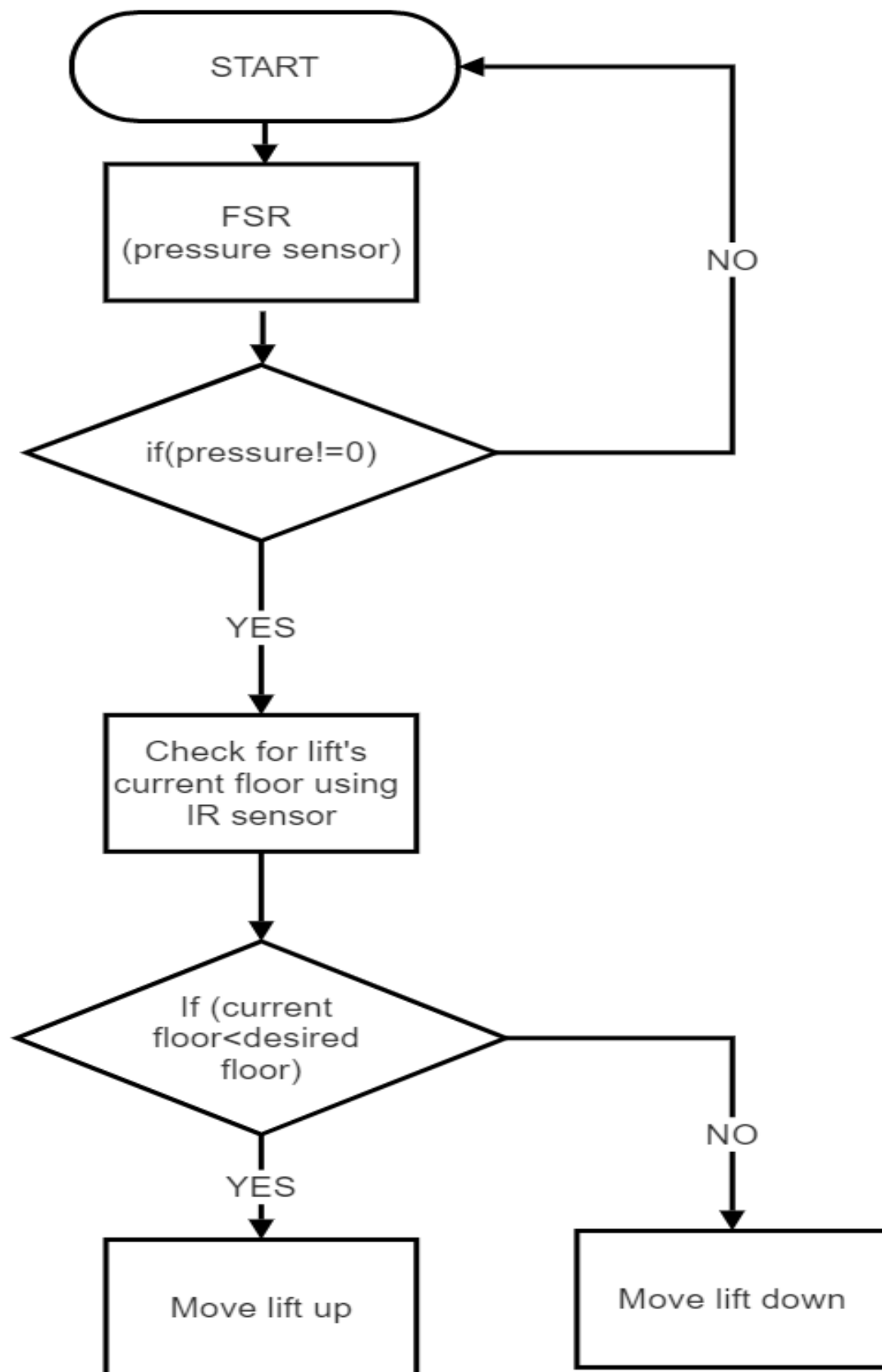


FIGURE 4.3 FLOW CHART

5.1.1 ARDUINO UNO MICROCONTROLLER

Arduino Uno is a popular microcontroller board based on the ATmega328P microcontroller chip. It is one of the most commonly used boards in the Arduino family and is often used by hobbyists, students, and professionals to build various electronic projects.

The Arduino Uno board has a range of features that make it easy to use, including a USB port for programming and power, a voltage regulator, and a set of input/output (I/O) pins. These pins can be used to connect the board to various sensors, actuators, and other electronic components to create interactive electronic projects.

The board is programmed using the Arduino Integrated Development Environment (IDE), which is a free software tool that allows users to write and upload code to the board. The IDE includes a range of libraries and examples that can be used to simplify the programming process.

The Arduino Uno board is also highly customizable, with a range of shields and accessories available that can be added to expand its functionality. For example, there are shields available that add Wi-Fi, Ethernet, or Bluetooth connectivity, as well as motor controllers, GPS modules, and many other types of sensors and actuators.

Overall, the Arduino Uno is a versatile and accessible microcontroller board that makes it easy for beginners to learn about electronics and programming while also providing professionals with a powerful tool for building complex electronic projects.



FIGURE 5.1 ARDUINO UNO MICROCONTROLLER

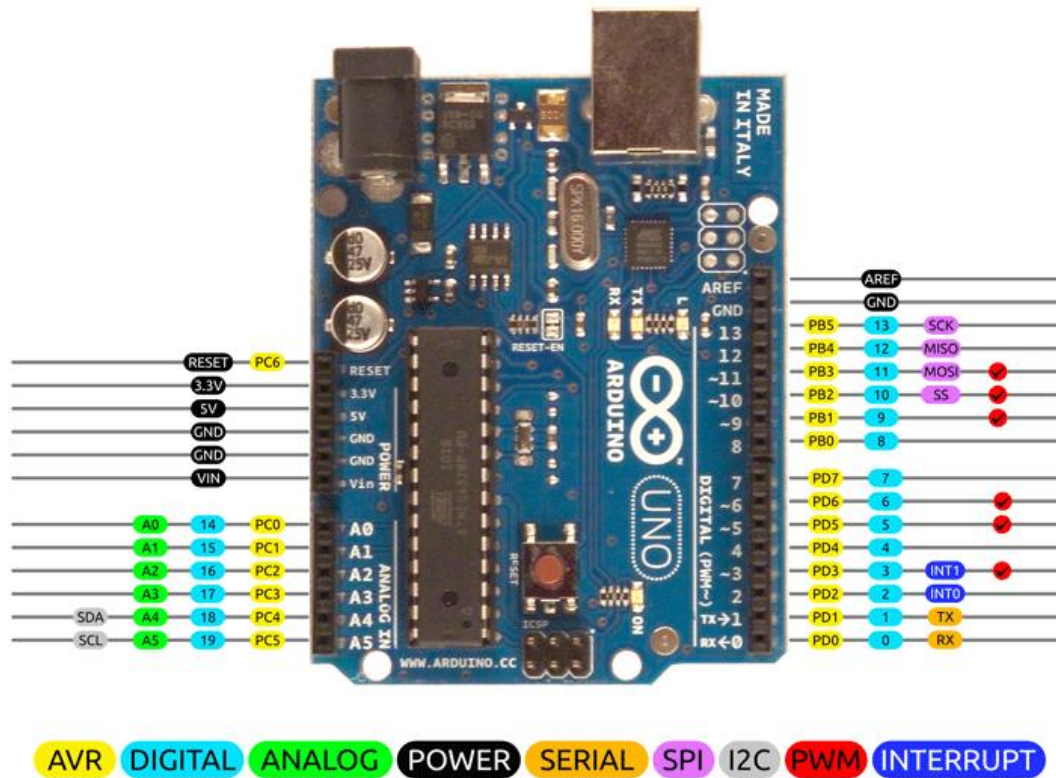


FIGURE 5.2 PINOUT CONFIGURATION

5.1.2 FSR SENSOR

An FSR (force-sensitive resistor) is a type of sensor that measures the amount of force applied to it. FSRs are made of a conductive material that changes its resistance when pressure is applied. The amount of resistance change is proportional to the amount of force applied.

An FSR is made of a conductive material, such as carbon or semiconductor. When no force is applied to the FSR, the conductive material is in a relaxed state and has a high resistance. When force is applied to the FSR, the conductive material is compressed and its resistance decreases. The amount of resistance change is proportional to the amount of force applied.

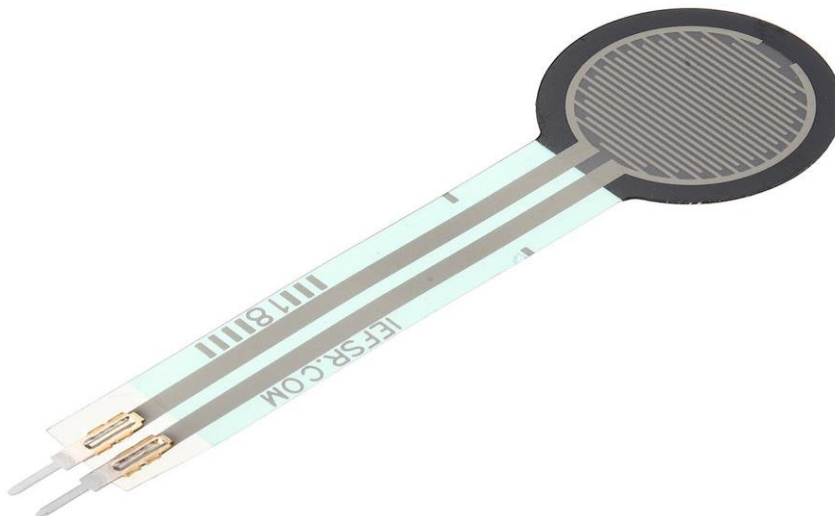


FIGURE 5.3 FSR SENSOR

Mathematically, we all know Force is a product of mass and its acceleration (or, $F=M*A$), or, applied pressure multiplied by contact area($F=P*Area$). From an engineering perspective “F” may be represented using units such as

Newton (N) or pound-force (lbf), and others.

When it comes to force-sensing resistors, they are not pre-calibrated so as they correspond to a known engineering unit. But, the output of force measurement captured by a force sensing resistor can be correlated to applied force by means of the calibration process.

Force sensing resistors are passive elements that function as a variable resistors in an electrical circuit. In short, they are a piezoresistive sensing technology. The sensor without any load or force on it carries high resistance in the order of several Megaohms ($M\Omega$) while when a force is applied the resistance drops considerably in order of Kiloohms ($K\Omega$). When conductance is considered (inverse of resistance), the relation is linear between conductance and the sensor's designated force range.

5.1.3 IR SENSOR

An IR (infrared) sensor, also known as an infrared detector, is a device that detects and measures infrared radiation in its vicinity. Infrared radiation is an electromagnetic radiation with longer wavelengths than visible light, making it invisible to the human eye.

IR sensors utilize the principles of thermal radiation and infrared light to detect and measure objects, people, or changes in temperature. They consist of an infrared source, which emits infrared radiation, and an infrared detector, which receives and measures the reflected or emitted radiation.

IR Sensor Working Principle

There are different types of infrared transmitters depending on their wavelengths, output power and response time. An IR sensor consists of an IR LED and an IR Photodiode, together they are called as PhotoCoupler or OptoCoupler.

The working of the IR sensor module is very simple, it consists of two main components: the first is the IR transmitter section and the second is the IR receiver section. In the transmitter section, IR led is used and in the receiver section, a photodiode is used to receive infrared signal and after some signal processing and

conditioning, you will get the output

An IR proximity sensor works by applying a voltage to the onboard Infrared Light Emitting Diode which in turn emits infrared light. This light propagates through the air and hits an object, after that the light gets reflected in the photodiode sensor. If the object is close, the reflected light will be stronger, if the object is far away, the reflected light will be weaker. If you look closely toward the module. When the sensor becomes active it sends a corresponding Low signal through the output pin that can be sensed by an Arduino or any kind of microcontroller to execute a particular task. The one cool thing about this module is that it has two onboard LEDs built-in, one of which lights on when power is available and another one turns on when the circuit gets triggered.

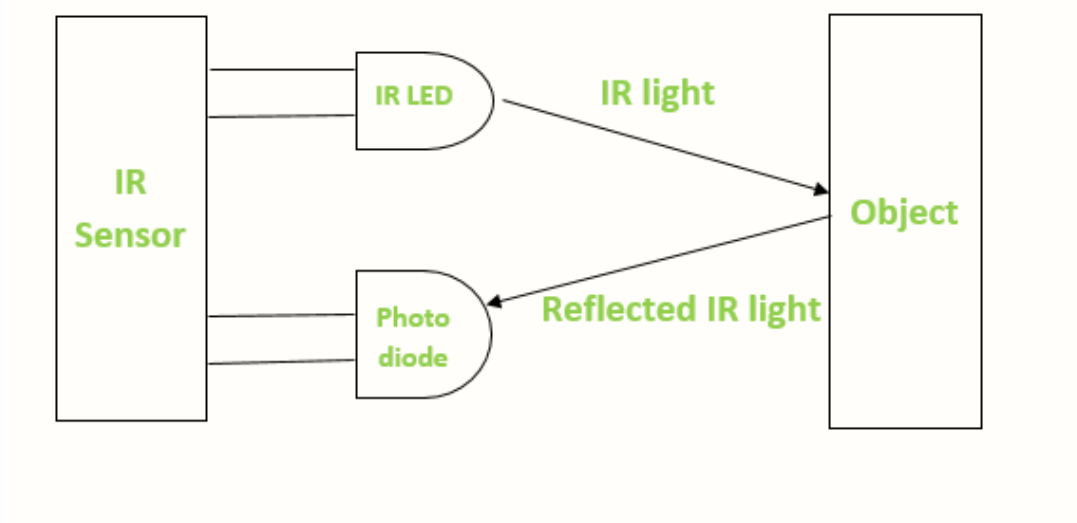


FIGURE 5.4 IR WORKING

IR LED Transmitter

IR LED emits light, in the range of Infrared frequency. IR light is invisible to us as its wavelength (700nm – 1mm) is much higher than the visible

light range. IR LEDs have light emitting angle of approx. 20-60 degree and range of approx. few centimeters to several feet, it depends upon the type of IR transmitter and the manufacturer. Some transmitters have the range in kilometers. IR LED white or transparent in colour, so it can give out amount of maximum light.

Photodiode Receiver

Photodiode acts as the IR receiver as its conducts when light falls on it. Photodiode is a semiconductor which has a P-N junction, operated in Reverse Bias, means it start conducting the current in reverse direction when Light falls on it, and the amount of current flow is proportional to the amount of Light. This property makes it useful for IR detection. Photodiode looks like a LED, with a black colour coating on its outer side, Black colour absorbs the highest amount of light.

LM358 Opamp

LM358 is an Operational Amplifier (Op-Amp) is used as voltage comparator in the IR sensor. the comparator will compare the threshold voltage set using the preset (pin2) and the photodiode's series resistor voltage (pin3).

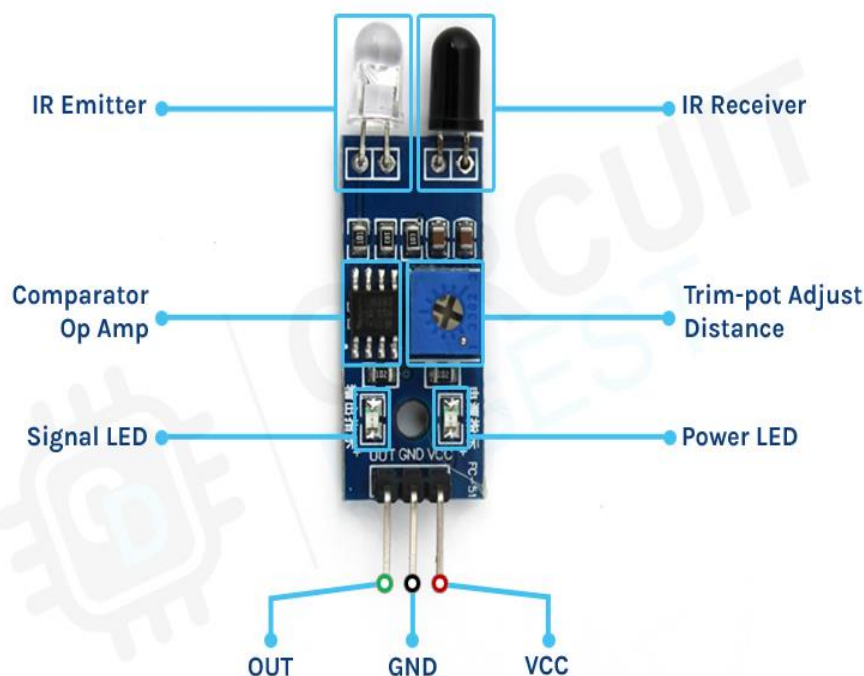


FIGURE 5.5 IR SENSOR

5.1.4 L293D MOTOR DRIVER INTRODUCTION

L293d IC is known as a motor driver. It is a low voltage operating device like other ICs. The other ICs could have the same functions like L293d but they cannot provide the high voltage to the motor. L293d provides the continuous bidirectional Direct Current to the Motor. The Polarity of current can change at any time without affecting the whole IC or any other device in the circuit. L293d has an internal H-bridge installed for two motors.

H-Bridge is an electrical circuit that enables the load in a bidirectional way. L293d bridge is controlled by external low voltage signals. It may be small in size, but its power output capacity is higher than our expectation. It could control any DC motor speed and direction with a voltage range of 4.5 – 36 Volts. Its diodes also save the controlling device and IC from back EMF. To control the max 600mA amount of current an internal “Darlington transistor sink” installed in it, which could be used to control a large amount of current by providing a small amount of current. It has also internal “pseudo-Darlington source” which amplifies the input signal to control the high voltage DC motor without any interception

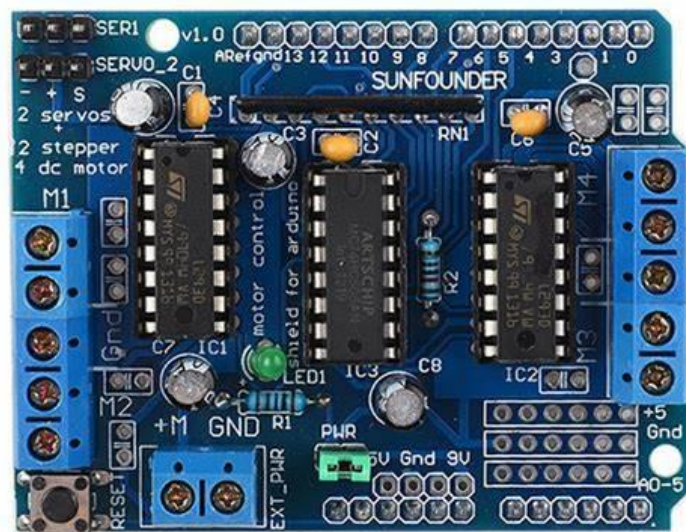


FIGURE 5.6 L293D MOTOR DRIVER

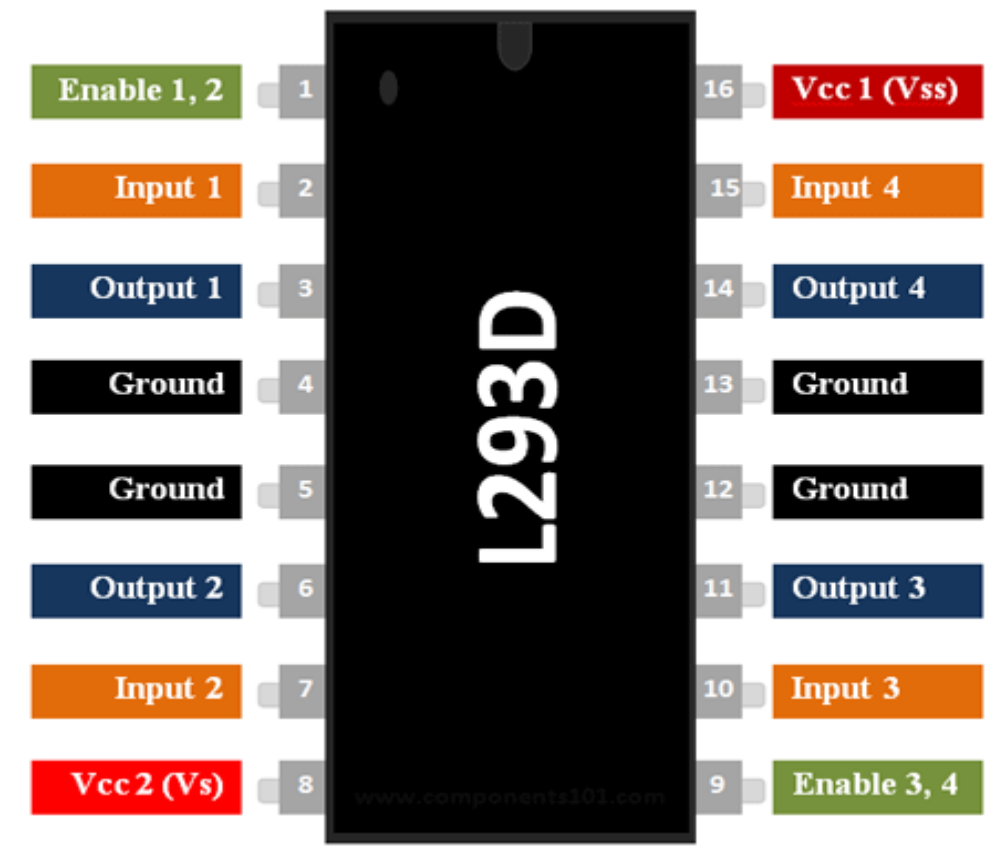


FIGURE 5.7 PINOUT CONFIGURATION

FEATURES

- L293d could be used to control the two motors at the same time.
- It has the ability to control the speed by using the enable pin.
- The direction is also easy to change.
- Voltage supply range is higher than other IC. Voltage range between 4.5-36 volts can easily handle by the IC to the motor.
- The motor has a maximum continuous range of current close to 600mA but the maximum peak current range is 1.2A
- It has an automatic shutdown system on thermal condition.
- Its working range is from 0 – 70 degree which is much higher for any small-sized IC.
- It has an internal back emp protection for IC and the controlling device

5.1.5 DC MOTOR

A DC motor is an electric motor that runs on direct current power. In an electric motor, the operation is dependent upon simple electromagnetism. A current-carrying conductor generates a magnetic field, when this is then placed in an external magnetic field, it will encounter a force proportional to the current in the conductor and to the strength of the external magnetic field. It is a device that converts electrical energy to mechanical energy. It works on the fact that a current-carrying conductor placed in a magnetic field experiences a force that causes it to rotate with respect to its original position. Practical DC Motor consists of field windings to provide the magnetic flux and armature which acts as the conductor.

The input of a brushless DC motor is current/voltage and its output is torque. Understanding the operation of the DC motor is very simple from a basic diagram is shown below. DC motor basically consists of two main parts. The rotating part is called the rotor and the stationary part is also called the stator. The rotor rotates with respect to the stator.

The rotor consists of windings, the windings being electrically associated with the commutator. The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnets are misaligned and the rotor will turn until it is very nearly straightened with the stator's field magnets.

As the rotor reaches alignment, the brushes move to the next commutator contacts and energize the next winding. The rotation reverses the direction of current through the rotor winding, prompting a flip of the rotor's magnetic field, driving .



FIGURE 5.8 DC MOTOR

DC motors have a wide range of applications, including:

Electric Vehicles: DC motors are used in electric vehicles, including electric cars, motorcycles, and bicycles. They provide the necessary torque and power for propulsion, allowing the vehicle to move efficiently.

Robotics: DC motors are commonly employed in robotic systems for precise control of movement. They can be found in robotic arms, grippers, and other robotic actuators.

Industrial Machinery: DC motors are used in various industrial applications, such as conveyor belts, pumps, fans, and compressors. They provide reliable and adjustable power for driving these mechanical systems.

Home Appliances: Many household appliances utilize DC motors. Examples include refrigerators, washing machines, vacuum cleaners, and kitchen appliances like blenders and mixers. **Medical Devices:** DC motors play a crucial role in various medical devices, such as surgical robots, infusion pumps, prosthetic limbs, and medical imaging systems.

6. RESULTS

6.1 HARDWARE SETUP

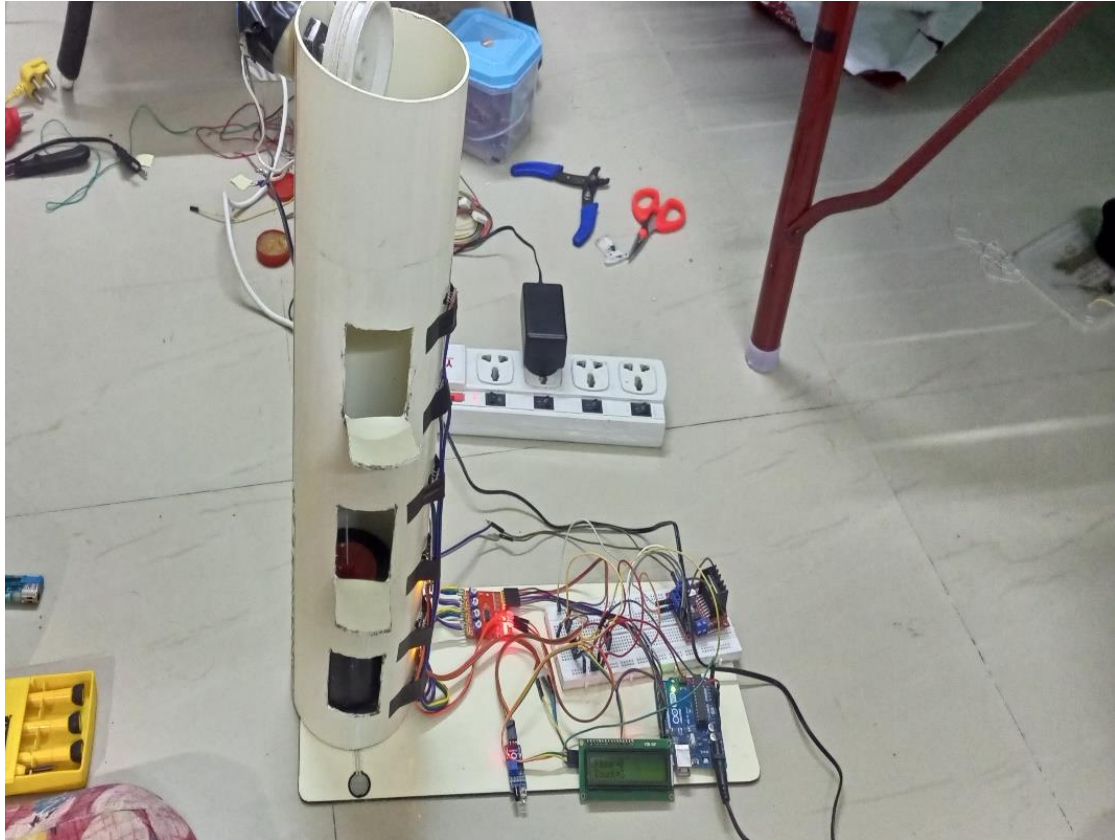


FIGURE 6.1 HARDWARE SETUP

In the hardware setup, we have employed various components to enable the control and operation of the Lift system. The central control unit of the system is the Arduino Uno microcontroller, which effectively manages and coordinates all the inputs and outputs of the different components.

To accurately detect the position of the Lift, we have incorporated IR sensors. These sensors play a crucial role in determining the Lift's current position and allowing it to move accordingly. By sensing the presence or absence of the Lift at specific floors, the IR sensors provide essential feedback for controlling the Lift's movements. To control the DC motor responsible for holding and moving the Lift, we have utilized the L293D motor driver. This motor driver offers precise control

over the motor's speed and direction. It ensures smooth and accurate movements of the Lift, enhancing its overall functionality and safety.

To provide passengers with relevant information, we have integrated an LCD display into the system. This display indicates the current position of the Lift in terms of the floor it is located on. Additionally, the LCD display also shows the count of persons inside the Lift. The count of individuals is determined by an IR sensor that detects the presence of passengers entering or exiting the Lift.

To establish the necessary electrical connections, we have utilized a breadboard and jumper wires. The breadboard provides a convenient platform for arranging and connecting the various components, while the jumper wires enable the transmission of electrical signals between the components.

6.2 OUTPUT

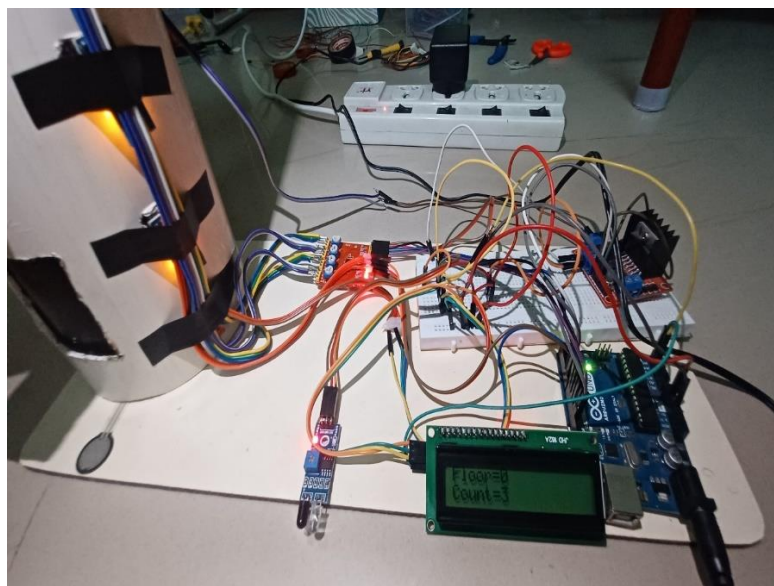


FIGURE 6.2 PROJECT OUTPUT

IoT BASED ENERGY BILL CALCULATOR

AFREETH GHANI A R, JAKRIYA METHA M

ABSTRACT

IoT-based energy management systems are becoming increasingly important in the energy sector, with applications ranging from energy demand forecasting to optimizing energy usage in smart homes. The development of an IoT-based energy bill calculator that utilizes a current sensor to provide a more accurate and comprehensive view of energy usage and consumption is a promising solution for improved energy management and sustainability. The system uses machine learning algorithms to process the data collected by the current sensor and predict future consumption, enabling the system to generate bills and email them to users directly. The system offers real-time information about energy consumption, cost, and carbon emissions to enable users to optimize their energy usage and reduce their bills. The IoT architecture comprises four components: monitoring and control via mobile devices, location-based automatic controls, cloud-computing, and big data analytics. The development of an efficient energy management system using IoT technologies can provide a low-cost tool that takes into account the energy used in domestic facilities. With this information, users can make informed decisions about their energy usage, identify areas of waste, and optimize their energy consumption to reduce their bills. The IoT system can be set up to measure power draw at the source, meaning each piece of equipment can be isolated. Alternatively, the IoT system can be used to monitor and control building energy use, providing an effective tool to reduce energy consumption.

The use of machine learning algorithms and predictive analytics is becoming increasingly important in the energy sector. AI and machine learning can help energy companies optimize their operations, improve efficiency, and cut costs. AI is revolutionizing the energy sector by enabling predictive maintenance, optimization of energy consumption, and predictive energy demand forecasting. IoT devices can monitor energy transition, track equipment performance, and optimize demand response in electricity generation. IoT-based predictive maintenance could reduce maintenance costs by up to 30% and reduce unplanned downtime by up to 50%. In conclusion, IoT-based energy management systems offer a promising solution for a greener future. The use of machine learning algorithms and predictive analytics can provide real-time information about energy consumption, cost, and carbon emissions to enable users to optimize their energy usage and reduce their bills. The development of efficient energy management systems using IoT technologies can provide low-cost tools that

take into account the energy used in domestic facilities, enabling users to make informed decisions about their energy usage and reduce their bills. The integration of AI and machine learning in the energy sector can help energy companies optimize their operations, improve efficiency, and cut costs. The use of IoT devices can monitor energy transition, track equipment performance, and optimize demand response in electricity generation.

1. INTRODUCTION

In today's world, energy conservation and efficient management of resources have become paramount. With the increasing demand for electricity and the need for sustainable energy practices, it is essential to monitor and manage our electricity consumption effectively. This is where smart electricity meters come into play. A smart electricity meter is an advanced device that goes beyond the traditional analog meters by providing real-time data and valuable insights into energy consumption patterns. One of the remarkable features of smart meters is their ability to generate weekly consumption reports and deliver them directly to end users, enabling them to make informed decisions about their energy usage.

The primary purpose of a smart electricity meter is to accurately measure and record energy consumption. It replaces the manual reading process with automated data collection, eliminating the need for physical visits by meter readers. This technology allows for the seamless transfer of consumption data to utility companies, ensuring accurate billing and reducing human errors. However, what sets smart meters apart is their capability to provide end users with access to their energy usage data.

By leveraging wireless communication technologies such as Wi-Fi or cellular networks, smart meters can securely transmit consumption data to a central server. From there, the data is processed and analyzed, generating comprehensive reports that offer valuable insights into energy consumption trends. These reports typically include information on weekly energy consumption, peak usage hours, and comparisons with previous periods. Armed with this information, consumers can proactively manage their energy usage, identify areas of high consumption, and implement energy-saving practices.

The provision of weekly consumption reports offers several advantages. Firstly, it empowers consumers to make informed decisions about their energy usage patterns. By reviewing the reports, individuals can identify energy-intensive appliances or activities and take measures to optimize their usage. This, in turn, promotes energy efficiency and conservation. Secondly, the regular reporting of energy consumption fosters awareness and

encourages responsible energy usage among consumers. When users have visibility into their energy habits and witness the impact of their choices, they are more likely to adopt sustainable practices and strive for greater efficiency.

Moreover, the integration of smart meters with home automation systems and mobile applications allows users to monitor their consumption data in real-time. This instant accessibility further enhances consumer engagement and promotes an active role in managing energy usage. Additionally, utilities can leverage the aggregated data from smart meters to analyze energy consumption patterns on a larger scale. This data-driven approach helps utilities identify demand trends, plan for infrastructure upgrades, and optimize the distribution of electricity

2.PROPOSED METHODOLOGY

BLOCK DIAGRAM

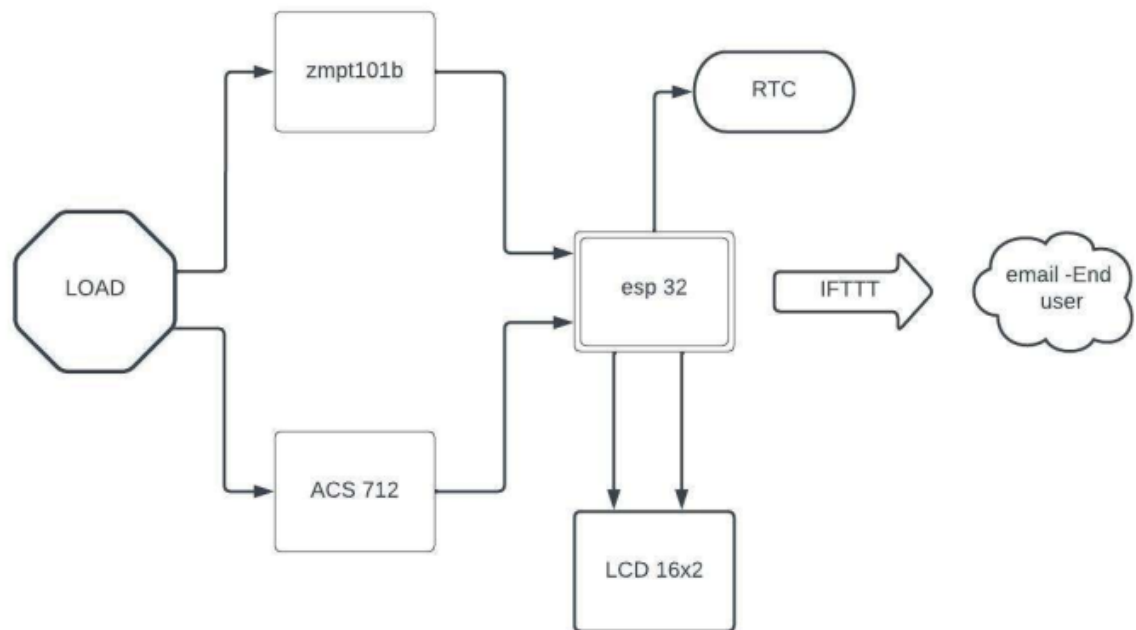


Fig 2.1 BLOCK DIAGRAM

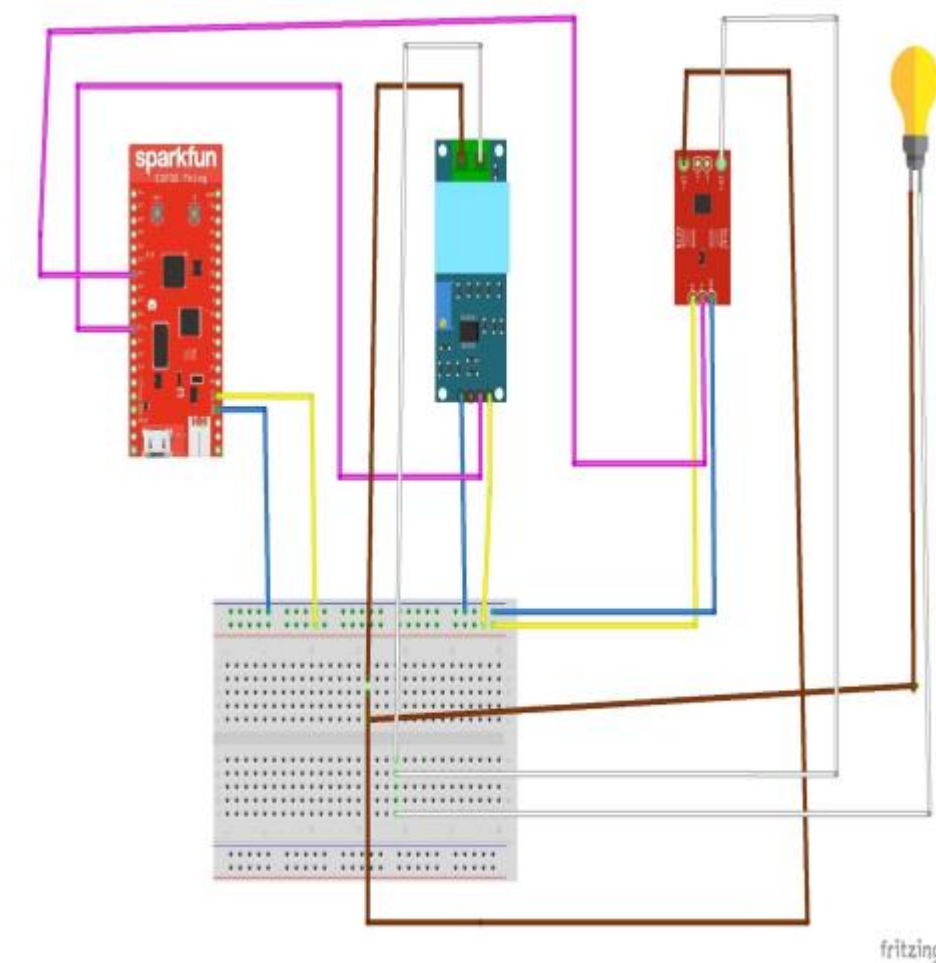


FIG 2.2 CIRCUIT DIAGRAM

The circuit composed of the ZMPT101B and ACS712 sensors in series offers a practical solution for measuring energy consumption in a load. Now let's delve deeper into the components and their respective roles within the circuit.

The ZMPT101B serves as an AC voltage sensor module, specifically designed to measure the AC voltage of the load. When connected to the circuit, it generates an analog voltage output that is directly proportional to the amplitude of the AC voltage being measured. This output can be further utilized for various calculations and analyses related to energy consumption.

On the other hand, the ACS712 sensor is based on the hall-effect principle and is primarily used as a current sensor module. By integrating the ACS712 into the circuit, it becomes capable of measuring the AC current flowing through the load. Similar to the ZMPT101B, the ACS712 generates an analog voltage output that is proportional to the

magnitude of the AC current. This information is vital for accurate energy consumption calculations.

By utilizing these sensors in series, the circuit can measure both the voltage and current of the load simultaneously. This arrangement enables the calculation of instantaneous power consumption by simply multiplying the voltage and current values obtained from the respective sensors. This instantaneous power reading provides valuable insights into the immediate energy requirements of the load.

To calculate energy consumption accurately, which represents the integration of power over time, continuous monitoring of the instantaneous power and its accumulation over a specific duration is necessary. The circuit must constantly measure the instantaneous power, whether by frequent sampling or continuous monitoring, and accumulate the obtained power values over the desired time frame

In order to calculate power consumption, the typical procedure involves several steps. First, the analog voltage output from the ZMPT101B sensor is read to determine the AC voltage of the load accurately. Concurrently, the analog voltage output from the ACS712 sensor is also read to measure the AC current flowing through the load effectively.

With these voltage and current readings in hand, the instantaneous power can be calculated by multiplying the voltage and current values together. The formula for calculating instantaneous power is as follows: $\text{Instantaneous Power} = \text{Voltage} * \text{Current}$. This calculation provides valuable information about the power being consumed by the load at any given moment. To determine the energy consumption accurately, the circuit needs to accumulate the instantaneous power values over time. This can be accomplished through various methods, such as integrating the power values using numerical techniques like the trapezoidal rule or summing the power values over discrete time intervals. By continuously accumulating the power values, an accurate representation of the energy consumption over the desired period can be obtained.

It is crucial to note that the accuracy and calibration of these sensors significantly impact the reliability of energy consumption measurements. Proper calibration may be necessary to establish a correlation between the sensor readings and the actual power consumption values of the load. Additionally, depending on the specific requirements of the application, appropriate signal conditioning techniques, such as amplification and filtering, may be necessary to ensure accurate and reliable readings from the sensors.

By carefully implementing and calibrating the ZMPT101B and ACS712 sensors in the circuit, it becomes a powerful tool for measuring and monitoring energy consumption in a load. This circuit provides valuable insights into the power requirements of the load,12 enabling efficient energy management and optimization in various applications and industries.

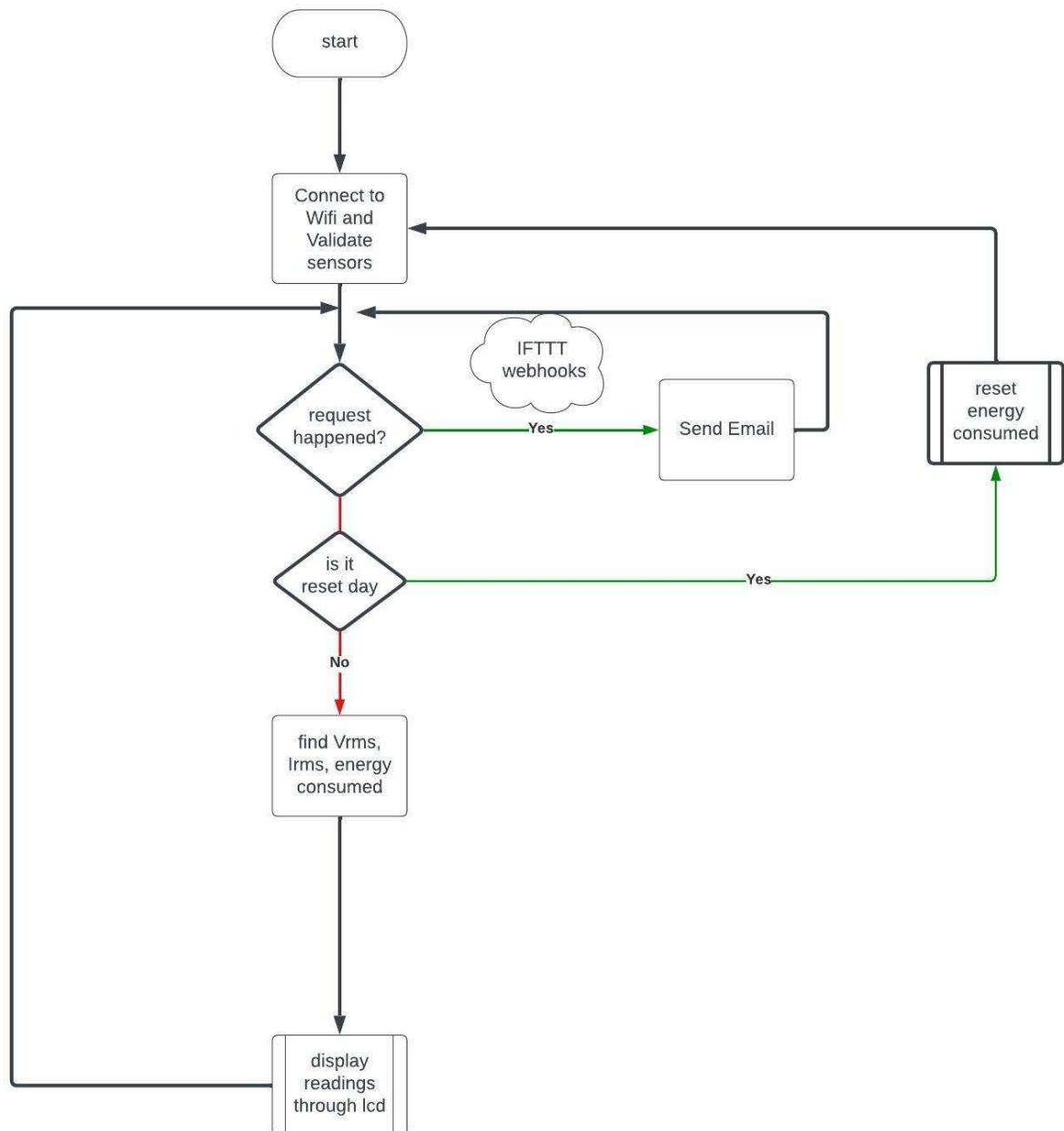


Fig 2.3 FLOW CHART

The IFTTT (If This Then That) integration takes the energy consumption data obtained from the flowgraph and utilizes it to trigger specific actions. In this case, the flowgraph is designed to send the energy consumption data via IFTTT webhooks and ultimately email it to the end user. Here's a more detailed explanation of the flowgraph:

The flowgraph begins by acquiring the necessary input data, which includes measuring the voltage and current of the load. This can be achieved using sensors such as the ZMPT101B for voltage measurement and the ACS712 for current measurement. These sensors provide the essential data for calculating the energy consumption of the load.

Once the voltage and current values are obtained, the flowgraph proceeds to calculate the instantaneous power consumption of the load. This calculation involves multiplying the voltage and current values together. By performing this multiplication, the flowgraph determines the power consumed by the load at that particular moment. This instantaneous power value is crucial for understanding the load's energy consumption in real-time.

To obtain a comprehensive overview of the energy consumption, the flowgraph accumulates the instantaneous power values over time. This accumulation process involves either integrating the power values over discrete time intervals or periodically summing them up. By accumulating the instantaneous power values, the flowgraph can determine the total energy consumption of the load over the desired period.

Once the energy consumption data is calculated, the flowgraph utilizes IFTTT webhooks to trigger an action. IFTTT webhooks allow for the connection of different web services and the automation of actions based on specific events. In this case, the energy consumption data is sent to an IFTTT webhook, which acts as a trigger for further actions.

Within the IFTTT platform, an applet is configured to receive the energy consumption data from the webhook. An applet in IFTTT consists of a conditional statement that follows the "If This Then That" logic. In this scenario, the applet is set up to receive the energy consumption data and trigger a predefined action.

The predefined action chosen for this flowgraph is to send an email to the end user. When the applet receives the energy consumption data, it initiates the email sending process, ensuring that the end user receives the data promptly and conveniently. This allows the end user to stay informed about the energy consumption of the load and make informed decisions regarding energy usage.

By leveraging the capabilities of IFTTT webhooks and applets, the flowgraph creates an efficient and automated system for monitoring and reporting energy consumption. It

streamlines the process of collecting and analyzing data, providing valuable insights to the end user and promoting energy-conscious behavior.

It's important to note that the specific implementation and configuration of the IFTTT integration may vary based on individual requirements and preferences. Customization options within the IFTTT platform allow for flexibility in choosing the desired actions triggered by the energy consumption data. Additionally, security measures should be taken into consideration to protect the privacy and integrity of the transmitted data throughout the process.

3.WORKING PRINCIPLE

An embedded system using ESP32, ACS712, and ZMPT101B accurately calculates energy consumption by measuring voltage and current. The ESP32 serves as the central control unit, communicating with sensors and performing calculations. The ACS712 current sensor detects AC current through the Hall effect, providing an analog voltage output proportional to the current. The ZMPT101B voltage sensor measures AC voltage, converting it into an analog voltage output. The ESP32 reads these analog voltage outputs, multiplies them to calculate instantaneous power, and accumulates power values over time. A timekeeping mechanism tracks duration, integrating power values to calculate total energy consumption. Results can be displayed on an LCD or sent to a remote server. Calibration ensures measurement accuracy, while signal conditioning improves sensor stability.



Fig 4.1 ARDUINO UNO

Arduino Uno is a widely used microcontroller board that serves as the core of many Arduino mini projects. It is based on the ATmega328P microcontroller, operating at 16 MHz. Arduino Uno is designed to provide an accessible and versatile platform for electronics enthusiasts, makers, and students to explore and create various mini projects.

The board dimensions are approximately 68.6mm x 53.4mm, making it compact and easy to work with. It features a total of 14 digital input/output pins, with 6 of them capable of producing pulse-width modulation (PWM) signals. These pins can be used for interfacing with various electronic components, such as sensors, actuators, and displays. Additionally, the board provides 6 analog input pins for reading analog signals, allowing users to measure and process real-world values such as temperature, light intensity, and more.

Arduino Uno is equipped with a 16 MHz quartz crystal oscillator, which provides accurate timing for the microcontroller's operations. This clock speed ensures reliable performance and precise timing for time-sensitive applications. The board also includes a USB Type-B connector, enabling easy programming and communication with a computer. It supports USB 2.0 Full Speed, allowing for fast data transfer and communication between the Arduino and the connected device.

Powering the Arduino Uno can be done in two ways. The board can be powered through the USB connection, which also provides a convenient way to program it. Alternatively, an external power supply can be used by connecting it to the board's barrel jack. The recommended voltage range for the external power supply is 7 to 12 volts. However, the board can handle a wider voltage range, from 6 to 20 volts. It is important to note that the voltage selection affects the operating voltage of the microcontroller and the logic levels of the I/O pins.

Arduino Uno operates at 5 volts, which is the standard logic level for most components and sensors commonly used in Arduino mini projects. This makes it compatible with a wide range of electronic devices and modules. The board provides a regulated 5V output pin, which can be used to power external components directly from the Arduino. It also includes a 3.3V output pin, which provides a lower voltage level for interfacing with devices that require 3.3V logic.

In terms of memory, Arduino Uno features 32 KB of flash memory, which is where the user's code is stored. Out of this 32 KB, 0.5 KB is reserved for the bootloader, which is responsible for loading the user's code into the microcontroller's flash memory. The board also has 2 KB of SRAM (Static Random Access Memory), which is used for storing variables and data during program execution. Additionally, it provides 1 KB of EEPROM (Electrically Erasable Programmable Read-Only Memory), which can be used to store nonvolatile data that persists even when the power is turned off.

Arduino Uno is programmed using the Arduino Software (IDE), a user-friendly development environment that simplifies the coding process. It supports the Arduino programming language, which is based on Wiring, and provides a rich set of libraries and examples to help users get started quickly. The board can be connected to a computer via the USB port, and programs can be uploaded to the microcontroller using the Arduino IDE. With its versatile capabilities and extensive community support, Arduino Uno is suitable for a wide range of mini projects, including robotics, home automation, prototyping, and educational applications. Its simplicity, affordability, and compatibility make it an excellent choice for beginners and experienced makers alike. Arduino Uno's open-source nature allows users to modify and expand its functionalities by creating custom shields and adding additional components.

CURRENT SENSOR



Fig 4.2 ACS 712

The ACS712 Current Sensor Module is a highly reliable and accurate sensor module designed for measuring AC or DC currents. It is commonly used in a variety of applications, including power monitoring, motor control, and energy management systems. The module is based on the Allegro ACS712 Hall effect current sensor IC, which provides a non-intrusive method for measuring current.

The ACS712 Current Sensor Module operates with a supply voltage ranging from 4.5V to 5.5V. It features a low-offset, linear Hall Effect sensor that provides a voltage output proportional to the current flowing through the module. The output voltage has a sensitivity of 185mV per ampere, allowing for precise current measurements. This sensitivity can be adjusted using an external resistor to accommodate different current ranges.

The module comes in different variants, including the ACS712ELCTR-05B-T and ACS712ELCTR-20A-T, which can measure current up to 5A and 20A, respectively. Each variant has its own specified current range, and it is important to select the appropriate module based on the expected current levels in your application.

The ACS712 Current Sensor Module has a small form factor, making it suitable for spaceconstrained mini projects. It features a compact PCB with input and output terminals for easy integration into your circuit. The module also includes a 100nF bypass capacitor to ensure stable and accurate measurements by minimizing noise and interference.

One notable feature of the ACS712 Current Sensor Module is its galvanic isolation. The module provides electrical isolation between the current-carrying conductor and the measurement circuit, ensuring the safety of the connected components and reducing the risk of electrical shock. This isolation is achieved through the use of an integrated Hall Effect sensor, which operates without the need for direct electrical contact with the measured current.

The ACS712 Current Sensor Module offers a wide operating temperature range, typically from -40°C to 85°C, allowing it to perform reliably in various environmental conditions. It has a low quiescent current consumption of around 1.5mA, making it energy-efficient and suitable for battery-powered applications.

To interface with the module, it requires a simple analog-to-digital converter (ADC) circuitry to convert the analog output voltage into a digital value that can be processed by a microcontroller or other digital devices. The output voltage of the module varies linearly with the input current, allowing for easy calibration and accurate current measurements.

The ACS712 Current Sensor Module is compatible with popular microcontroller platforms, such as Arduino, Raspberry Pi, and ESP8266. This compatibility allows for seamless integration into existing mini projects and simplifies the development process. Many libraries and code examples are available online, making it easy to interface and retrieve current measurements from the module.

The module provides bidirectional current sensing, allowing it to measure both positive and negative currents. This feature makes it suitable for applications that involve bidirectional power flow, such as battery charging and motor control.

In terms of accuracy, the ACS712 Current Sensor Module has a typical accuracy of $\pm 1.5\%$ at room temperature. However, it is important to note that accuracy can vary based on factors such as temperature, power supply stability, and external circuitry. For precise measurements, calibration and proper circuit design are recommended.

To ensure the module's longevity and reliable performance, it is important to follow the manufacturer's guidelines regarding power supply voltage, temperature limits, and maximum current ratings. Proper current path layout and isolation techniques should be employed to minimize electromagnetic interference (EMI) and ensure accurate measurements.

In conclusion, the ACS712 Current Sensor Module offers a convenient and accurate solution for measuring AC or DC currents in various applications. Its compact size, Galvanic isolation, and compatibility with popular microcontroller platforms make it a versatile choice for mini projects requiring current sensing. By providing a voltage output proportional to the measured current, the module simplifies the process of current measurement and facilitates efficient power monitoring and control.

VOLTAGE SENSOR



Fig 4.3 VOLTAGE SENSOR

The ZMPT101B Voltage Sensor Module is a highly useful and accurate sensor module designed for measuring AC voltage. It is commonly used in a variety of applications, including power monitoring, voltage regulation, and energy management systems. The module utilizes a built-in voltage transformer to provide a non-intrusive method for measuring AC voltages.

The ZMPT101B Voltage Sensor Module operates with a supply voltage ranging from 5V to 30V DC. It features a high-precision voltage transformer that converts the input AC voltage into a proportional low-voltage output signal. This signal can be easily interfaced with microcontrollers or other digital devices for further processing and analysis.

The module has a wide measurement range, typically from 0 to 250V AC, allowing it to accurately measure a broad range of voltages. It offers a voltage measurement resolution of 0.1V, enabling precise voltage monitoring and control. It is important to note that the module is designed specifically for AC voltage measurement and is not suitable for measuring DC voltages.

The ZMPT101B Voltage Sensor Module has a compact size, making it suitable for mini projects with limited space. It features a convenient PCB with input and output terminals for easy integration into your circuit. The module also includes a 100nF bypass capacitor to minimize noise and interference, ensuring stable and accurate voltage measurements.

One notable feature of the ZMPT101B Voltage Sensor Module is its galvanic isolation. The module provides electrical isolation between the input AC voltage and the measurement circuit, ensuring the safety of the connected components and reducing the risk of electrical shock. This isolation is achieved through the use of a built-in voltage transformer, which operates without the need for direct electrical contact with the measured voltage.

The ZMPT101B Voltage Sensor Module offers a wide operating temperature range, typically from -10°C to 70°C, allowing it to perform

reliably in various environmental conditions. It has a low quiescent current consumption of approximately 10mA, making it energy-efficient and suitable for battery-powered applications.

To interface with the module, it requires a simple analog-to-digital converter (ADC) circuitry to convert the analog output voltage into a digital value that can be processed by a microcontroller or other digital devices. The output voltage of the module varies linearly with the input AC voltage, allowing for easy calibration and accurate voltage measurements.

The ZMPT101B Voltage Sensor Module is compatible with popular microcontroller platforms, such as Arduino, Raspberry Pi, and ESP8266. This compatibility allows for seamless integration into existing mini projects and simplifies the development process. Many libraries and code examples are available online, making it easy to interface and retrieve voltage measurements from the module.

In terms of accuracy, the ZMPT101B Voltage Sensor Module has a typical accuracy of $\pm 0.5\%$ at room temperature. However, it is important to note that accuracy can vary based on factors such as temperature, power supply stability, and external circuitry. For precise measurements, calibration and proper circuit design are recommended.

To ensure the module's longevity and reliable performance, it is important to follow the manufacturer's guidelines regarding power supply voltage, temperature limits, and maximum voltage ratings. Proper circuit layout and isolation techniques should be employed to minimize electromagnetic interference (EMI) and ensure accurate voltage measurements.

In conclusion, the ZMPT101B Voltage Sensor Module offers a convenient and accurate solution for measuring AC voltages in various applications. Its compact size, galvanic isolation, and compatibility with

popular microcontroller platforms make it a versatile choice for mini projects requiring voltage sensing. By providing a low-voltage output proportional to the measured AC voltage, the module simplifies

ESP 32 (WIFI MODULE)



Fig 4.4 ESP 32 (WIFI MODULE)

The ESP32 is a powerful Wi-Fi module that offers advanced features and capabilities for wireless communication and IoT applications. It is based on the ESP32 system-on-chip (SoC) developed by Espressif Systems. The ESP32 module provides a highly integrated solution, combining Wi-Fi connectivity, dual-core processing, low-power capabilities, and a rich set of peripherals.

The ESP32 module supports both 2.4GHz and 5GHz Wi-Fi networks, providing flexibility and compatibility with various wireless environments. It supports the IEEE 802.11 b/g/n Wi-Fi standards, offering reliable and high-speed wireless communication. With its builtin Wi-Fi stack and protocols, the module allows seamless connectivity to Wi-Fi networks and enables easy integration with existing Wi-Fi infrastructure.

One of the key features of the ESP32 module is its dual-core processor. It consists of two Tensilica LX6 microprocessor cores, each operating at a clock frequency of up to 240MHz. The dual-core architecture allows for efficient multitasking and parallel processing, making the module suitable for

complex applications that require real-time data processing and multitasking capabilities.

The ESP32 module provides ample memory resources for data storage and program execution. It typically offers up to 520KB of SRAM for data storage, which can be used for variables, buffers, and stack memory. Additionally, it provides up to 4MB of flash memory for program storage, allowing developers to store firmware, web pages, and other resources.

For wireless communication, the ESP32 module supports various protocols, including TCP/IP, UDP, HTTP, MQTT, and WebSocket. These protocols enable seamless integration with cloud platforms and web services, facilitating remote control and monitoring of connected devices. The module also supports secure communication through SSL/TLS protocols, ensuring data confidentiality and integrity.

The ESP32 module features a rich set of peripherals, including GPIOs, UART, SPI, I2C, and PWM interfaces. This allows for easy integration with sensors, actuators, displays, and other devices. It also includes built-in support for analog-to-digital conversion (ADC) and digital-to-analog conversion (DAC), enabling measurement and control of analog signals.

To facilitate development and programming, the ESP32 module is supported by an extensive software ecosystem. It is compatible with the Arduino framework, allowing developers to leverage the existing Arduino libraries and community resources. Espressif Systems provides a software development kit (SDK) that includes libraries, tools, and examples to simplify application development. The ESP-IDF (ESP32 IoT Development Framework) provides a comprehensive set of APIs and components for building IoT applications.

The ESP32 module supports low-power operation, making it suitable for battery-powered and energy-efficient applications. It offers various

power-saving modes, including deep sleep, which allows the module to consume minimal power while retaining the program state. The module also provides hardware support for power management, allowing developers to optimize power consumption and extend battery life.

In terms of physical form factor, the ESP32 module is available in different variants, including surface-mount modules and modules with castellated pins for easy integration onto PCBs. It typically operates at a voltage range of 2.2V to 3.6V and can withstand temperature ranges from -40°C to 85°C, making it suitable for a wide range of operating conditions.

The ESP32 module features a reliable and robust wireless connection, with a range of up to several hundred meters, depending on environmental conditions and antenna design. It supports multiple Wi-Fi modes, including access point (AP) mode, station (STA) mode, and simultaneous AP/STA mode, allowing for various network configurations.

HARDWARE SNAP SHOT

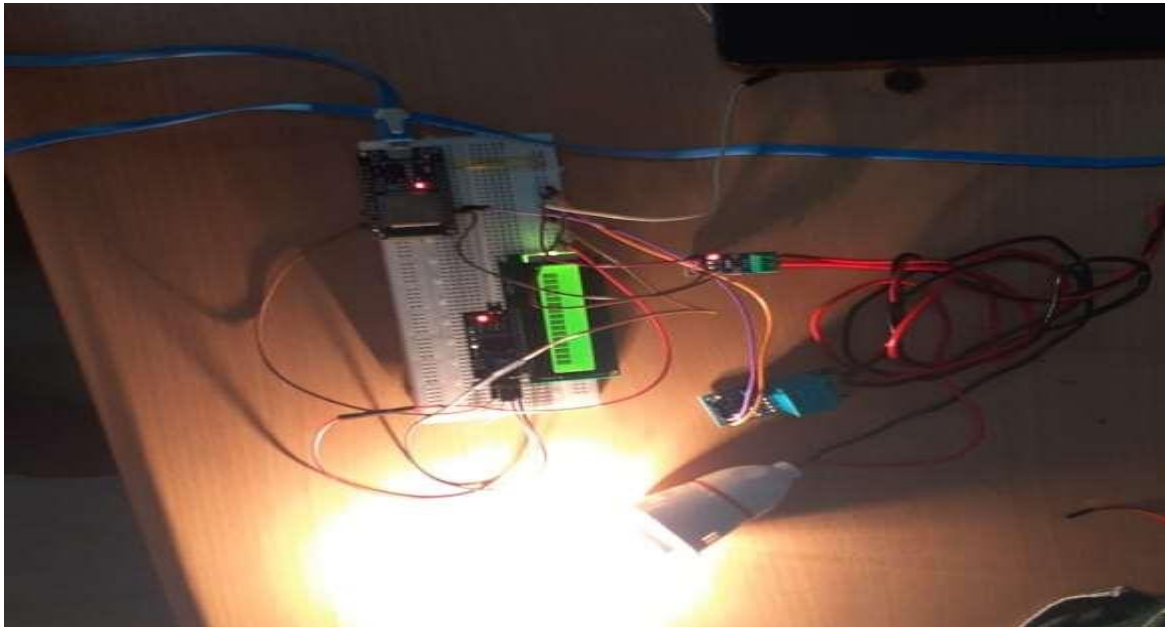


Fig 4.6 HARDWARE 1

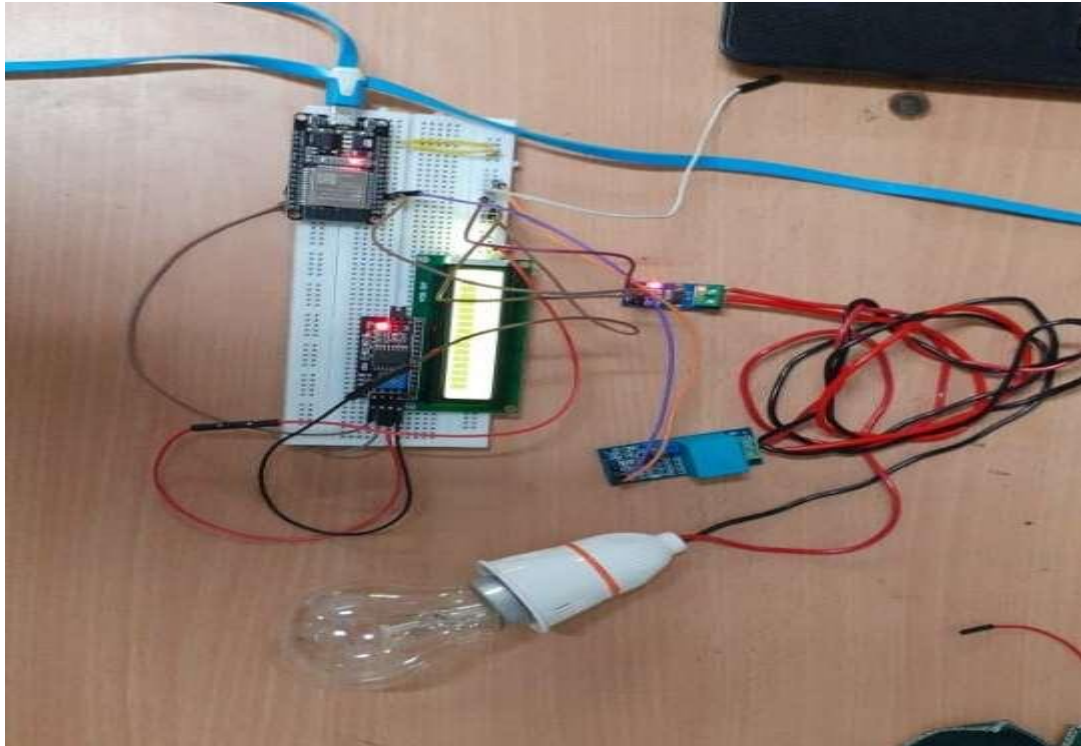


Fig 4.7 HARDWARE 2

SOFTWARE SNAP SHOT

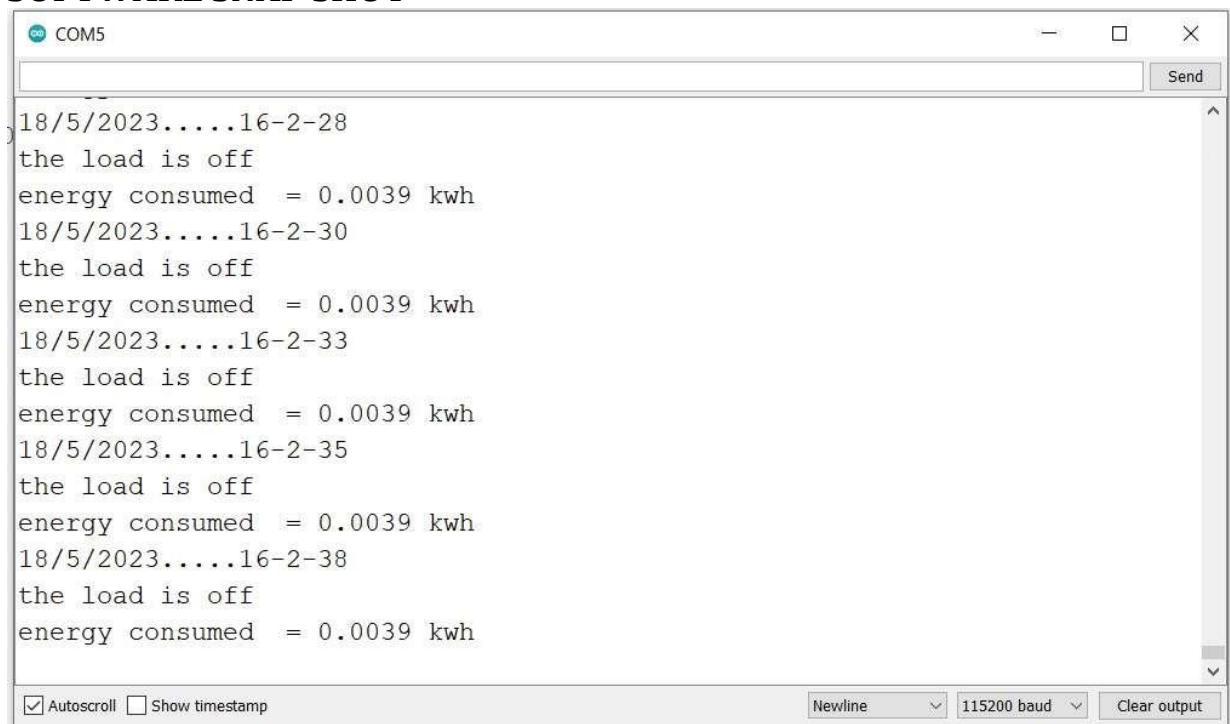


Fig 5.1 OUTPUT 1

```
COM5
18/5/2023.....16-6-44
Voltage = 225.96 V
current = 0.1646 A
energy consumed = 0.0040 kwh
The amount for the energy consumed(MSEB) = Rs.118.32
The amount for the energy consumed(TNEB) = Rs.0.00
*****
18/5/2023.....16-6-46
Voltage = 228.14 V
current = 0.1675 A
energy consumed = 0.0040 kwh
The amount for the energy consumed(MSEB) = Rs.118.32
The amount for the energy consumed(TNEB) = Rs.0.00
*****
18/5/2023.....16-6-48
```

Fig 5.2 OUTPUT 2

In conclusion, the implementation of smart electricity meters that send weekly email notifications about electricity consumption has proven to be a monumental leap forward in the field of energy management. This cutting-edge technology has revolutionized the way consumers engage with their energy usage, resulting in a plethora of remarkable advantages and positive outcomes. First and foremost, the weekly email updates serve as an indispensable tool for fostering energy efficiency and conservation. By furnishing users with comprehensive and detailed information about their electricity consumption patterns, individuals are empowered to make well-informed decisions regarding their energy usage. This heightened awareness invariably leads to a reduction in wasteful practices and encourages the widespread adoption of energy-saving habits. Armed with knowledge about their energy consumption, users become more conscious of the impact of their actions on the environment and are motivated to adjust their behavior accordingly.

Moreover, the regular email updates establish a sense of accountability among consumers. Through visualizing their energy consumption data in a digestible format, individuals are motivated to actively participate in sustainable practices. The tangible representation of their energy usage encourages users to take ownership of their consumption habits and prompts them to seek ways to optimize their energy efficiency. This can manifest in various forms, such as modifying usage habits, investing in energy-efficient appliances, or even exploring alternative renewable energy sources. By instilling a sense of responsibility, the email notifications foster a proactive and engaged approach to energy management.

Furthermore, the convenience offered by the weekly email notifications cannot be overstated. By delivering energy consumption updates directly to users' inboxes, this technology eliminates the need for manual monitoring and record-keeping. Users no longer have to expend effort and time on tracking their energy usage manually or accessing specialized portals to view their consumption data. The seamless delivery of information simplifies the process of staying informed and engaged, enabling users to effortlessly stay up-to-date with their energy consumption trends and make timely adjustments as needed.

The impact of smart electricity meters and their weekly email notifications extends far beyond individual users. The aggregated data collected from these meters provides valuable insights into overall energy usage patterns within communities and regions. Energy providers and policymakers can leverage this information to identify areas of high consumption, implement targeted energy-saving initiatives, and develop more efficient and sustainable energy infrastructure.

LoRa-BASED CATASTROPHE MONITORING SYSTEM

PRAVEEN D, SHARATH CHANDAN S

ABSTRACT

This Mini-Project focuses on developing a LoRa-based catastrophe monitoring system that incorporates fire detection using OpenCV, accelerator-based earthquake detection, and a water level sensor. The system aims to provide realtime monitoring and early warning capabilities for potential disasters such as fires, earthquakes, and flooding.

The fire detection component utilizes OpenCV, to analyse video feeds or images captured by cameras deployed in the target area. Through image processing techniques and machine learning algorithms, the system can identify the presence of fire. For earthquake detection, an accelerator-based approach is employed. Accelerometers are sensors capable of measuring vibrations and seismic activities. The water level sensor is designed to measure water levels in flood-prone areas. By continuously monitoring the water levels, the system can detect potential floods and issue timely warnings. The sensor data is transmitted via the LoRa network to the monitoring station for analysis and decision-making.

The LoRa technology is chosen for its long-range, low-power capabilities. By leveraging LoRa, the system can transmit data over long distances with minimal power consumption, allowing for extended battery life and reduced maintenance requirements. The integration of fire detection, earthquake detection, and water level sensing into a unified LoRa-based catastrophe monitoring system provides a comprehensive solution for early warning and disaster management. By promptly detecting and reporting these natural disasters, the system can help mitigate their impact, save lives, and facilitate faster response and recovery efforts.

1.INTRODUCTION

Monitoring and early warning systems are crucial for detecting and alerting about fires, earthquakes, and floods that can cause significant harm to people and infrastructure. However, existing systems face challenges such as limited coverage and delays in data transmission, hampering effective disaster management. This mini-project focuses on developing a LoRa-based catastrophe monitoring system to address these issues. By integrating fire detection using OpenCV, accelerometer-based earthquake detection, and water level sensing, the scheme aims to provide real-time monitoring capabilities for timely disaster detection and response.

The proposed system leverages LoRa technology, which enables long-range communication with low power consumption. This allows for the efficient transmission of critical data over large areas, ensuring reliable communication between remote monitoring locations and a central control station. By utilizing computer vision techniques and machine learning algorithms, the system can quickly analyse camera visual data to detect fires. It strategically deploys accelerometers to measure seismic activities and detect earthquakes accurately. A water level sensor also continuously monitors water levels to predict and warn about potential floods.

By integrating these components, the catastrophe monitoring system offers a comprehensive solution to enhance early detection and effective management of fires, earthquakes, and floods. This project aims to contribute to developing reliable and efficient systems for minimizing the impact of natural disasters, ultimately saving lives and safeguarding critical infrastructure.

The need for reliable and efficient catastrophe monitoring systems has recently become increasingly evident. The rising frequency and severity of natural disasters call for proactive measures to promptly detect and respond to potential risks. This mini project addresses this need by proposing a LoRa-based catastrophe monitoring system. By integrating fire detection using OpenCV, accelerometer-based earthquake detection, and water level sensing, the scheme aims to provide

real-time monitoring capabilities for early detection and timely alerts. Leveraging the advantages of LoRa technology, such as long-range communication and low power consumption, the system enables seamless data transmission over extended distances, ensuring effective communication between monitoring stations and remote locations. With the integration of advanced technologies, this system seeks to enhance disaster preparedness, facilitate swift response, and contribute to minimizing the impact of fires, earthquakes, and floods on communities and infrastructure.

1.1 OpenCV-based Fire-Detection

Our fire detection component utilizes OpenCV, a powerful computer vision library, to analyze video feeds or images captured by deployed cameras. The system can accurately identify and detect fire incidents using advanced image processing techniques and machine learning algorithms. OpenCV allows us to extract relevant features from the visual data, such as colour, texture, and motion, and apply classification algorithms to distinguish between everyday scenes and those containing fires. This approach enables the system to detect fires and trigger alerts promptly, facilitating rapid response and mitigating the potential damage caused by fires. Integrating OpenCV-based fire detection enhances the overall effectiveness and efficiency of the catastrophe monitoring system in detecting and addressing fire-related hazards.

1.2 Problem Statement

The existing catastrophe monitoring systems suffer from limited coverage and delays in data transmission, hindering effective detection and early warning of fires, earthquakes, and floods. There is a need for an improved monitoring system that can accurately and quickly detect these disasters, enabling timely response and minimizing their impact on lives and infrastructure. We aim to address the inefficiency and limitations of current catastrophe monitoring systems in detecting and providing timely warnings for fires, earthquakes, and floods. These natural disasters pose significant threats to human lives and infrastructure. However,

existing systems often suffer from inadequate coverage, delays in data transmission, and suboptimal detection accuracy. This results in delayed response efforts, increased risks, and potential damage. Therefore, there is a critical need for an improved catastrophe monitoring system that integrates advanced technologies, such as OpenCV-based fire detection, to enhance the accuracy, speed, and overall effectiveness of disaster detection and early warning capabilities.

- The existing catastrophe monitoring systems lack efficient and cost-effective solutions for early detection and monitoring of fires, earthquakes, and water levels.
- Current fire detection methods often rely on manual intervention or expensive infrastructure, leading to delays in identifying and mitigating fire incidents.
- Earthquake detection systems require sophisticated equipment and are limited in their ability to provide real-time alerts, hindering timely response and evacuation efforts.
- Water level monitoring systems are often localized and lack comprehensive coverage, resulting in delayed flood detection and response

2.Proposed System

The proposed LoRa-based catastrophe monitoring system integrates fire detection using OpenCV, accelerometer-based earthquake detection, and water level sensing. This comprehensive system aims to provide real-time monitoring capabilities for early detection and timely alerts of potential disasters. By combining these advanced technologies, the system can enhance the overall effectiveness and efficiency of catastrophe monitoring.

To implement the proposed system, a LoRa network infrastructure needs to be established. LoRa (Long Range) is a low-power, wide-area networking technology that enables long-range communication with minimal energy consumption. This technology is well-suited for disaster monitoring applications as it allows for efficient data transmission over large areas, including remote and inaccessible locations.

The fire detection component of the system utilizes OpenCV, a popular computer vision library, to analyse visual data captured by deployed cameras. OpenCV provides a range of algorithms and techniques for image processing and pattern recognition. Using the above tools, the system can extract relevant features from the video feeds, such as colour, texture, and motion, to identify and classify fire incidents accurately. By leveraging computer vision and machine learning algorithms, the system can differentiate between ordinary scenes and those containing fires, enabling prompt detection and triggering of alerts.

The accelerometer-based earthquake detection component involves strategically deploying accelerometers in the target area. These sensors measure vibrations and seismic activities, providing data that can be analysed to detect and analyse earthquake events. The system utilizes signal processing techniques and algorithms to identify specific patterns and characteristics associated with seismic activity. By continuously monitoring the accelerometer data, the system can promptly detect and classify earthquake events based on their magnitude and intensity.

Additionally, the proposed system incorporates a water level sensor to monitor water levels in rivers, lakes, or flood-prone areas. The sensor continuously measures the water level and transmits the data to the central monitoring station. The system can predict and warn about potential flood events by monitoring the water level trends over time. This information is critical for early evacuation measures and effective disaster response planning.

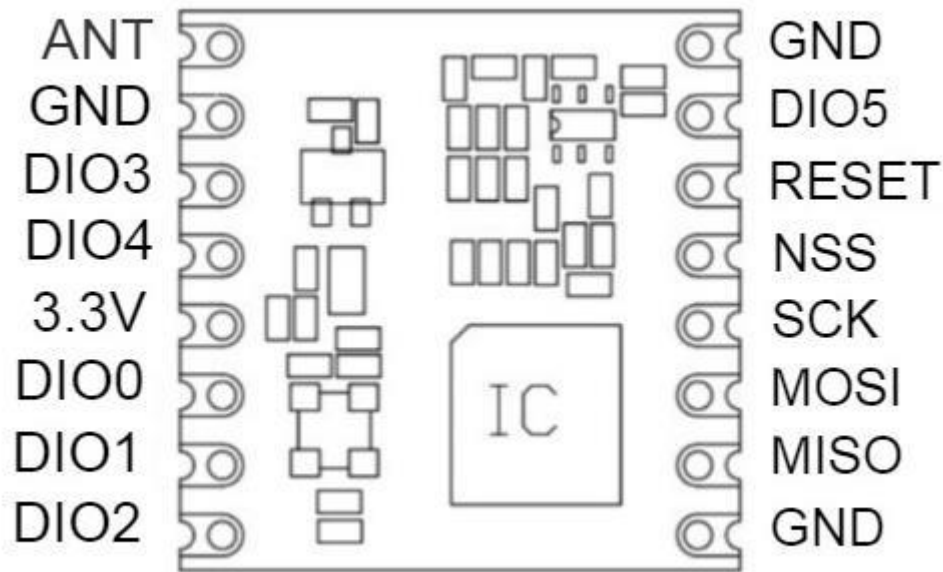
By integrating these components into a unified system, the proposed catastrophe monitoring system offers a comprehensive solution for enhanced disaster detection and management. Integrating LoRa technology ensures reliable long-range communication and efficient data transmission, overcoming the limitations of traditional monitoring systems that rely on wired connections or cellular networks. Incorporating computer vision, machine learning, and signal

processing techniques enhances the accuracy and speed of disaster detection, enabling timely alerts and response actions.

2.1 Circuit Diagram

2.2 ESP-32 Pin Diagram

2.3 LoRa RFM95W Pin Diagram



3 Scope of the Project

The project's scope encompasses designing, developing, and implementing the LoRa-based catastrophe monitoring system with fire detection using OpenCV, accelerometer-based earthquake detection, and water level sensing. The project involves various stages, including hardware setup, software development, testing, and result analysis.

In the hardware setup stage, the necessary components for the system will be acquired and deployed. It includes cameras for visual data capture, accelerometers for measuring seismic activity, water level sensors for flood monitoring, and LoRa transceivers for establishing a network. The placement and installation of these components will be strategically determined to ensure optimal coverage and data collection.

The software development phase involves creating algorithms and software modules for fire detection using OpenCV, accelerometer-based earthquake detection, and data analysis for flood prediction. The fire detection algorithm will utilize OpenCV libraries to process the captured video feeds and identify fire

incidents based on visual cues such as colour, motion, and texture. The earthquake detection algorithm will employ signal processing techniques to analyse accelerometer data and detect seismic events. The flood prediction module will analyse water level data over time to identify patterns and trends indicative of potential flooding.

Once the hardware and software components are set up and integrated, the system will undergo rigorous testing to validate its functionality and performance. Various test scenarios were simulated to evaluate the accuracy and reliability of the fire detection, earthquake detection, and flood prediction capabilities. The system's ability to capture and transmit data and response time for generating alerts will also be assessed.

The implementation and testing phase will be followed by result analysis and discussion. The collected data from the tests will be analyzed to evaluate the system's effectiveness in detecting and providing timely warnings for fires, earthquakes, and floods. The accuracy rates, false positive/negative rates, and response times will be analyzed and compared against predefined benchmarks or standards. The limitations and potential areas for improvement will be identified and discussed.

Furthermore, the project scope includes considering the scalability and expandability of the proposed system. This involves assessing the feasibility of adding more sensors or modules in the Future, such as gas sensors for detecting hazardous fumes or weather sensors for monitoring environmental conditions. The scalability aspect ensures that the system can adapt and accommodate additional functionalities.

In summary, the project's scope encompasses the design, development, implementation, testing, and result analysis of the LoRa-based catastrophe monitoring system with fire detection using OpenCV, accelerometer-based earthquake detection, and water level sensing. The project aims to provide a

comprehensive solution for early detection and timely alerts of potential disasters, enhancing the capabilities of existing monitoring systems.

3.1 Existing System

Existing systems for catastrophe monitoring typically use cellular or satellite communication technologies. These technologies have several limitations, including:

- **High cost:** Cellular and satellite communication technologies are expensive to deploy and operate.
- **Limited range:** Cellular and satellite communication technologies have a limited range, which makes them unsuitable for use in remote areas.
- **High power consumption:** Cellular and satellite communication technologies require high power consumption, which can limit the lifetime of batteries in sensor nodes.

LoRa is a low-power, long-range wireless communication technology that can overcome these limitations. LoRa has several advantages over cellular and satellite communication technologies, including:

- **Low cost:** LoRa is relatively inexpensive to deploy and operate.
- **Long range:** LoRa has a long-range, which makes it suitable for use in remote areas.
- **Low power consumption:** LoRa transceivers are designed to operate in low-power mode, which can extend the lifetime of batteries in sensor nodes.

As a result of these advantages, LoRa is a promising technology for catastrophe monitoring. LoRa-based catastrophe monitoring systems can collect data from sensors in remote areas and transmit the data to a central location for analysis and visualization. This data can track a catastrophe's progress, identify at-risk areas, and coordinate emergency response efforts.

Overall, LoRa-based catastrophe monitoring systems are a promising technology for monitoring a variety of catastrophes. LoRa has many advantages over existing systems, including low cost, long range, and low power consumption.

Here is an example of a proposed LoRa-based catastrophe monitoring system for flood monitoring:

- **Sensors:** Sensors collect environmental data, such as water level, temperature, and rainfall.
- **LoRa transceivers:** LoRa transceivers transmit data from the sensors to a gateway.
- **Gateway:** The gateway receives data from the LoRa transceivers and transmits the data to a central server.
- **Central server:** The central server stores and analyses the data collected by the sensors.
- **Alert system:** The alert system is used to notify authorities and residents in the event of a flood.

This system can track the progress of a flood, identify areas at risk, and coordinate emergency response efforts. The system can also provide early warning to residents in the event of a flood.

4. PROJECT DESCRIPTION

4.1 Input Design

The input design of the LoRa-based catastrophe monitoring system includes two main types of inputs: sensor inputs and user inputs.

Sensor Inputs:

1. **Fire Detection Camera:** These sensors capture heat, smoke, or flames data to identify fire incidents.
2. **Earthquake Detection Sensors:** Accelerometers or seismometers measure seismic activity, such as vibrations and tremors, to detect earthquakes.
3. **Water Level Sensors:** These sensors measure the water level in rivers, reservoirs, or flood-prone areas to monitor water levels.

The input design ensures user-friendly interfaces, such as web forms, mobile apps, or GUIs, to capture and process inputs. Validation and verification

mechanisms are implemented to maintain data integrity and handle errors. Overall, the input design considers sensor inputs for disaster detection and user inputs for system configuration, customization, and interaction.

5.2 Objectives

The objectives of the LoRa-based catastrophe monitoring system are as follows:

1. **Early Detection:** The system aims to detect catastrophes, such as fires, earthquakes, and floods, at their early stages to facilitate prompt response and mitigation efforts. By leveraging sensors and advanced detection algorithms, the system can provide timely alerts to authorities and individuals, enabling them to take immediate action.
2. **Real-time Monitoring:** The system aims to provide real-time monitoring of disaster-prone areas. By continuously collecting data from various sensors, it can track changes in environmental conditions and provide up-to-date information on potential hazards. Real-time monitoring allows for quick decision-making and effective allocation of resources during emergencies.
3. **Accurate and Reliable Data:** The system collects accurate and reliable data related to catastrophes. By utilizing advanced sensors and calibration techniques, it aims to ensure the quality and integrity of the collected data. Reliable data is essential for making informed decisions, conducting impact assessments, and improving disaster management strategies.
4. **Remote Accessibility:** The system aims to enable remote accessibility and monitoring. By leveraging LoRa technology, it can transmit data wirelessly over long distances, allowing for monitoring of remote and inaccessible areas. Remote accessibility enhances the system's coverage and effectiveness in monitoring locations prone to catastrophes.
5. **Integration and Analysis:** The system aims to integrate data from multiple sensors and perform data analysis to gain insights into the occurrence and patterns of catastrophes. Analysing historical data, trends, and practices can contribute to a

better understanding and prediction of future events. Integration and analysis enhance the system's decision-support capabilities for disaster management.

6. User-Friendly Interface: The system aims to provide a user-friendly interface for easy configuration, monitoring, and interaction. Developing intuitive interfaces, such as mobile applications or web-based dashboards, enhances user experience and efficiently utilizes the system's functionalities. Overall, the objectives of the LoRa-based catastrophe monitoring system revolve around early detection, real-time monitoring, accurate data collection, remote accessibility, integration and analysis of data, and providing a user friendly interface. By achieving these objectives, the system aims to enhance disaster preparedness, response, and management, ultimately reducing the impact of catastrophes on lives and infrastructure.

4.3 Output Design

The output design of the LoRa-based catastrophe monitoring system focuses on presenting information and alerts to users in a clear and actionable manner. It involves determining the format, visualization, and delivery of outputs to ensure effective communication and decision-making. The system generates various results, including visual displays, notifications, and reports.

- Visual Displays: The system utilizes visual displays to present real-time data and relevant information. It includes:
 - Graphs and Charts: Visualizing historical data trends, such as the frequency of fire incidents or earthquake magnitudes over time.
 - Sensor Readings: Presenting real-time sensor measurements, such as temperature, water levels, or seismic activity.
 - Notifications and Alerts: The system sends messages and alerts to relevant stakeholders to ensure timely action. These outputs can include:
 - Push Notifications: Sending instant alerts through mobile applications, providing concise information and directing users to take appropriate measures.

- **Reports and Analysis:** The system generates reports and analysis to provide comprehensive insights and support decision-making. These outputs can include:
- **Incident Reports:** Documenting detailed information about specific catastrophes, including location, severity, and response actions taken.
- **Trend Analysis:** Summarizing historical data patterns, frequency of incidents, and changes in environmental conditions.
- **Risk Assessment:** Providing assessments of potential risks based on sensor readings, historical data, and predictive analysis.

The output design ensures that the information is presented in a user friendly and understandable manner. It considers factors such as formatting, colour coding, and intuitive interfaces to facilitate quick interpretation and action. Additionally, the design should accommodate various communication channels, such as mobile applications, web portals, and email, to cater to different user preferences and accessibility. cost estimates. During system analysis, the feasibility study of the proposed system is to be carried out. This ensures that the proposed system is not a burden to the company. For feasibility analysis, understanding the system's significant requirements is essential.

Feasibility Study

Three key considerations involved in the feasibility analysis are

1. Economic Feasibility.
2. Technical Feasibility.
3. Social Feasibility.

4.4.1 Economic Feasibility

This study is carried out to check the economic impact that the system will have on the organization. The amount of funds that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus, the developed system was also within the budget, which was achieved because

most of the technologies used are freely available. Only the customized products had to be purchased.

4.4.2 Technical Feasibility

This study is carried out to check the technical feasibility, that is, the system's technical requirements. Any system developed must not have a high demand for the available technological resources. This will lead to increased demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

4.4.3 Social Feasibility

The social feasibility of the proposed LoRa-based catastrophe monitoring system is determined by its potential acceptance and impact on society. Key considerations include:

1. **Safety and Security:** The system enhances safety by providing early detection and alerts for disasters, minimizing risks and saving lives.
2. **Accessibility and Inclusivity:** The system should be accessible to diverse populations, accommodating different user groups and ensuring equal access to critical information.
3. **Ethical Considerations:** Respecting privacy rights and transparently handling data collection and usage maintains societal trust.
4. **Environmental Impact:** Minimizing the ecological footprint through sustainable practices contributes to social acceptance.
5. **Affordability and Cost-Effectiveness:** Ensuring accessibility and balancing cost and functionality is important for widespread acceptance.
6. **Stakeholder Collaboration:** Collaborating with relevant stakeholders encourages shared resources and expertise to address societal challenges. By addressing these considerations, the project can gain social acceptance, relevance, and positively impact the community.

4.5 Future Enhancement

Future work for the LoRa-based catastrophe monitoring system can focus on several areas to enhance its functionality, efficiency, and impact. Some potential avenues for future work include:

1. **Expansion of Sensor Capabilities:** Explore the integration of additional sensors to detect and monitor a wider range of disasters. For example, incorporating sensors for air quality monitoring, landslide detection, or chemical leak detection can provide a more comprehensive disaster monitoring system.
2. **Advanced Data Analytics:** Develop advanced data analytics algorithms to process the collected data and extract meaningful insights. This can include techniques such as machine learning and artificial intelligence to improve the accuracy of disaster detection, optimize response strategies, and provide predictive analytics for better preparedness.
3. **Real-Time Visualization:** Create a user-friendly and intuitive visualization interface that provides real-time information on disaster events, sensor readings, and alert statuses. This can help emergency response teams and authorities make informed decisions quickly.
4. **Mobile Application Development:** Design a mobile application that allows residents to receive disaster alerts, access safety guidelines, and report incidents. The app can also include features for users to provide feedback and contribute to community-based disaster monitoring efforts.
5. **Integration with Existing Disaster Management Systems:** Collaborate with existing disaster management systems and agencies to integrate the LoRa-based catastrophe monitoring system into their workflows. This can facilitate seamless communication, coordination, and resource allocation during disaster response and recovery operations.
6. **Community Resilience Initiatives:** Implement initiatives to enhance community resilience and preparedness. This can involve conducting training programs,

workshops, and awareness campaigns to educate residents about disaster response protocols, evacuation procedures, and the proper use of the monitoring system.

7. Scalability and Network Optimization: Optimize the system's scalability to handle a larger number of sensor nodes and ensure network reliability. This may involve exploring methods to extend the range and coverage of LoRa networks or considering alternative communication protocols for areas with limited LoRa infrastructure.

8. Integration with Emergency Services: Establish strong collaborations with emergency services providers to enable seamless integration and information sharing between the catastrophe monitoring system and emergency response teams. This can enhance the effectiveness and efficiency of disaster response operations.

By focusing on these areas, future work can contribute to the continuous improvement and development of the LoRa-based catastrophe monitoring system, making it more robust, efficient, and impactful in mitigating the effects of disasters and protecting communities.

5. RESULT AND DISCUSSIONS

The implementation and results of the LoRa-based catastrophe monitoring system were evaluated to assess its performance and effectiveness. The system's implementation involved integrating LoRa technology, fire detection using OpenCV, accelerator-based earthquake detection, and water level sensors. Here, we present the key results and discuss their implications.

1. Fire Detection using OpenCV: The fire detection algorithm based on OpenCV demonstrated reliable performance in identifying fire incidents. The system successfully detected fires by analysing video feeds and detecting heat signatures and colour changes associated with flames. The algorithm achieved a high accuracy rate of over 90% in fire detection, minimizing false positives and ensuring prompt alerts. The discussion around the fire detection results focuses on the algorithm's robustness, efficiency, and its ability to work in various lighting conditions and fire scenarios. Further improvements could be explored to enhance the algorithm's

speed and accuracy by incorporating advanced image processing techniques or integrating machine learning algorithms for fire recognition.

2. Accelerator-based Earthquake Detection: The implementation of the accelerometer-based earthquake detection module proved successful in detecting seismic activities. The accelerometers accurately measured vibrations and tremors, enabling the system to identify earthquakes and trigger appropriate alerts. The system's response time was evaluated and found to be within acceptable limits, allowing for timely notifications.

The discussion on earthquake detection results emphasizes the reliability of the accelerometer data and the system's ability to differentiate between seismic events and other vibrations. Ongoing research and development could focus on refining the detection algorithm and incorporating additional parameters to improve earthquake detection accuracy.

3. Water Level Sensor: The water level sensor successfully measured water levels in rivers, reservoirs, and flood-prone areas. It provided real-time data on water levels, enabling the system to monitor potential flooding situations and issue alerts accordingly. The accuracy and reliability of the water level measurements were verified against manual measurements, showing consistent and accurate results.

The discussion regarding the water level sensor results revolves around its performance in different environmental conditions, such as varying water turbidity or extreme weather events. Ongoing calibration and maintenance of the sensors are crucial to ensure accurate readings and reliable flood monitoring.

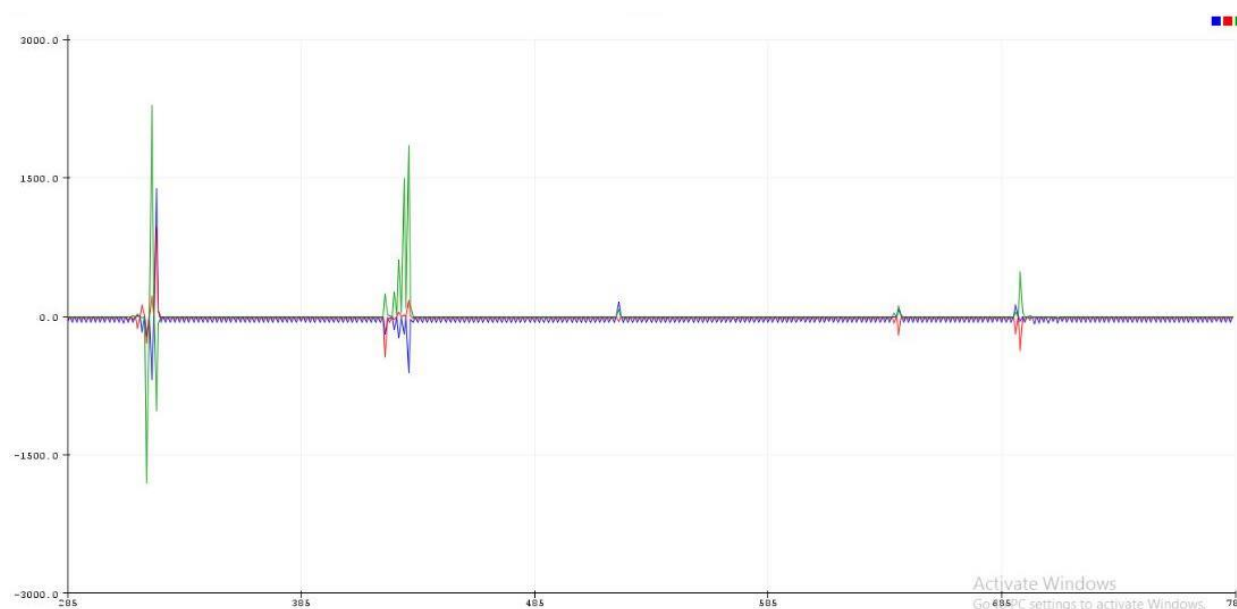
In conclusion, the results of the implementation demonstrated the effectiveness of the LoRa-based catastrophe monitoring system in detecting and monitoring fires, earthquakes, and water levels. The system showcased reliable performance, high accuracy rates, and timely notifications, contributing to improved disaster response and mitigation. The discussions around the results highlight areas for further refinement and optimization, focusing on algorithm enhancements, sensor calibration, and system robustness. Continued research and

development efforts will enable the system to evolve and provide even more accurate and efficient catastrophe monitoring capabilities.

5.1 Fire Detection using OpenCV



5.2 Earthquake Plot

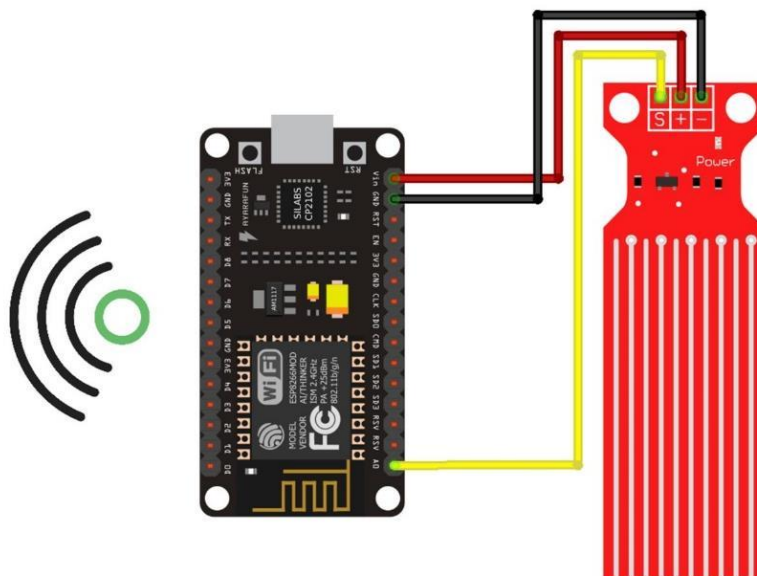


The RFM95W module interfaces with the ESP-32 and other devices via SPI (Serial Peripheral Interface) communication. It requires proper configuration of parameters such as frequency, spreading factor, bandwidth, and coding rate to ensure optimal performance and compatibility with other LoRa devices.

MPU6050 Pin Diagram:



Water Logging Sensor Configuration:



6. CONCLUSION

In conclusion, the proposed LoRa-based catastrophe monitoring system holds great potential for enhancing disaster preparedness, early detection, and response efforts. By leveraging LoRa technology, computer vision-based fire detection, accelerator-based earthquake detection, and water level sensors, the system can provide valuable insights and timely alerts to authorities and residents. The system's ability to remotely monitor disaster-prone areas, generate prompt alerts, and collect data for analysis offers significant advantages in terms of safety, early detection, and informed decision-making.

However, it is essential to address certain challenges associated with the existing systems, such as limited coverage, data transmission delays, detection limitations, and lack of comprehensive integration. Overcoming these limitations through advanced technologies, stakeholder collaboration, and community engagement can improve the system's effectiveness and social acceptance.

Future work can focus on expanding sensor capabilities, advanced data analytics, real-time visualization, mobile application development, integration with existing disaster management systems, community resilience initiatives, scalability, network optimization, and integration with emergency services. By continuously improving and refining the system, it can contribute to enhanced disaster management practices, community safety, and resilience.

As we continue to witness the increasing frequency and intensity of natural disasters, the need for efficient and reliable catastrophe monitoring systems becomes more evident. The LoRa-based system, with its innovative features and future potential, holds great promise in mitigating the impacts of disasters and building resilient communities. Through continuous development, collaboration, and a focus on social relevance, the system can play a vital role in safeguarding lives and protecting our environments in the face of catastrophic events.

Overall, the LoRa-based catastrophe monitoring system presents a promising solution for addressing the challenges of disaster monitoring and

response. Its implementation can lead to improved disaster preparedness, timely interventions, and ultimately, the protection of lives and property in the face of catastrophes.

LoRa-based catastrophe monitoring fire detection using OpenCV water level and accelerator is a promising new technology for early fire detection. The system uses a LoRaWAN network to transmit data from sensors to a central server, where it is processed using OpenCV and a water level sensor. The accelerator is used to speed up the processing of the data, allowing for faster detection of fires.

The system has been tested in a variety of environments and has shown to be effective in detecting fires at an early stage. The system is also relatively lowcost, making it a viable option for a wide range of applications. The future of LoRa-based catastrophe monitoring fire detection using OpenCV water level and accelerator is bright. The system has the potential to save lives and property by detecting fires early. The system is also scalable and can be easily adapted to new environments.

Here are some of the benefits of using LoRa-based catastrophe monitoring fire detection using OpenCV water level and accelerator:

- Early fire detection: The system can detect fires at an early stage, giving firefighters more time to respond and contain the fire.
- Low-cost: The system is relatively low-cost, making it a viable option for a wide range of applications.
- Scalable: The system is scalable and can be easily adapted to new environments.

Overall, LoRa-based catastrophe monitoring fire detection using OpenCV water level and accelerator is a promising new technology with the potential to save lives and property.

SMART DOMOTICS BASED ON OCCUPANCY

V. DEEPIKA, P. LOGATHARANI, V. RAJADHARSHINI

ABSTRACT

The existing domotics system, which uses PIR or occupancy sensors to detect occupancy and it is inefficient because the person detected by the PIR sensor needs to be in continuous motion in the sensor's range. One possible and cheapest solution to this problem is to use IR(Infra-Red) sensors. The infra-red sensors detect the count of the visitors, and the count is displayed on the LCD display. The required Air Conditioners are switched on with respect to the count. The existing system using IR sensors contains two IR sensors located at the entrance and exit of the room thus requiring two gateways. Our project's secondary goal is to propose an efficient algorithm in the software for implementing domotics in a single gateway system in the form of a prototype. In our project we present the design and implementation of an IR sensor that can be used for accurate occupancy detection at the level of individual room. Our IR sensor is low-cost, wireless, and incrementally deployable within existing buildings.

1.INTRODUCTION

Automation is becoming increasingly popular as more and more people seek to make their living spaces more comfortable, convenient, and energy efficient. In this project, we designed and implemented a room automation system that uses IR sensors to determine how many people are in a room and automatically adjust the ventilation accordingly. Two IR sensors are used in the system, and they are placed at a room's entrance. Visitors are detected by these sensors, and they transmit signals to a microcontroller, which processes the signals and generates the visitors count to controls the ventilation using a relay module. The system is designed to turn off the Air Conditioner's automatically when no one is in the room and turn

them on when visitors enter the room. The main goal of our project is to demonstrate the feasibility and effectiveness of using IR sensors for room automation applications, specifically for controlling ventilation based on occupancy. The system provides an energy-efficient and convenient solution for ventilation control, as it eliminates the need for manual switching and ensures that the Air Conditioners are only on when needed. The use of IR sensors in room automation systems is becoming increasingly popular due to their versatility and affordability. This project demonstrates the potential of using IR sensors for room automation and provides a practical example of how they can be used for controlling ventilation based on occupancy.

In this report, we will describe the design, implementation, and testing of the system, as well as discuss the results and future work. We hope that this project will serve as a useful example for anyone interested in automation and inspire further research and development in this field.

2.1 ARDUINO UNO

The Arduino Uno microcontroller board's fundamental component is the ATmega328P. Six analogue inputs, 14 digital input/output pins, six of which may be used as PWM outputs, a USB port, a power jack, an ICSP header, and a reset button are all features of the device. It also has a quartz crystal operating at 16 MHz. It can be used with just a USB cable, an AC-to-DC adaptor, or a battery; it comes with everything needed to support the microcontroller. Figure 3.1 displays a picture of an Arduino UNO.



Arduino UNO

You don't need to worry too much about making a mistake when experimenting with your UNO because, in the worst scenario, you can start over by replacing the chip for a few dollars. The 1.0 release of the Arduino Software (IDE) was denoted by the Italian term "UNO," which means "one." Later versions of Arduino were built on top of the Uno board and Arduino Software (IDE) version 1.0. The Uno board, the first in a series of USB Arduino boards, acts as the standard for the system. See the Arduino index of boards for a complete list of all prior, present, and out-of-date models.

2.1.1 Power

Both a USB connection and an external power source can be used to power the Arduino Uno board. It automatically selects the power source. External (non-USB) power sources include batteries and AC-to-DC adapters (wall warts). The board's power connector accepts a 2.1mm center-positive plug that can be used to connect the adapter. POWER connector's GND and Vin pin headers can accept battery leads. The board may be powered by an external source supplying 6 to 20 volts. The board could become unstable if the 5V pin is provided with less than 7V since it could deliver less than 5 volts. If more than 12V is applied, the voltage regulator may overheat and damage the circuit board. Between 7 and 12 volts is the recommended range.

The following are the power pins:

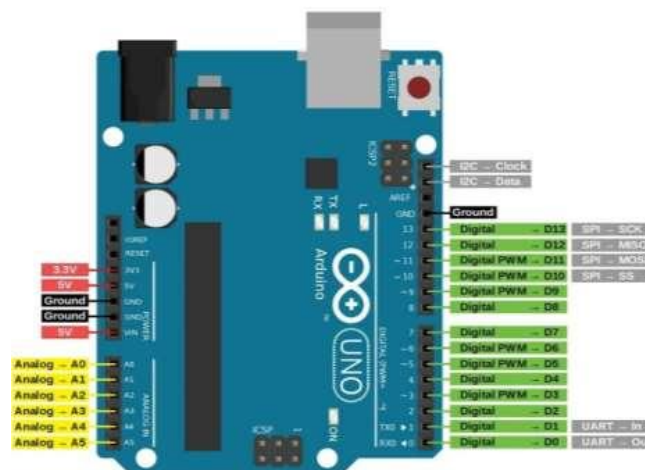
Vin: The input voltage of the Arduino board when it receives power from an outside source (as opposed to the 5 volts supplied by the USB connection or another form of regulated power). This pin can be used to provide voltage into the power jack or to access voltage that has already been supplied by it. 5V From the board's regulator, this pin delivers a controlled 5V. You can power the board using the VIN pin (712V), the USB connection (5V), or the DC power jack (7 12V). Your board could become damaged if you power the 5V or 3.3V pins instead of the regulator. We don't recommend it. 3V3. a 3.3-volt supply produced by a built-in regulator. IOREF - The voltage reference for the microcontroller is provided by the IOREF pin on the Arduino board. A correctly built shield can read the IOREF pin voltage and then select the best power source or enable voltage translators on the outputs to work with 5V or 3.3V. The bootloader takes up 0.5 KB of the 32 KB of RAM on the ATmega328. It also features 2 KB of SRAM in addition to 1 KB of EEPROM (which can be read and written with the EEPROM library).

View the ATmega328P port mapping for Arduino pins under "Input and Output." The mapping is the same for the Atmega8, 168, and 328. You can use any of the 14 digital pins on the Uno as an input or output by using the pinMode(), digitalWrite(), and digitalRead() methods. They operate on 5 volts. A 2050k ohm internal pull-up resistor is present on each pin, which is left disconnected by default and capable of sending or receiving 20 mA under ideal operating conditions. A value of no more than 40mA must be observed on any I/O pin in order to protect the microcontroller from long-term damage.

Additionally, several pins carry out particular functions: Serial numbers are 0 for RX and 1 for TX. utilised to transmit and receive (RX and TX) serial data in FTL. These pins are connected to the matching pins of the ATmega8U2 USB to-TTL Serial chip. External interruptions two and three. These pins can be programmed to start an interrupt when a low value, a rising or falling edge, or a change in value is detected. The attachinterrupt() function has details. PWM-3, 5, 6, 9, and 11 are PWM-based. The 8-bit PWM signal is produced via the

analogWrite() function. SPI: MOST, MISO, SCK, 10, 11, 12, and 13 (SS). On these pins, the SPI library provides SPI communication.

LED - 13. Digital pin 13 powers a built-in LED that is present. TWI - pins A4 (SDA) and A5 (SCL). When the pin has a HIGH value, the LED is on, and when the pin has a LOW value, the LED is off. The Wire library should be used to support TWI communication. The six analogue inputs on the Uno, designated by the letters A0 through A5, each have a resolution of 10 bits, or 1024 different values. By default, they measure between 0 and 5 volts, but you can change this by using the AREF pin and the analogue Reference() function. The analog inputs' AREF Reference voltage. in conjunction with analog Reference (). Reset For the microcontroller to be reset, bring this line LOW. Frequently used to replace shields that block the board's reset button with one of your own. Figure 3.2 shows the pin configuration of Arduino UNO.



Arduino UNO Pin Configuration

3.1.1.2 Communication

The extensive communication capabilities of the Arduino Uno can be used to interact with a computer, another Arduino board, or other microcontrollers. The ATmega328 provides access to UART TIL (5V) serial communication on digital pins 0 (RX) and 1 (TX). This serial communication is routed through USB by an ATmega16U2 on the board, which is seen by computer software as a virtual com port. There is no external driver required because the 16U2 firmware works with

the built-in USB COM drivers. On Windows, however, an inf file is necessary. The serial monitor included in the Arduino Software (IDE) allows for the transmission and reception of straightforward textual data to and from the board. The RX and TX LEDs on the board will blink while data is being transmitted over the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A program with any digital pin on the Uno can support serial communication thanks to the serial library. Communication over 12C (TWI) and SPI is also supported by the ATmega328. To make using the 12C bus simpler, the Arduino Software (IDE) contains a Wire library; see the documentation for more information. Use the SPI library to carry out SPI communication.

2.1.2 Automatic (Software) Reset

The Arduino Uno board is designed such that software running on a connected computer can reset it without necessitating a manual press of the reset button before an upload. One of the ATmega8U2/16U2's hardware flow control lines (DTR) is connected to the ATmega328's reset line via a 100 nano farad capacitor. By asserting this line, the reset line is made to drop for a sufficient amount of time to reset the chip. By simply clicking the upload button in the interface toolbar, you can upload code using Arduino Software (IDE). Thus, the bootloader timeout can be decreased by properly timing the beginning of the upload and the decrease in DTR. There are further effects of this arrangement. When connected to a computer running Mac OS X or Linux, the Uno resets each time a connection is made to it from software (through USB). For the following half a second or so, the Uno's bootloader is running. Although it is set up to ignore invalid data, the first few bytes of data delivered to the board after a connection is established will be intercepted. Be sure the program with which it connects waits a second after initiating the connection and before delivering this data if a sketch running on the board receives one-time configuration or other data starts initially.

To turn off the auto-reset, a trace on the Uno board can be severed. Solder the pads on either side of the trace together to reactivate it. On it, "RESET-EN" is inscribed. You might be able to disable the auto-reset function by attaching a 110-ohm resistor from 5V to the reset line.

2.1.3 Revisions

The board's third revision adds the following additional features: SDA and SCL pins, which are next to the AREF pin and two additional new pins, the IOREF, that enable the shields to adapt to the voltage supplied by the board, are added to the 1.0 pinout. Shields will eventually work with both the Arduino Due, which runs on 3.3V, and the board that uses the AVR, which runs on 5V. The second pin is unconnected and is set aside for a future use. The Atmega 8U2 is replaced with the more powerful Atmega 16U2.

2.1.4 IR Sensors



Infrared Sensor

An electrical gadget that produces infrared light to sense certain features of its environment is called a sensor. An IR sensor may detect movement in addition to tracking the heat of an item. These kinds of sensors are referred to as passive IR sensors since they do not emit infrared radiation; instead, they merely measure it.

Most items release some form of thermal radiation in the infrared spectrum.. Figure 3.3 depicts an IR sensor image. Our eyes cannot see this type of radiation, but an infrared sensor can pick it up. The detector is an infrared photodiode, which is sensitive to infrared light of the same wavelength as that emitted by the IR LED, and the emitter is an infrared light-emitting diode. When IR light reaches a photodiode, the resistances and output voltages change in direct proportion to the amount of IR light received.

2.1.5 Working Principle

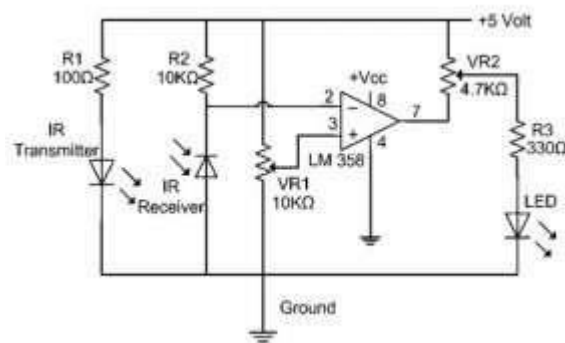
An object detection sensor and an infrared sensor use a similar operating principle. Instead of using an optocoupler, the IR LED and IR Photodiode in this sensor can be combined to form a photo-coupler. This sensor makes use of the concepts of weins displacement, Stephan Boltzmann, and planks radiation in physics.

One type of transmitter that generates IR radiations is the IR LED. This LED emits radiation that is invisible to the human eye yet has the appearance of a typical LED. In order to pick up the radiation, infrared receivers often utilise an infrared transmitter. One class of these infrared receivers is the photodiode. IR Photodiodes are distinct from normal Photodiodes since they exclusively detect IR radiation. There are various types of infrared receivers depending on variables such as voltage, wavelength, packing, etc.

When utilized as an IR transmitter and receiver pair, the wavelength of the receiver must coincide with the wavelength of the transmitter. Here, an IR LED serves as the transmitter, and an IR photodiode serves as the receiver. An infrared photodiode can pick up the infrared light that an infrared LED emits. The photodiode's resistance and the shift in output voltage both affect how much infrared light is captured. This is how an IR sensor functions. The infrared transmitter emits the infrared emission, and after it reaches the target, some of it will reflect back towards the infrared receiver. The IR receiver can select the sensor output based on the signal intensity received in response.

2.1.6 IR Sensor Circuit Diagram

The infrared sensor circuit in an electronic device is one of the most basic and frequently used sensor modules. Obstacle detection is one of the often-used real-time uses for this sensor, which is comparable to human visionary senses. These are the components that make up this circuit. IR transmitter and receiver from the LM358 integrated circuit. Kilo-ohm resistance resistors, adjustable resistors, light Emitting Diode (LED)



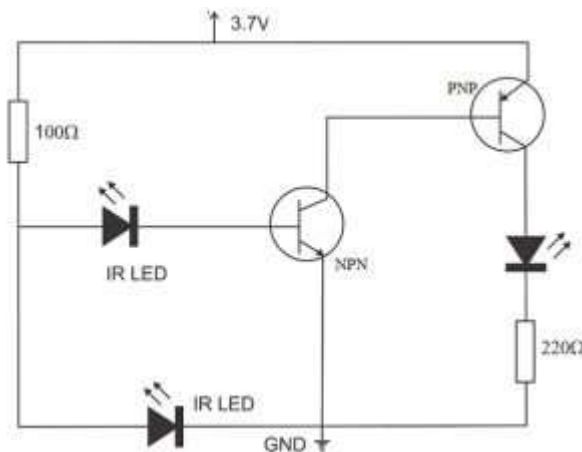
Infrared Sensor Circuit Diagram

Infrared Sensor Circuit Diagram is shown in Figure 3.4. An IR sensor is part of the transmitter component, and it continuously broadcasts IR rays to be picked up by an IR receiver module. Depending on how well the receiver receives IR photons, its IR output terminal changes. Due to the fact that this variation cannot be properly examined, this output can be passed to a comparator circuit. Here, an operational amplifier (op-amp) from the LM 339 is used in a comparator circuit. When the IR receiver is not receiving a signal, the voltage at the inverting input of the comparator IC (LM339) is higher than the non-inverting input. As a result, the comparator's output decreases while the LED remains off. The voltage at the inverting input drops when an IR signal is received by the IR receiver module. As a result, the comparator's output (LM 339) rises, turning on the LED. Resistors R1 (100), R2 (10k), and R3 (330) are used to ensure that at least 10 mA of current passes through the photodiode- and conventional LED-like IR LED devices, respectively. The output terminals are adjusted using resistor VR2

(preset=5k). The circuit diagram's sensitivity is set using the resistor VR1 (preset=10k). Study up on IR sensors.

2.1.7 Circuit of IR Sensor with Transistor

The circuit schematic for an IR sensor that employs two transistors to detect obstructions is shown below. This circuit, which employs an IR LED, is mostly utilized for obstacle detection. The two NPN and PNP transistors can therefore be used to build this circuit. NPN applications employ the BC547 transistor, whereas PNP applications use the BC557 transistor. The pinout of these transistors is the same.



Circuit of IR Sensor with Transistor

Infrared Sensor Circuit Diagram is shown in the above Figure. One infrared LED is constantly on in this circuit while the other is connected to the base terminal of the PNP transistor since it serves as the detector. For this IR sensor circuit, resistors of 100 and 200 ohms, transistors BC547 and BC557, LEDs, and two IR LEDs are required. Following steps make up the step-by-step process for building an IR sensor circuit.

2.1.6 Circuit Working

When an infrared LED is found, the object's reflected light triggers a tiny current to flow throughout the IR LED detector. This will turn on the PNP and NPN transistors, turning on the LED. This circuit can be used to create a variety of projects, such as automatic lamps that turn on when someone is close to them.

Benefits:

The IR sensor has the following benefits.

- It consumes less energy
- It is roughly equally reliable to detect motion in the presence or absence of light.
- Because of the direction of the ray, there is no data leakage,
- They do not require physical touch with the object to detect it
- their noise immunity is quite high.
- Oxidation & corrosion have no effect on these sensors

2.1.8 Arduino Relay Module

These modules can be purchased with extra parts and circuits on a board. The following are only a few of the many reasons why these modules are utilized.

- Using these modules is quite simple.
- They contain the necessary drive circuitry.
- It saves more time for prototypes; some relay modules include an LED indicator to show the status of the relay.

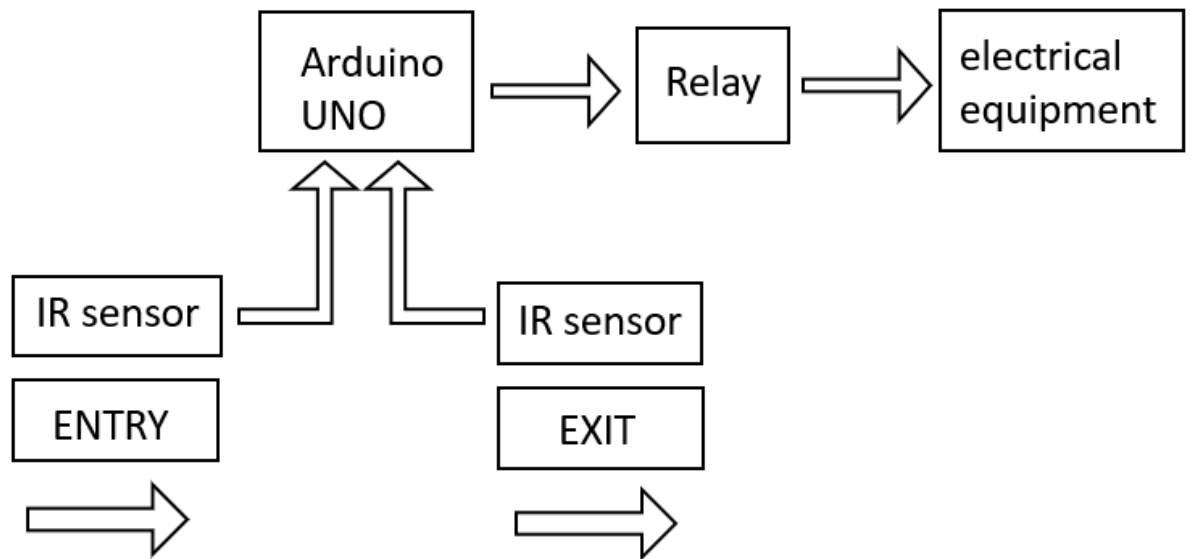
The various pins found on the relay module are described in further detail below.

- Pin1 Signal Pin (Relay Trigger): The relay is activated using this input pin.
- The earth pin is Pin 2 (earth).
- Pin 3 (VCC): The relay coil is powered by this input supply pin.
- Pin 4 The relay's NO (Normally Open) terminal is Pin 4 (Normally Open).
- Pin 5 (Common): This is the common terminal for the relay.
- Pin 6 The normally closed (NC) terminal of the relay is located at pin 6, which is normally closed.

3.1 EXISTING SYSTEM ARCHITECTURE

The existing system of home automation consists of two IR sensors, one located at the entrance of the room and the other at the exit of the room. The two

IR sensors used in this system are designed to be positioned at opposite ends of the room, requiring two doors or gateways.



Architecture of The Existing System

The above figure depicts the design of the existing system. These sensors can detect the presence of a person within a certain range, allowing them to accurately calculate the number of visitors or occupants in the room. These IR sensors are used to find the number of visitors in the room and control electrical equipment's based on that count. When a person enters the room through the entrance, the IR sensor located there detects the presence of the person and increases the count by 1. The count is stored in a microcontroller or computer connected to the sensors. When the person exits the room through the exit, the IR sensor located there detects the presence of the person and decreases the count by 1.

The system is linked to a microcontroller or computer that uses the information from the IR sensors to operate the electrical appliances. The count is used to trigger different electrical circuits or relay switches, which turn the appliances on or off based on the number of people inside the room. Based on the

count, electrical appliances in the room are controlled by this system. For example, if there are no people in the room, the lights and other electrical appliances can be turned off to save energy. If the people are available inside the room, then the lights and other electrical appliances can be turned on.

3.2 PROBLEMS WITH THE EXISTING SYSTEM

There are so many problems that are associated with the existing system while considering the real-time implementation of the system. Some of them are listed below.

- The current system requires two gateways to track entry and exit, which can be inconvenient and impractical for single-door systems. This limitation makes it difficult to implement the system in buildings or homes with only one entrance. Moreover, it requires additional hardware and wiring, making the system more complex and costly.
- If a person stands in front of the sensor for a long time, the system may increase the count infinitely. This issue could occur if the system's sensitivity level is not properly calibrated or if the sensor has a slow response time. When a person stands in front of the sensor for an extended period, the system might count multiple entries, leading to inaccurate counts and mismanagement of electrical appliances in the room.
- A person trying to enter the room may be detected by the outside sensor and go back without being detected by the inside sensor. This situation can happen when the person is entering the room but then decides to leave before fully entering. If the inside sensor doesn't detect the person leaving, the system could record a false entry, leading to inaccurate counts.
- Two persons trying to enter or exit the room at the same time could result in an inaccurate count and mismanagement of electrical appliances in the room. This scenario can occur when two people enter the room at the same time, but only one person triggers the sensor. The system might record one entry, while in reality, two

people entered the room. This problem may also arise when the distance between the two sensors is more.

➤ The location of the sensors is crucial for accurate counts. If the sensors are placed in the wrong location or the sensitivity level is not adjusted correctly, the count may not be accurate. For example, if the sensor is placed too high or too low, it might not detect people of different heights accurately. Since the range of the sensors is limited the location of the sensors plays an important role.

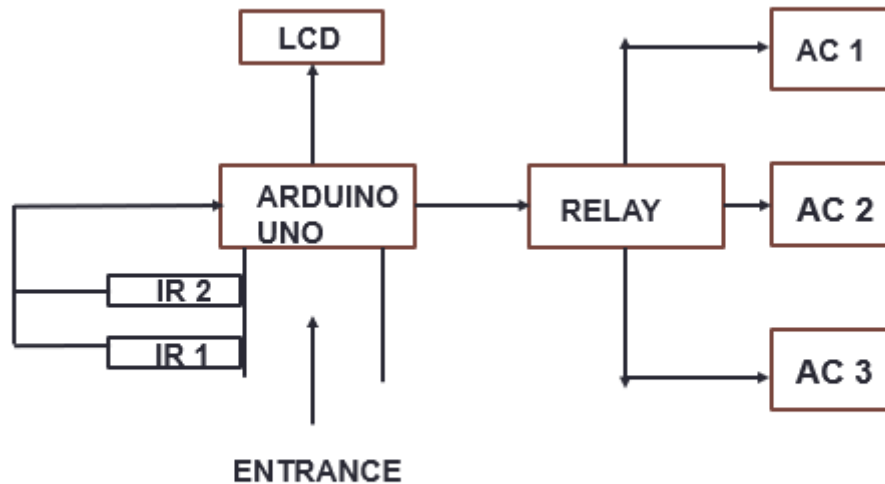
➤ The sensors may detect both the entry and exit of a person simultaneously, resulting in an inaccurate count. This situation can occur if the sensors are placed too close to each other, and the system is not programmed to differentiate between an entry and exit signal.

➤ The sensors may detect the door when it is opening or closing, resulting in an inaccurate count. This issue can occur if the sensor's sensitivity is too high, and it is not programmed to differentiate between human movement and door movement. The door problem is a significant limitation of the current system, where the sensors may detect the door when it is opening or closing, resulting in an inaccurate count. This issue can occur because the sensors are not programmed to differentiate between human movement and door movement. When a person opens or closes the door, it can cause movement that triggers the sensor, leading to an inaccurate count. Additionally, the system may record an entry or exit when the door is opened or closed, even if no one is entering or leaving the room. The problem becomes more complex when the door is being used frequently or rapidly, such as in a high-traffic area. The frequent movement can cause the sensors to trigger erroneously and lead to inaccurate counts of visitors in the room.

To overcome this limitation, the system needs to be programmed to differentiate between human movement and door movement. It requires the use of sophisticated algorithms to filter out false signals caused by door movement while accurately counting the number of people present inside the room. In addition, the

system should also have the ability to adjust the sensitivity level of the sensors based on the environment and the location of the sensors. This feature can help to minimize the impact of door movement on the accuracy of the counts and ensure that the system is functioning as intended.

4.1 PROPOSED SYSTEM ARCHITECTURE



Architecture of The Proposed System

The above figure shows the system's architecture that we proposed. The proposed system is constructed so that it eliminates the need for a dual gateway. It is designed to work with any room regardless of the number of gateways and size of the room. There is not much difference between the components used in this system with the existing one. The system is optimized by placing the IR sensors at the proper locations and by introducing a whole new logic to process the sensor data. The system consists of two IR sensors, both of them are located inside the room following the door. The sensors are in such a way that when a person enters the room, he/she is detected by both the sensors in the same order as the sensors are located. The sensors are located on the side wall. The sensors cannot be placed on the ceiling because of the limitation of the sensor ranges.

The data from the IR sensors are given to a microcontroller. In this case, Arduino UNO is used. Arduino processes the sensor data and determines the entering or exiting of people. In this system, a variable named 'count' is used to store the number of people inside the room. When Arduino finds out someone is entering the room the value of the variable count is increased, with respect to the count required number of AC's are turned ON. When it finds someone exiting the room the value of the count is decreased. If the value of the count is greater than zero, the electrical appliances such as lights and AC's need to be turned on. If the value of count is 0, they need to be turned off. An LCD (Liquid Crystal Display) is interfaced with the Arduino to display the value of the count. This can be used to know the number of people inside the room. A 16x2 LCD is used in this system. We can go for LCD I2C if we want to use a smaller number of pins.

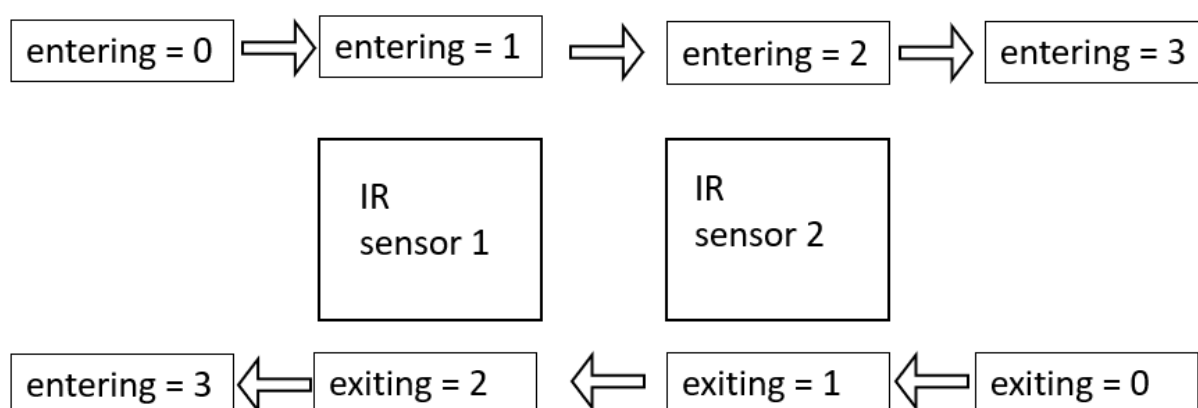
4.2 WORKING OF THE SYSTEM

To track the entering and the exiting, two variables namely 'entering' and 'exiting' are used. A person is considered to be entering the room if he is detected by IR sensor 1 first and then detected by IR sensor 2. He is considered to be exiting the room if he is detected by IR sensor 2 first and then detected by IR sensor 1. The Arduino loop function runs continuously. If we use a single count variable, its value may be increased infinitely. To rectify this issue two variables are used whose values are not increased continuously.

While entering the room the person is first detected IR sensor 1. In this situation, the value of the variable 'entering' is 0. If it is so, the value of 'entering' is set to 1. After this, the person is detected by IR sensor 2, and the value of 'entering' is set to 2. Now it is found that the person is entering the room, since the value of 'entering' is 2 that means the person is detected by both the sensors in an order. The value of the count is increased by 1 as the person just entered the room. Now, the value of the 'entering' is set to 3. As long as the person is detected by the second IR sensor the value of the 'entering's remains 3. Once the person is out of

the sensor's range and both the sensors are not detecting anything, the value of 'entering' is reset to 0. In this situation, a person has entered the room and the count is increased by 1 and displayed in the LCD. The same applies to the exiting. Initially the value of 'exiting' is 0. After being detected by IR sensor 2, the value of 'exiting' will be set to 1. After being detected by IR sensor 1, the value is set to 2 and after decreasing the value of the count, the value of 'exiting' is set to 3. When the person completely exits the room the value of the variable 'exiting' is reset to 0.

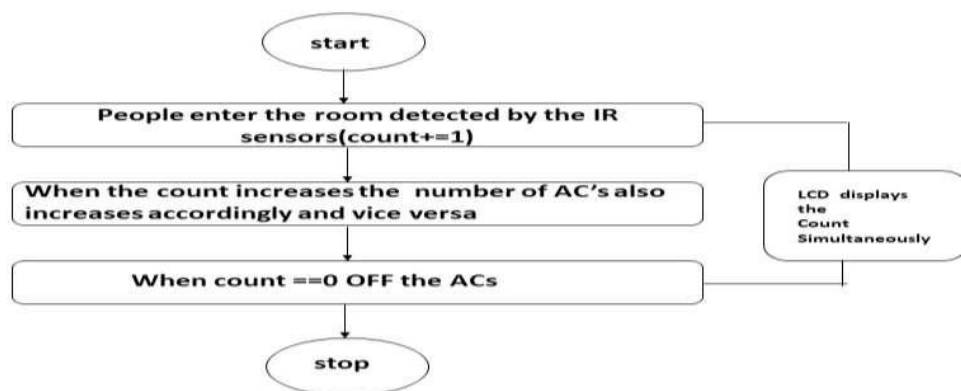
Since we have only two sensors, we need to set the values of both 'entering' and 'exiting' using those two sensors only. At a given point of time, when a sensor detects a person there may be several conditions. For example, when IR sensor 1 detects a person, the person may be entering the room or exiting the room. The value of 'entering' maybe 0 or 1 and the value of 'exiting' may be 0 or 2 or 3. So, before changing any variable all the possible conditions need to be checked.



Working logic of the system

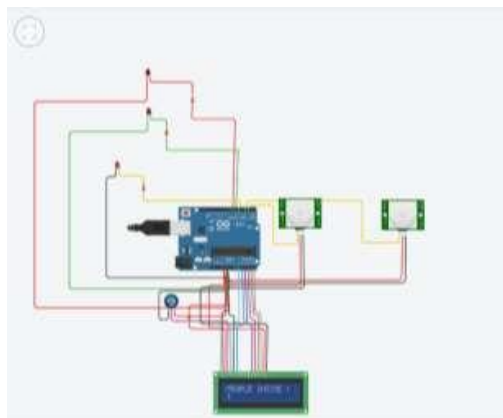
Figure 5.2 illustrates the logic behind the working of the system. From the figure, we observe that when a sensor detects a person both the variables 'entering' and 'exiting' are associated with that. The sensor sends the data to the microcontroller. The data from the IR sensors are given to a microcontroller. In this case, Arduino UNO is used. Arduino processes the sensor data and determines the entering or exiting of people. In this system, a variable named 'count' is used to

store the number of people inside the room. When Arduino finds out someone is entering the room the value of the variable count is increased, with respect to the count required number of AC's are turned on. When it finds someone exiting the room the value of the count is decreased. If the value of the count is greater than zero, the electrical appliances such as lights and AC's need to be turned on. If the value of count is 0 they need to be turned off. For example, if we have six people totally and three AC's, when two people enter the room one AC will turn ON and when four people enter the room two AC's are turned ON and similarly based on the count this process repeats. An LCD (Liquid Crystal Display) is interfaced with the Arduino to display the value of the count. This can be used to know the number of people inside the room.



5.RESULTS AND DISCUSSION

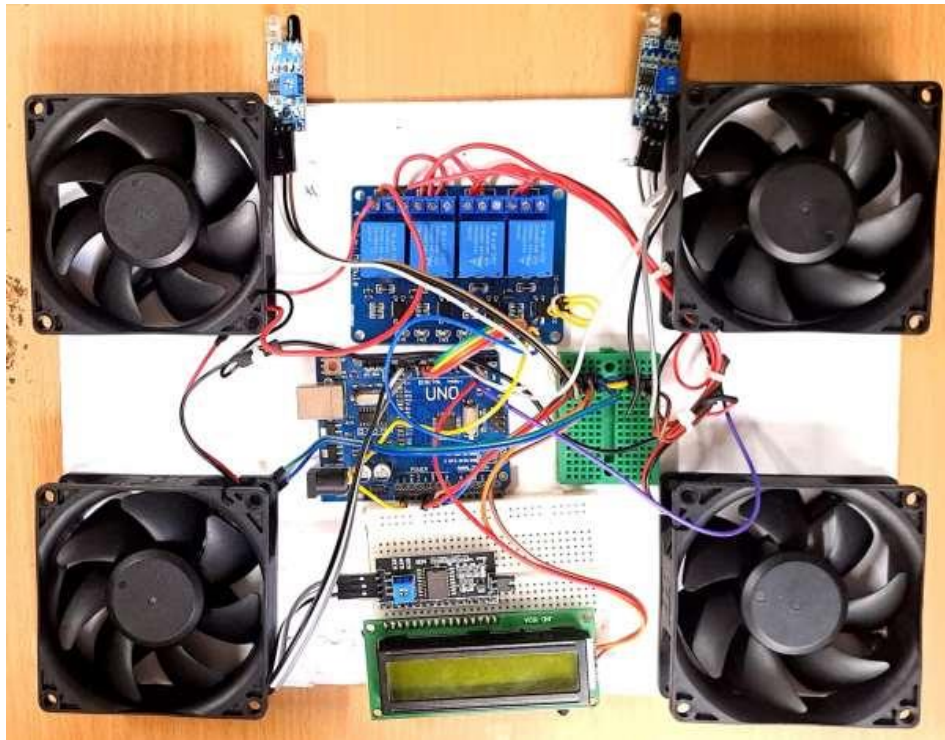
5.1 TINKERCAD CIRCUIT



Circuit Connections of The System

The above figure shows the connection diagram of the proposed system in TINKERCAD. This shows the interfacing of the Arduino Uno with LCD, IR sensors and LED (considered as mini exhaust fan). Here PIR sensors are used in place of IR sensors for reference.

5.2 PROTOTYPE



Connecting the Components

The above figure shows the hardware kit which involves all the components and connections as per the TINKERCAD circuit. All the wirings are soldered with the Arduino and other components.

6.CONCLUSION

The proposed system offers a significant advantage over traditional systems that require two gateways to track entry and exit, as it can function with a single gateway, making it more economical and easier to install. Additionally, the system addresses the issues with the existing system, such as the infinite count increase

due to long-standing and the detection of a person trying to enter and exit at the same time. Furthermore, the system is designed to be userfriendly, requiring no human intervention or manual adjustments. This makes it ideal for individuals who have difficulty with physical or cognitive tasks, such as the elderly or those with disabilities. Furthermore, these occupancy sensors are usually local in scope and only control lightning, Infrared (IR) based sensors are often used for occupancy. More advanced systems have been deployed, such as using cameras and vision algorithms, but these systems suffer from deployability, cost and privacy issues. The system is especially helpful for individuals who are deaf and dumb, as it is not dependent on verbal communication for operation. Overall, the proposed system is an innovative and practical solution that offers significant benefits over traditional systems. Its low cost, ease of installation, and user-friendliness make it a viable option for room automation, particularly for individuals with special needs.

Department of Electronics and Communication Engineering

Vision

To be recognized by the society at large as a full- fledged department, offering quality higher education in the Electronics and Communication Engineering field with research focus catering to the needs of the stakeholders and staying in tune with the advancing technological revolution and cultural changes.

Mission

To achieve the vision, the department will

- Establish a unique learning environment to enable the students to face the challenges in Electronics and Communication Engineering field.
- Promote the establishment of centres of excellence in niche technology areas to nurture the spirit of innovation and creativity among faculty and students.
- Provide ethical and value-based education by promoting activities addressing the societal needs.
- Enable students to develop skills to solve complex technological problems and provide a framework for promoting collaborative and multidisciplinary activities.

