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A Project Report on

"IOT BASED STREET LIGHT SHORT CIRCUIT DETECTION"

Submitted in partial fulfillment for the award of degree of Bachelor of Engineering in Computer Science & Engineering during the year 2023 -2024

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CERTIFICATE

This is to certified that the project work titled "**IOT BASED STREET LIGHT SHORT CIRCUIT DETECTION"** has been successfully carried out by **ANJALI KASHYAP S [4MN20CS005], DRUPAD S[4MN20CS015], GAARGI B[4MN20CS016], KARTHIK S [4MN20CS023]** bonafide students of **Maharaja Institute of Technology Thandavapura in partial fulfillment of requirements of Degree of Bachelor of Engineering in Computer Science & Engineering of Visvesvaraya Technological University, Belgaum** during the academic year 2023-24. The project report has been approved has it satisfies the academic requirements with respect to the project work prescribed for Bachelor of Engineering Degree.

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It gives us immense pleasure to bring our Project report entitled **“IOT BASED STREET LIGHT SHORT CIRCUIT DETECTION”** in the Final Year Engineering Course.

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ABSTRACT

Locating faults, specifically short circuits, in power distribution lines is a complex and serious issue in the power system. Our solution involves a microcontroller, GSM mobile, driver circuit, control circuit interfaced with GSM modem, and advanced IoT devices. This system enables remote monitoring and control of streetlight infrastructure. Under normal conditions, the system records and periodically reports overall performance. However, if it detects any incorrect behavior such as short circuit or fire hazard, it immediately alerts operator. Our work describes the development of a microcontroller-based protection system for electric distribution, which effectively monitors and sends information about the distribution system while identifying the exact location of fault. To ensure a more general, flexible, and cost-effective implementation, remote communications are based on a powerful GSM network. In case of a fault, such as a short circuit or fire hazard, the microcontroller immediately sends signal through the GSM modem and IoT devices. The interfaced GSM modem receives the signal, which is then sent as a message to the distribution side or the substation or the line patrol staff. A voice alert is also made to alert the staff. Later, the staff can locate the exact fault occurrence region and take necessary actions.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Electricity consumption is growing fast. Distribution system losses are higher than transmission losses and faults are more frequent in distribution. In fact, 80% of service interruptions are due to distribution failures. Detecting and locating faults in power lines is crucial for keeping the power system healthy. This project aims to design a power supply, microcontroller, and GSM modem to detect faults in distribution lines and notify Electricity Board automatically. It will reduce the need for manpower and save time while operating efficiently. The project also includes a street light control system that works based on the intensity of the environment. An immediate notification is sent to the Electricity Board, which can track the location using IoT devices.Power transmission lines face various electrical faults caused by lightning, birds, trees, and other natural conditions. These faults can lead to poor power supply quality and must be identified and corrected promptly. Fault detection is essential for the safe operation of electric power transmission and distribution systems.

There are scenarios where many technicians have lost their lives while addressing the faults in streetlight, unable to determine precise location of faults. Without fault detection, removing short circuits from a transmission system is impossible. These faults can persist and may damage essential electrical equipments . Various methods for detecting and locating faults on power transmission lines exist. Most of these methods use measurements from voltage and current transformers at substations or switching stations to perform their analyses.

Street lighting is a very crucial aspect of public safety and security as it provides adequate illumination during nighttime. However, various issues like short circuits and fire accidents can pose significant risks to both infrastructure and public safety.

Inefficient energy usage in street lighting systems also contributes to environmental concerns and operational costs.

The proposed system integrates various sensors, including switches that detect short circuits, Light Dependent Resistors (LDR sensors), and flame sensors, to monitor and detect potential hazards in street lighting infrastructure. The short circuit detector switches detect electrical faults such as short circuits in street lights. Whenever a short circuit is detected, the system initiates an alert mechanism that notifies designated authoritative personnel, enabling prompt intervention to mitigate the issue and ensure public safety.

In order to detect fire accidents in the vicinity of street lights, the system contains fire sensors. Detecting the fire hazards allows for timely response measures, reducing the risk of property damage and ensuring the safety of nearby residents.

The system utilizes LDR sensors to vary the intensity of street lights based on ambient light conditions, optimizing energy usage and promoting sustainability. During nighttime, when ambient light is low, the system automatically increases the intensity of street lights to maintain adequate illumination for safe navigation. Conversely, during daytime, the system reduces the intensity of street lights to conserve energy without compromising safety.

Overall, the proposed Street Light Short Circuit Detection and Optimization System offers a proactive approach to enhancing the safety, efficiency, and sustainability of the infrastructure of the street lights through real-time monitoring, detection, and responsive control mechanisms. The system has the ability to significantly decrease the risks associated with street lighting infrastructure while promoting sustainable practices, making it an ideal and effective solution for modern cities.

1.2 Overview with Problem Identification

Detecting and locating faults in power lines is crucial for the healthy operation of the power system. Electrical power line faults occur frequently and can make the power system unreliable. In this regard, a wireless sensor network (WSN) is proposed for detecting faults, including phase-to-phase, short-circuits, and line-to-ground faults in power lines, to ensure reliable and optimum operation of the system. It can display the faulty condition to the operator and can send an SMS through a GSM modem.

Traditional street lighting systems typically use high-intensity discharge lamps and are controlled by a centralized system. These systems often face challenges such as delayed detection of short circuits, which can result in prolonged downtime and increased maintenance costs. Moreover, these lighting systems lack real-time monitoring and optimization capabilities, which means that they cannot adjust to changing conditions such as weather patterns, traffic flow, and pedestrian movement. As a result, these systems can be less efficient than newer, more advanced lighting technologies that incorporate smart sensors and real-time monitoring features.

1.3 Objective

1. Design an intelligent IoT-based system for managing street lights:

   • The system must employ IoT technology to monitor and regulate street lights.

2. Detect electrical faults and fire hazards:

   • Integrate Short Circuit Detector Switches and Flame Sensors to quickly identify electrical faults and fire incidents.

3. Optimize lighting intensity:

   • Use LDR sensors to dynamically adjust street light intensity, ensuring optimal illumination levels at night and conserving energy during the day.

4. Enable real-time alerting:

   • Develop a mobile application using Java to alert relevant personnel of any incidents detected, allowing for swift intervention.

5. Allow for remote control:

   • Provide authorities with the ability to remotely manage street lights, including the option to turn off power to specific lights in the event of an emergency.

1.4 Scope

Street light short circuit detection systems enhance public safety, operational efficiency, and energy conservation by promptly identifying and addressing electrical faults. These systems prevent accidents and fires, ensure reliable street lighting for improved road visibility and security, and reduce energy waste. They enable proactive maintenance, minimizing downtime and repair costs, and support sustainability goals by lowering energy consumption and greenhouse gas emissions. Integration with smart city technologies and IoT allows for real-time monitoring and predictive maintenance, further optimizing street light management. Additionally, these systems help municipalities comply with safety standards and improve public satisfaction through reliable and aesthetically pleasing lighting infrastructure.

1.5 Existing System

- Visual Inspection: Human technicians conduct regular visual inspections of electrical infrastructure, such as power lines, street light poles.
- Limited Automation: basic automation may be employed, such as remote control of street lights using a central control system.

- Manual Control: Street lights are controlled manually by local authorities. They may be turned on or off as needed based on observations or specific requirements.

Disadvantages:

- Labour Intensive
- Delayed Response
- Dependency on manual reporting
- Increased Downtime
- Slow alert notifications

1.6 Proposed System

Identifying a short circuit in a power distribution line is one of the complex and critical issue in the power system. Our solution, designed with a microcontroller, GSM mobile, driver circuit, control circuit interfaced with a GSM modem and advanced IoT devices, enables remote supervising and overseeing of multiple stand-alone distribution transformer plants. Under normal conditions, the system records and periodically reports overall performance. However, if incorrect behavior is detected, the operators are immediately informed. Users can also modify plant elements and measurement system settings with appropriate instructions. Our microcontroller-based protection of electric distribution system offers effective monitoring and sends information related the distribution system, allowing for exact location of the disorder. For general, flexible, and cost-effective implementation, the remote communications could be done through powerful GSM networking. In case of interruption such as short circuit, the microcontroller provides an immediate indication through the GSM modem and IoT Devices. The GSM modem receives the signal and data is sent from the distribution side to the substation and to the line patrol staff as a message. A voice alert is also made to alert the staff, who can subsequently find the exact location of fault or damage. and needs urgent attention.

Advantages:

- Reduced energy wastage.
- Cost – Effective
- Easy to main street light infrastructure.

1.7 Applications

- Urban Infrastructure: Supports smart city initiatives by integrating with other IoT systems for city management.
- Commercial and Industrial Facilities: Optimized lighting and energy management in parking lots and industrial areas.
- Residential Areas: Enhances safety in residential neighborhoods by quickly addressing electrical faults.
- Rural Areas and Remote Locations: Efficient lighting control in rural communities.

CHAPTER 2

LITERATURE SURVEY

Author and year	Title	Methodology	Description	Conclusion
H.P.Khandagale, R.Zambare , P.Pawar,P.Jadhav, P. Patil, S.Mule. 2020	Street Light Controller With Gsm Technology.	The GSM-based streetlamp system comprises three modules: lamp switching (On/Off), sensor module, and GSM module for control.	Wireless GSM streetlight control with SMS automation, integrating microcontroller, IoT, sensors, GSM, and LDR-regulated smart lighting.	System for better control of poorly managed street lamps.
M. Vasantha Lakshmi, Y.Rajesh, S.Chandra Sekhar, S.Prabhu Kiran, R.SaiMahesh. 2020	IOT Based Automatic Street Light Control and Fault Detection System.	Raspberry Pi3, with inbuilt WiFi, uses LDR sensor for automated day/night streetlight control, ensuring energy efficiency.	IoT-based streetlight control and fault detection with Raspberry Pi3 and LDR sensors monitor intensity, alerting faults promptly.	The project improves efficiency and reduces costs and minimizes energy wastage.
Ashok Kumar Nanduri, Siva Kumar Kotamraj , G L Sravanthi, Sadhu Ratna Babu, K V K V L Pavan Kumar 2020	IOT based Automatic Damaged Street Light Fault Detection Management System.	Smart streetlights adjust brightness with IoT and GSM, detecting obstacles and notifying mobile phones for energy conservation and efficient maintenance.	Raspberry Pi program controls streetlights, detects faults in streetlights with cloud storage, and manages ON/OFF of the lights based on LDR.	Automated streetlight control minimizes human efforts, swiftly identifies and resolves issues in lamps.

Krunal Khobragade, Kundan Gaikwad, Pravin Bhiogade, Akshay Pardhi, Sonali Kharwade 2021	GSM Based Automatic Street Light Control System.	LDR-controlled streetlights automatically turn off in light and on in darkness, sending GSM notifications.	Energy-efficient system with adaptable LEDs adjusts intensity based on PIR sensor, detects faults, and communicates via GSM for efficient maintenance.	Smart adaptive lighting for energy conservation.
Prashant Kumar, Shivaraj S Hiremath, G V Sandeep , Santoshkum Javalagi, Dr. Venkata Siva Reddy 2021	IOT based Automatic Street Light Control and Fault Detection.	Control the intensity of a lamp based on readings from an IR sensor and an LDR.	Automated streetlights use LDR for streetlight control, with fault detection and GSM alerts instantly to the authorized person during faults. Infrared sensors enhance security and energy efficiency.	Cost-effective IoT streetlights save energy, need minimal maintenance.
Vuyyuru Chandra Sekhar , PadamataNeelima, Tatiparthi Anantha Lakshmi, Sodadasu Siromani 2022	IOT- Based Smart Streetlight Monitoring System with Fault Detection using GSM.	Smart streetlights use IoT and GSM for adaptive brightness, obstacle tracking, and user-friendly light failure alerts.	System uses IoT and GSM to adjust brightness based on conditions. An app on ThingSpeak tracks light status, and GSM sends alerts if lights fail, contributing to energy conservation	Improved streetlight efficiency and control for greater effectiveness.

Table 2.1: Literature Survey

CHAPTER 3

SYSTEM REQUIREMENT SPECIFICATIONS

3.1 Functional Requirements

Functional Requirement defines a function of a software system and how the system must behave when presented with specific inputs or conditions. These may include calculations, data manipulation and processing and other specific functionality.

In this system following are the functional requirements: -

- Input test case must not have compilation and runtime errors.
- The application must work when kept running for even a long time.
- The application must function as expected for every set of test cases provided.
- The application should generate the output for given input test case and parameters.
- The application should generate on-demand services.

3.2 Non – Functional Requirements

Non-functional requirements are the requirements which are not directly concerned with the specific function delivered by the system. They specify the criteria that can be used to judge the operation of a system rather than specific behaviors. They may relate to emergent system properties such as reliability, response time and store occupancy. Non-functional requirements arise through the user needs, because of budget constraints, organizational policies, the need for interoperability with other software and hardware systems or because of external factors such as:-

- Product Requirements.
- Organizational Requirements.
- Basic Operational Requirements.

In systems engineering and requirements engineering, a non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours. This should be contrasted with functional requirements that define specific behaviour or functions. The plan for implementing non-functional requirements is detailed in the system architecture. Broadly, functional requirements define what a system is supposed to do and non- functional requirements define how a system is supposed to be.

Non-functional requirements of our project include:

- Response time The time the system takes to load and the time for responses on any action the user does.
- Processing time - How long is acceptable to perform key functions or export / import data?
- Storage - The amount of data to be stored for the system to function.

3.3 Hardware Requirements

- Node MCU
- ESP32 WIFI
- Micro Controller
- Power Supply
- LCD
- IR Sensor
- LDR Sensor
- Smart Phone

3.4 Software Requirements

- Embedded C
- Aurdino IDE

3.5 Requirement Traceability matrix

Serial No	Requirement ID	Requirement Description
1	RID-1	The system should be able to detect the movement of vehicle on the road.
2	RID-2	The system should be able to detect short circuit in the street light infrastructure.
3	RID-3	The system should be able to detect fire hazards near the street light infrastructure.
4	RID-4	The system should be able to send voice alert to notify the authorities.
5	RID-5	The system should be able to locate the exact region of fault occurrence .

Table 2.1: Requirement Traceability Matrix

CHAPTER 4

SYSTEM ANALYSIS AND DESIGN

4.1 System Analysis

The system design process builds up a general framework building design. The programming outline includes speaking to the product framework works in a shape that may be changed into one or more projects. The prerequisite indicated by the end client must be put systematically. An outline is an inventive procedure; a great configuration is a way to the viable framework. The framework "Outline" is characterized as "The procedure of applying different systems and standards with the end goal of characterizing a procedure or a framework inadequate point of interest to allow its physical acknowledgment". Different configuration components are taken after to add to the framework. The configuration detail portrays the components of the framework, the segments or components of the framework, and their appearance to end clients.

4.2 System Architecture

The architectural configuration procedure is concerned with building up a fundamental basic system for a framework. It includes recognizing the real parts of the framework and the interchange between these segments. The beginning configuration procedure of recognizing these subsystems and building up a structure for subsystem control and correspondence is called construction modeling outline and the yield of this outlined procedure is a portrayal of the product structural planning. The proposed architecture for this system is given below. It shows the way this system is designed and the brief working of the system.

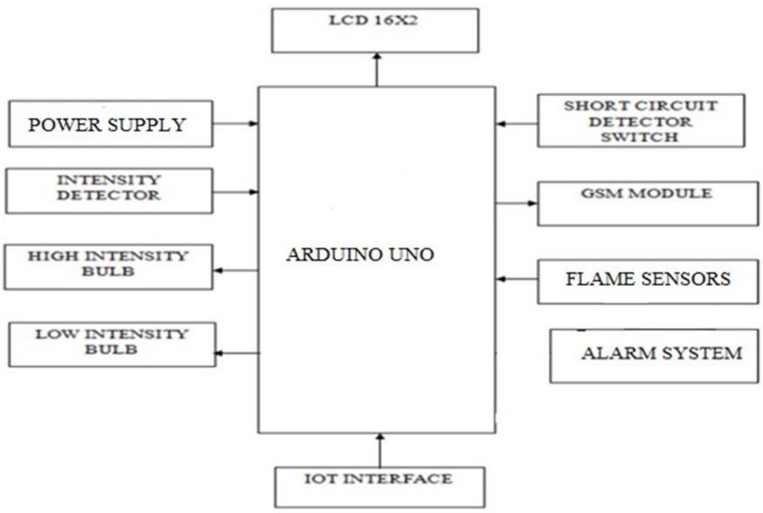

Fig 4.1: System Architecture

A network of interconnected components, such as flame detectors, light intensity sensors, and short circuit detector switches, are all combined with microcontrollers for real-time processing in Internet of Things systems. In addition ,there are flame detectors to detect fire incidents, these sensors are fitted near the street lights to detect short circuits and adjust their intensity based on ambient light levels. GSM modules are used to transfer data from these sensors to an Internet of Things interface, allowing for remote monitoring and control for effective street lighting management and quick reaction to possible threats that could occur.

4.3 High-Level Design

High-Level Design (HLD) explains the architecture that would be used for developing a software product. The architecture diagram provides an overview of an entire system, identifying the main components that would be developed for their interfaces. The HLD uses possibly non-technical to mildly technical terms that should be understandable to the administrators of the system. In contrast, low-level design further exposes the logical detailed design of each of these elements for programmers.

4.3.1 Sequence Diagram

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

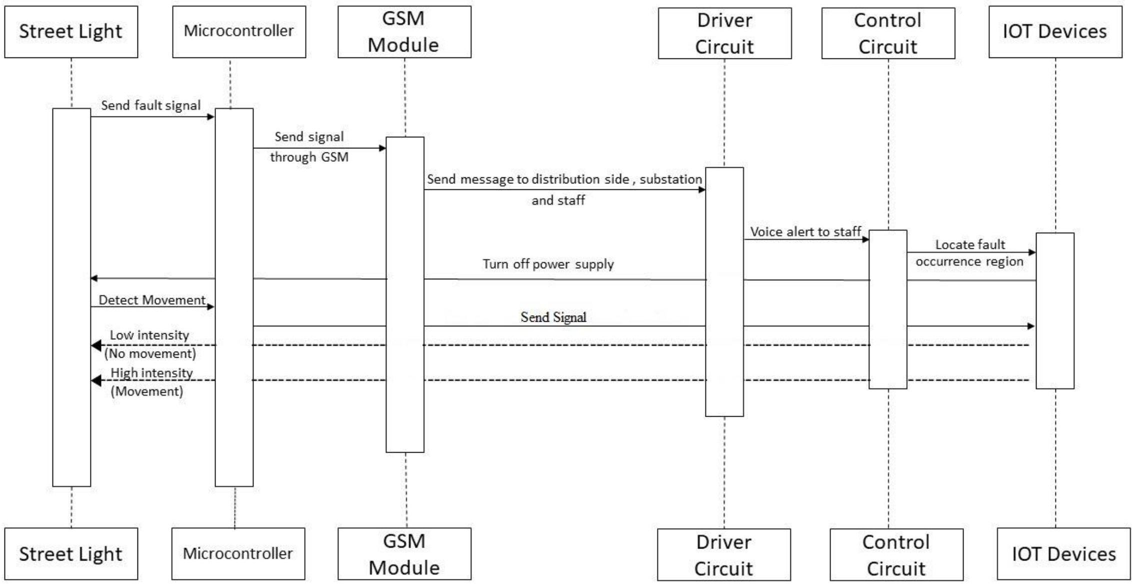

Fig 4.2: Sequence Diagram

4.4 Low-Level Design

Low-Level Design (LLD) is a component-level design process that follows a step by-step refinement process. This process can be used for designing data structures, required software architecture, source code, and ultimately, performance algorithms. Overall, the data organization may be defined during requirement analysis and then refined during data design work. During the detailed phase, the logical and functional design is done and the design of the application structure is developed during the High Level Design.

4.4.1 Flowchart

A flowchart is a diagram that represents a set of instructions. Flowcharts normally use standard symbols to represent the different types of instructions. These symbols are used to construct the flowchart and show the step-by-step solution to the problem.

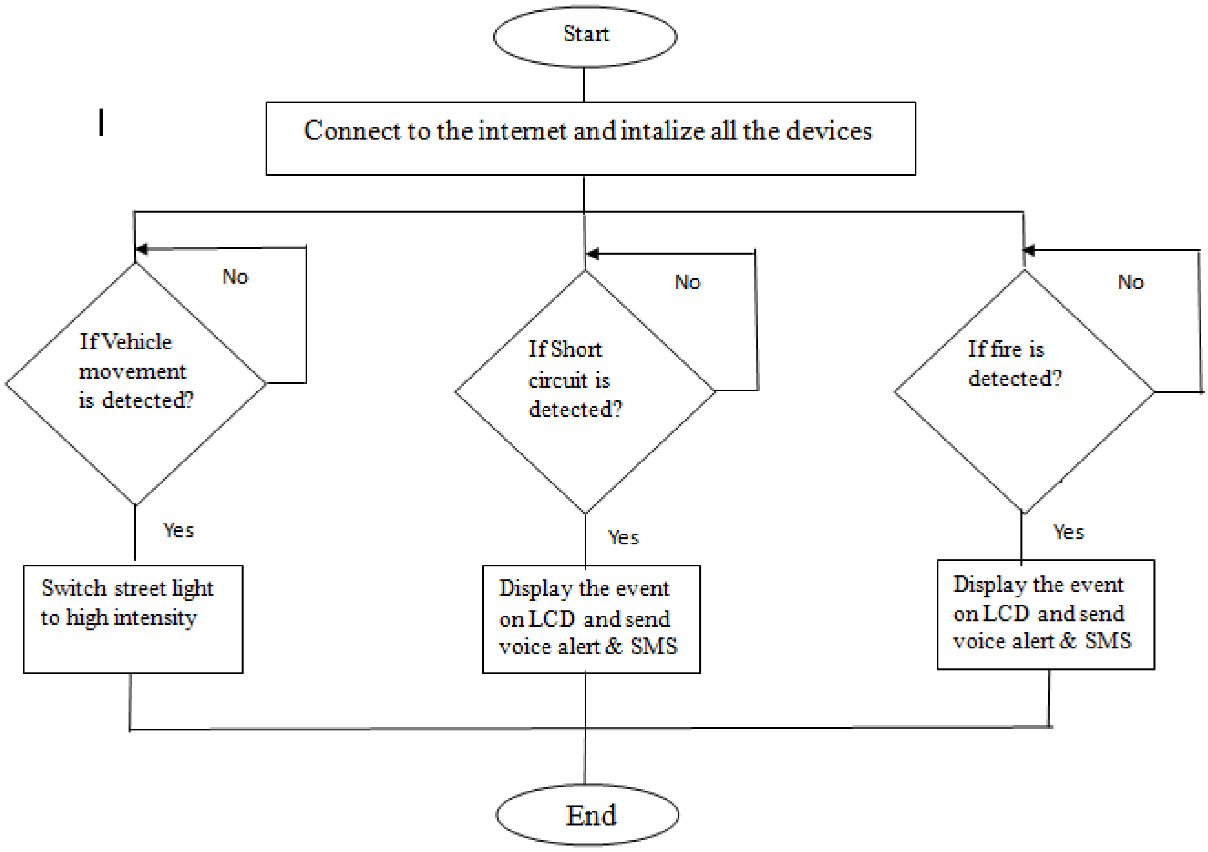

Fig 4.3: Flow Chart

CHAPTER 5

IMPLEMENTATION

The circuitry for this project includes various components such as ESP8266 Wi-Fi, IR Sensors, I2C LCD, Arduino IDE and Node MCU. The sensors used in the project are responsible for detecting the garbage level, fire, smoke and odour. These sensors send the data to the microcontroller, which processes the input and sends necessary signals to the user.

NODE MCU

NodeMCU is a low-cost open source IoT platform. ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios.

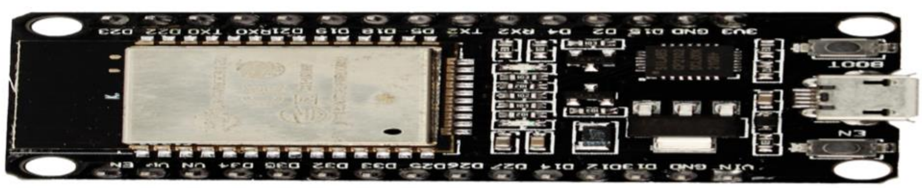

Fig 5.1 Node MCU

Both the firmware and prototyping board designs are open source. The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP32. It uses many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards.

I2C LCD

This is I2C interface 16x2 LCD display module, a high-quality 2 line 16 character LCD module with on-board contrast control adjustment, backlight and I2C communication interface. For Arduino beginners, no more cumbersome and complex LCD driver circuit connection. The real significance advantages of this I2C Serial LCD module will simplify the circuit connection, save some I/O pins on Arduino board, simplified firmware development with widely available Arduino library.

Fig 5.2 I2C LCD

I2C LCD DISPLAY

At first you need to solder the I2C-to-LCD piggy-back board to the 16-pins LCD module. Ensure that the I2C-to-LCD piggy-back board pins are straight and fit in the LCD module, then solder in the first pin while keeping the I2C-toLCD piggy-back board in the same plane with the LCD module. Once you have finished the soldering work, get four jumper wires and connect the LCD module .

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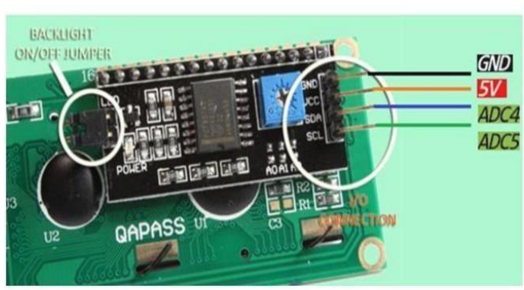


Fig 5.3 :I2C LCD DISPLAY

IR sensor

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. Infrared radiation was accidentally discovered by an astronomer named WilliamHerschel in 1800. While measuring the temperature of each colour of light (separated by a prism), he noticed that the temperature just beyond the red light was highest. IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum). Anything that emits heat (everything that has a temperature gives off infrared radiation. The sensor provides a digital output (1 or 0).The sensor outputs a logic one(+3.5V) at the digital output when an object is placedin front of the sensor and logic zero(OV), when there is no object in front of the sensor. An on board LEDis used to indicate the presence of an object.

IR sensors typically consist of an IR emitter and an IR receiver. The emitter sends out a beam of infrared radiation that is directed toward the surface of the garbage in the container. The receiver then detects the amount of infrared radiation that is reflected back from the surface of the garbage and converts this into a measurement of the distance between the sensor and the garbage surface.By using this distance measurement, IR sensors can estimate the level of garbage inside the container. When the garbage reaches a certain level, the sensor can trigger an alert or notification that prompts the waste management personnel to empty the container.IR sensors can be designed to operate in different ranges of infrared radiation, allowing them to sense different types of materials and surfaces

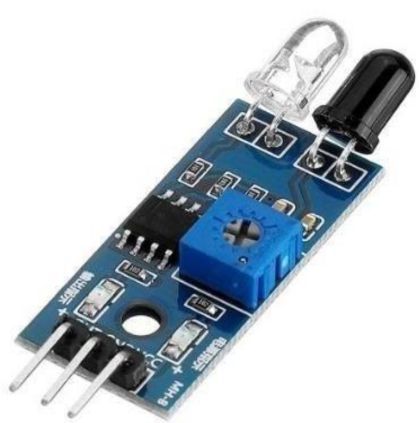


Fig 5.4 IR sensor

LDR SENSOR

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistancedecreases with an increase in the intensity of light.

It is often used as a light sensor, light meter, Automatic street light, and in areas where we need to have light sensitivity. LDR is also known as a Light Sensor. LDR are usually available in 5mm, 8mm, 12mm, and 25mm dimensions.

It works on the principle of photoconductivity whenever the light falls on its photoconductive material, it absorbs its energy and the electrons of that photoconductive material in the valence band get excited and go to the conduction band and thus increasing the conductivity as per the increase in light intensity.

Also, the energy in incident light should be greater than the band gap energy so that the electrons fromthe valence band got excited and go to the conduction band.

The LDR has the highest resistance in dark around 1012 Ohm and this resistance decreases with the increase in Light.

Fig 5.5 LDR sensor

Flame Sensor

A flame sensor is an electronic device that is used to detect the presence of flames. It is commonly used infire safety and security systems, but it can also be used in garbage monitoring systems to detect fires that may have started in or around garbage bins.

Flame sensors work by detecting the infrared radiation emitted by flames. They use a photo detector to measure the amount of infrared radiation in the surrounding environment. When a flame is present, it emits infrared radiation that is detected by the sensor, triggering an alert or alarm in the system.

In garbage monitoring systems, flame sensors can be used to detect fires caused by combustible materialsor hot weather conditions. This helps waste management authorities to respond quickly to potential fires and prevent them from spreading and causing damage to the surrounding environment.

Flame sensors typically consist of a sensitive material that is capable of detecting infrared radiation, such as a photo detector or a thermocouple. When a flame is present, it emits infrared radiation that is absorbedby the sensitive material in the flame sensor. This causes the material to heat up and generate a small electrical current. This electrical current is then detected by the flame sensor and used to trigger an alarm or other response in the system. The sensitivity of the flame sensor can be adjusted to detect different types of flames, such as those produced by gas, oil, or wood fires. The sensor can also be programmed to detect specific wavelengths of infrared radiation, which can help to distinguish between flames and other sources of infrared radiation, such as sunlight or heat lamps.

The use of flame sensors in garbage monitoring systems is a proactive approach to fire safety and can improve the efficiency of waste management systems.

Fig 5.6 Flame Sensor

Hotspot

A hotspot is a physical location where people can access the Internet, typically using Wi-Fi, via a wireless local area network (WLAN) with a router connected to an Internet service provider. Most people refer to these locations as “Wi-Fi hotspots” or “Wi-Fi connections.” Simply put, hotspots are the physical places where users can wirelessly connect their mobile devices, such as smartphones and tablets, to the Internet. A hotspot can be in a private location or a public one, such as in a coffee shop, a hotel, an airport, or even an airplane. While many public hotspots offer free wireless access on an open network, others require payment. Later in the article you’ll learn how to connect a mobile device to a Wi-Fi hotspot.

ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendordevelopment boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.

User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive programwith the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploadingtool to flash the user code onto official Arduino boards.

Arduino IDE is a derivative of the Processing IDE, however as of version 2.0, the Processing IDE will be replaced with the Visual Studio Code-based Eclipse The IDE framework. With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to other microcontrollers.

In October 2019 the Arduino organization began providing early access to a new Arduino Pro IDE with debugging and other advanced features. Introduction to Arduino IDE IDE stands for “Integrated Development Environment” :it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device.

- Arduino IDE is an open source software that is mainly used for writing and compiling the code intothe Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo,Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts theinformation in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a HexFile which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code.

This environment supports both C and C++ languages. How to get Arduino IDE we can download the Software from Arduino main website. As I said earlier, the software is available for common operating systems like Linux, Windows, and MACos, we select to download the correct software version that is easily compatible with our operating system.

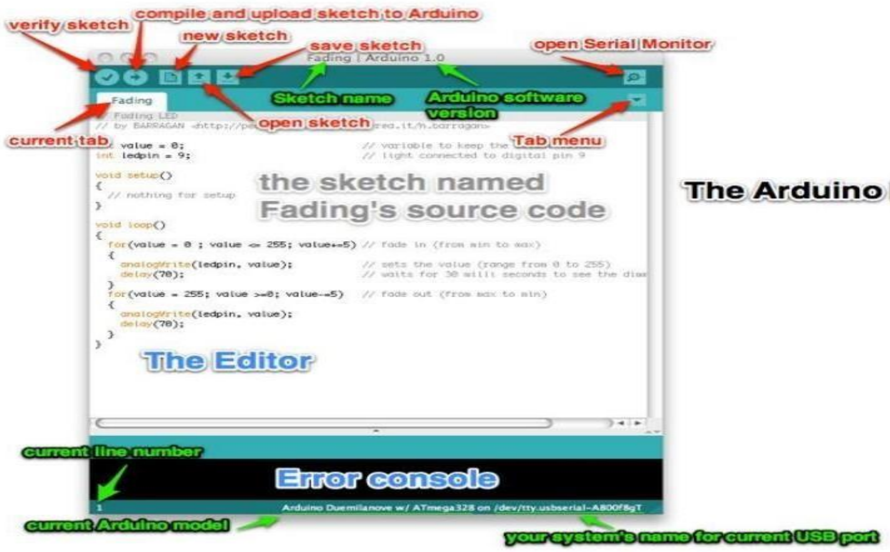
Details on IDE: The IDE environment is mainly distributed into three sections

1.Menu Bar

2.Text Editor

3.Output Pane

- As we download and open the IDE software, it will appear like an image below



The bar appearing on the top is called Menu Bar that comes with five different options as follow :

- **File** – You can open a new window for writing the code or open an existing one.And at the end of compilation, it will show you the hex file it has generated for the recent sketch that will send to theArduino Board for the specific task you aim to achieve.
- **Edit** – Used for copying and pasting the code with further modification for font
- **Sketch** – For compiling and programming
- **Tools** – Mainly used for testing projects.
- **Help** – In case you are feeling skeptical about software, complete help is available from getting started to troubleshooting.

The Six Buttons appearing under the Menu tab are connected with the running program as follow.

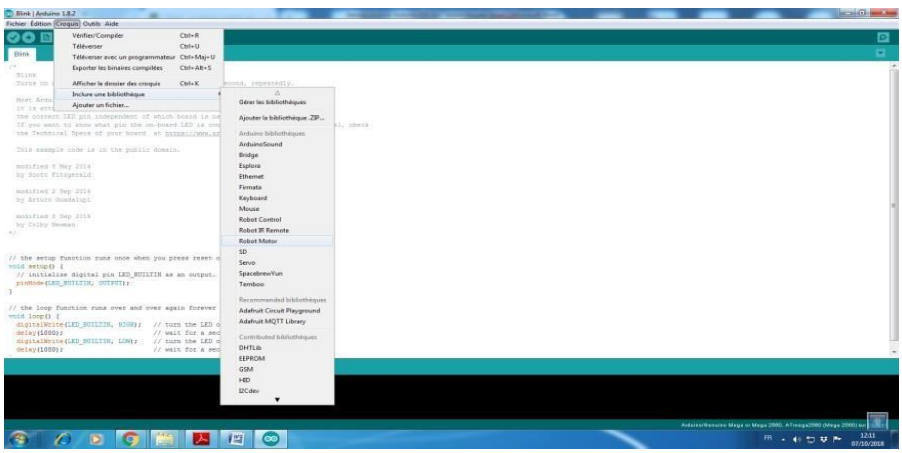
The check mark appearing in the circular button is used to verify the code. Click this once you have writtenyour code. The arrow key will upload and transfer the required code to the Arduino board.

- The dotted paper is used for creating a new file.
- The upward arrow is reserved for opening an existing Arduino project.
- The downward arrow is used to save the current running code.
- The button appearing on the top right corner is a Serial Monitor.

The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how yourprogram is operating. Your Arduino Module should be connected to your computer by USB cable in orderto activate the Serial Monitor. You need to select the baud rate of the Arduino Board you are using right now. For our Arduino Uno Baud Rate is 9600, as you right the following code and click the Serial Monitor,the output will show as the image below.

LIBRARIES

Libraries are very useful for adding the extra functionality into the Arduino Module. There is a listof libraries you can add by clicking the Sketch button in the menu bar and going to Include As you click the Include Library and Add the respective library it will on the top of the sketch witha #include sign. Suppose, I Include the EEPROM library, Temperature sensors DHT11/22, LCD or I2C library it will appear on the text editor as #include .. However, we can also download them from the external sources.

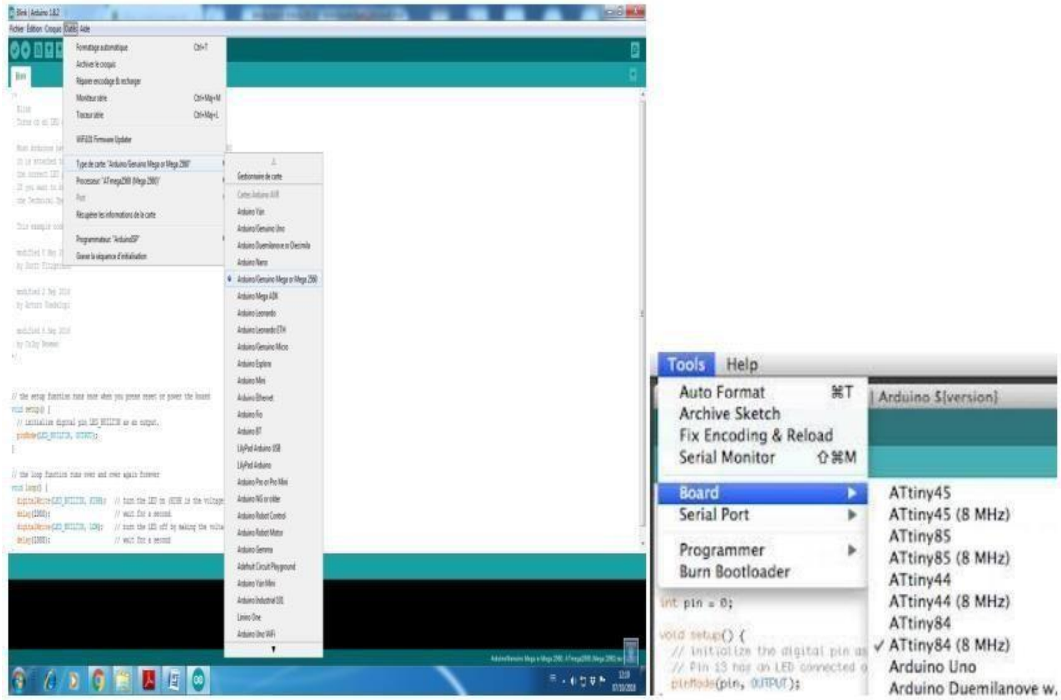


MAKING PINS AS INPUT OR OUTPUT

The digital Read and digital Write commands are used for addressing and making the Arduino pinsas an input and output respectively. These commands are text sensitive i.e. you need to write them down the exact way they are given like digital Write starting with small "d" and write with capital "W". Writingit down with Digital write or digital write won't be calling or addressing any function.

SELECTING BOARD OF ARDUINO

In order to upload the sketch, we need to select the relevant board we are using and the ports for that operating system. As we click the Tools on the Menu, it will open like the figure below

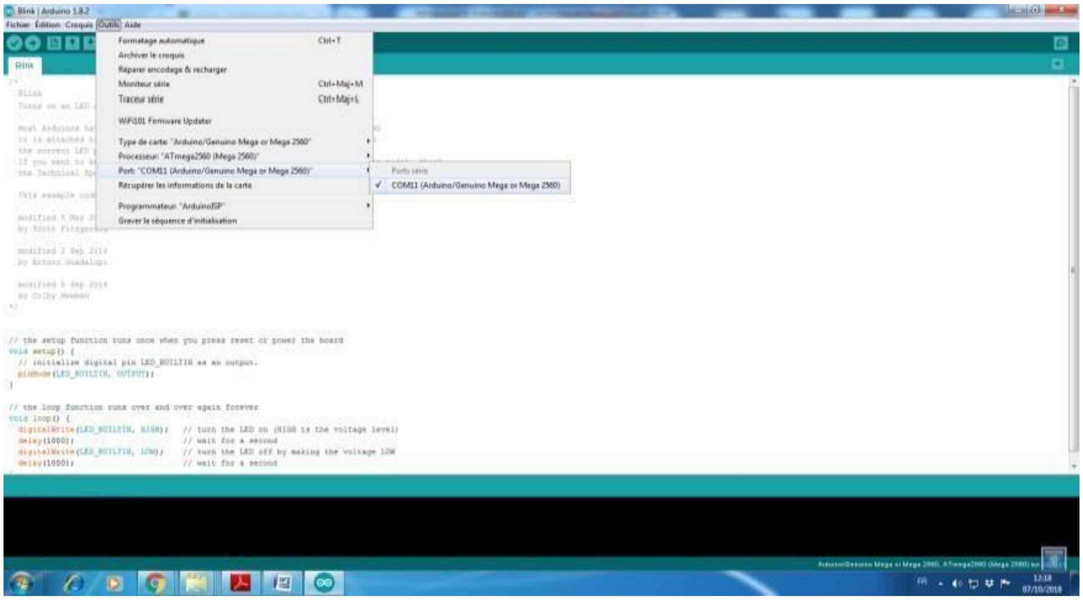


Just we go to the "Board" section and select the board we would like to work on. Similarly, COM1, COM2, COM4, COM5, COM7 or higher are reserved for the serial and USB board. we can look for the USB serial device in the ports section of the Windows Device Manager. Following figure shows the COM4 that we have used for my project, indicating the Arduino Uno with COM4 port at the right bottom corner of the screen.

After correct selection of both Board and Serial Port, click the verify and then upload button appearing in the upper left corner of the six button section or you can go to the Sketch section and press verify/compile and then upload. The sketch is written in the text editor and is then saved with the file extension .

It is important to note that the recent Arduino Modules will reset automatically as you compile and press the upload button the IDE software, however, older version may require the physical reset on the board. As we upload the code, TX and RX LEDs will blink on the board, indicating the desired program is runningsuccessfully.

The amazing thing about this software is that no prior arrangement or bulk of mess is required to install this software, you will be writing your first program within 2 minutes after the installation of the IDE environment.



5.1 Circuit Connection

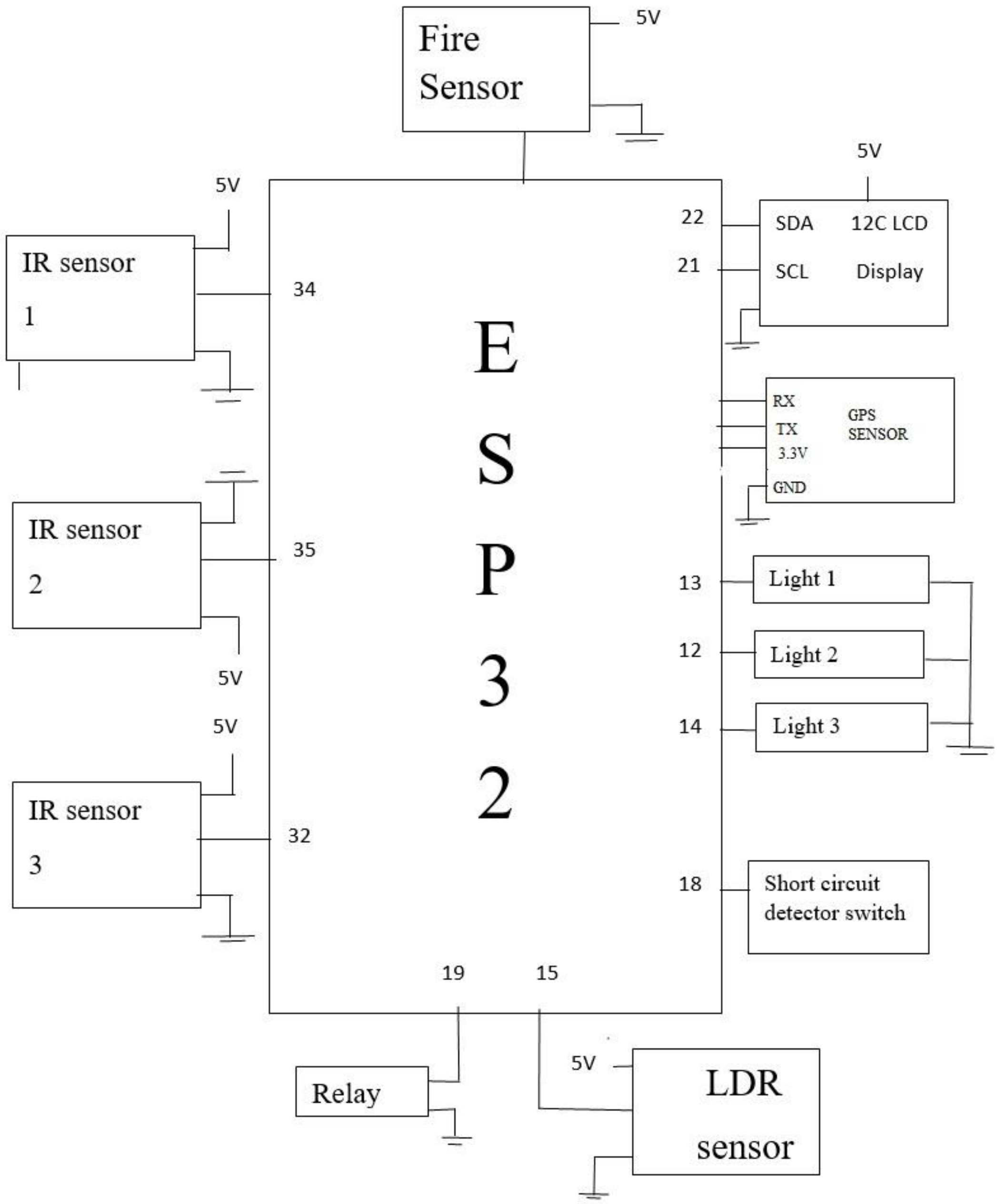


Fig 5.7 Circuit Diagram for Proposed System

CHAPTER 6

TESTING

6.1 Design of Test Cases

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies, and/or a finished product It is the process of exercising software with the intent of ensuring that the software system meets its requirements and user expectations and does not fail unacceptably. There are various types of tests. Each test type addresses a specific testingrequirement.

6.2 Types of Testing

6.2.1 Unit Testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application. It is done after the completion of an individual unit before integration. This is structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at the component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

6.2.2 Integration Testing

Integration tests are designed to test integrated software components to determine if they run as oneprogram. Testing is event-driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfied, as shown by successful unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

6.2.3 Functional Testing

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals. Functional testing is centered on the following items: Valid Input: identified classes of valid input must be accepted. Invalid Input: identified classes of invalid input must be rejected. Functions: identified functions must be exercised. Output: identified classes of application outputs must be exercised. Systems/Procedures: interfacing systems or procedures must be invoked. The organization and preparation of functional tests are focused on requirements, key functions, or special test cases. In addition, systematic coverage identifies business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current testsis determined.

6.2.4 System Testing

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration- oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

6.2.5 White Box Testing

White Box Testing is a testing in which the software tester knows the inner workings, structure, and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black-box level.

6.2.6 Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure,or language of the module being tested. Black box tests, like most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box. you

cannot "see" into it. The test provides inputs and responds to outputs without considering how the softwareworks.

6.3 Test Strategy and Approach

Field testing will be performed manually and functional tests will be written in detail.

6.3.1 Test objectives

- To ensure the IR sensors are detecting the approach of objects accurately.
- To verify that the Arduino Uno microcontroller is receiving and processing input from the sensorscorrectly.
- Verify that the microcontroller accurately detects normal and abnormal conditions in the distribution line.
- Test the microcontroller's ability to process data and trigger alerts correctly.
- To ensure the LED lights are changing intensity correctly when a object is detected .
- To verify that the voice alert is played when there is a fault in the distribution line.
- Test the system's ability to send alert messages to designated mobile devices, substations, and line patrol staff promptly.
- To ensure that whole system is operating properly in all scenarios

6.3.2 Features to be Tested

- IR sensor accuracy: Verify that the IR sensors are detecting the movement of vehicle or people on the road.
- LED lights functionality: Test the LED lights by simulating a vehicle approach and verify that the lights are glowing in high intensity in presence of vehicle and in low intensity otherwise.
- Alert Message : Test that alert message is being sent to the authorised personnel by simulating short circuit .
- Accuracy of Location: Test whether the exact location of fault is being sent to the authorities or not.

6.4 Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end-user. It also ensures that the system meets the functional requirements.

6.5 Test Cases

Requirement ID	Test Case Reference	Input	Output	Test Result	Remarks
RID-1	TC-1	Reflected IR rays to the IR sensor.	Vehicle movement detected	Pass	IR sensor detects the movement of vehicle on the road
RID-1	TC-2	No signal is reflected	No vehicle movement is detected	Fail	IR sensor transmits IR rays but rays not reflected.
RID-2	TC-1	Short circuit in the street light infrastructure	Short circuit detected	Pass	The system detects short circuit in street light.
RID-2	TC-2	No short circuit Signal to ESP Module	No short circuit detected	Fail	Streetlight infrastructure functioning normally
RID-3	TC-1	Fire in the street light infrastructure	Fire detected	Pass	Flame sensor detects fire hazard.
RID - 3	TC-2	No signal from flame sensor	No Fire Detected	Fail	No fire hazard in the street light infrastructure
RID-4	TC-1	Signal from ESP Module to GSM Module	Voice alert sent	Pass	Notifies authorities with voice alert when short circuit or fire hazard occurrs.
RID - 5	TC-1	Signal from GPS sensor to GSM Module	Exact location detected.	Pass	Obtains the exact location of fault to take immediate actions.

Table 6.1: Test Cases

CHAPTER 7

RESULTS AND SNAPSHOTS

IoT-based automated streetlight infrastructure is a cost-effective solution. With consistent monitoring, staff or routine inspections are no longer necessary, which effectively minimizes problems likedelayed short circuit detection and prolonged downtimes. This system optimizes the intensity of the street light to reduce energy wastage, resulting in accurate and reliable outcomes within the specific field.

7.1 Results

Input	Output	Remarks
Detects movement of vehicle	Vehicle movement detected	IR sensor detect the movement ofvehicle on the road
Detects shortcircuit	Short circuit detected	The system detects shortcircuit when occurs.
Detects theFire	Fire detected	Flame sensor detects fire when it appears.
Send voice alert	Voice alert sent	Notifies authorities with voice alert when short circuit or fire hazard occurrs.
Detect exact location of fault.	Exact location ddetected.	Obtains the exact location of fault to takeimmediate actions.

Table 7.1:Results

7.2 Snapshots

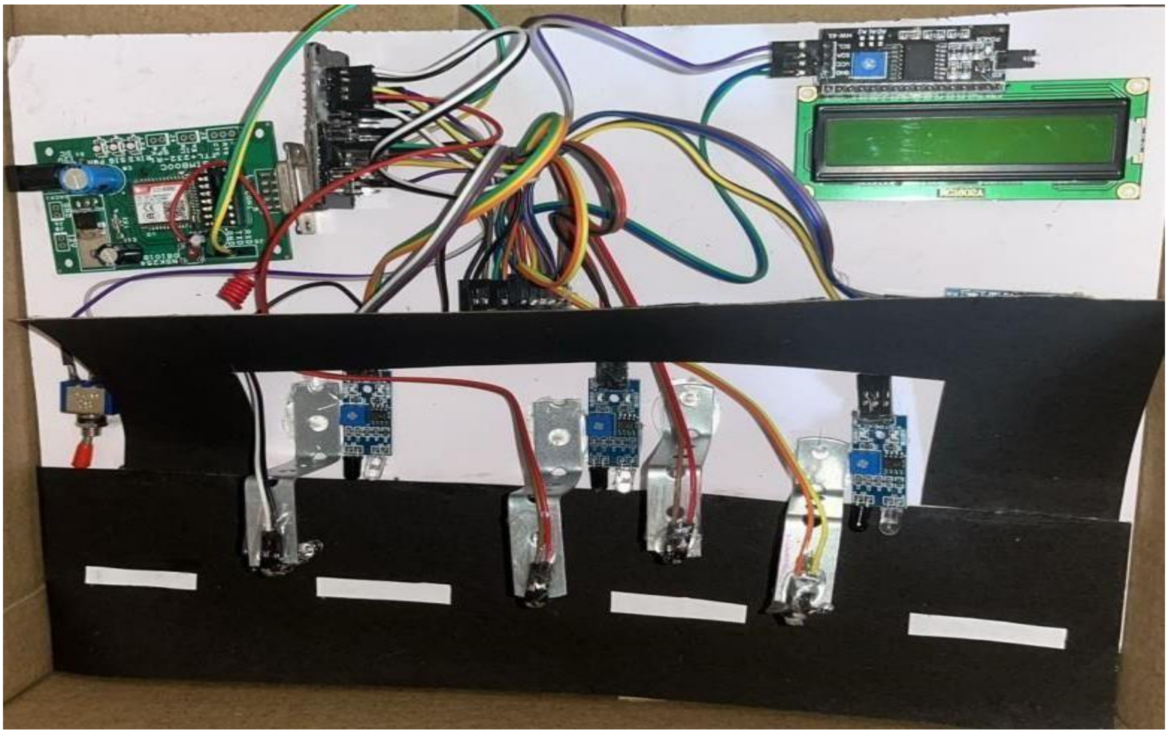


Fig 7.1: Street Light Short circuit detection model

Fig 7.2: Short circuit detected

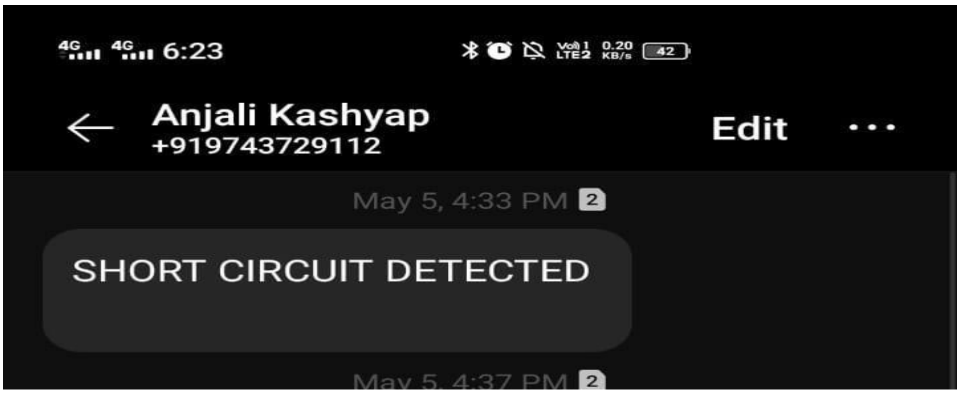


Fig 7.3: Alert SMS for Short circuit

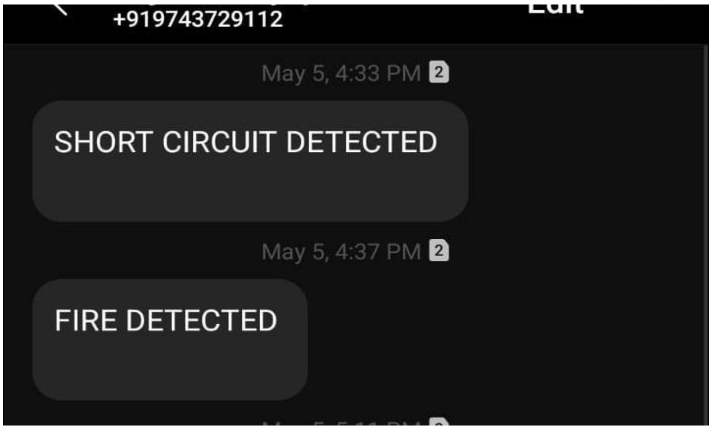


Fig 7.4: Alert SMS for Fire Accidents

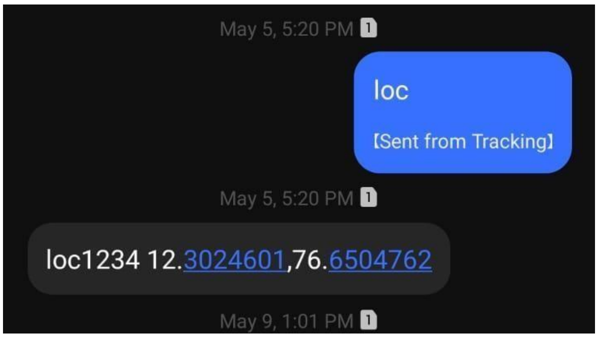


Fig 7.5 Longitude and Latitude of the Location

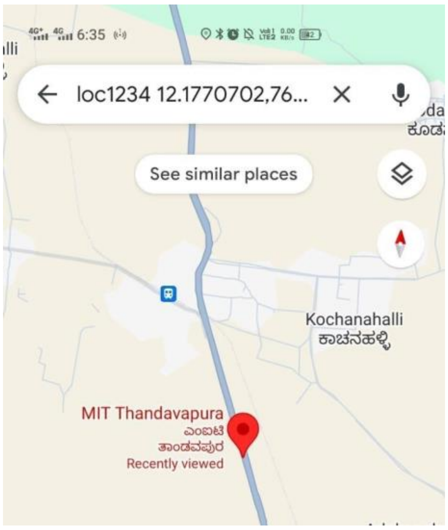


Fig 7.6: Location of the Fault

CONCLUSION AND FUTURE ENHANCEMENT

CONCLUSION

Detecting the area where the fault is occurred is difficult but it is simple when we use IOT devices. Using microcontroller and GSM based method is reliable to detect and intimate the Short Circuit. In the short time we can know that a fault as occurred and rectify immediately by identifying the location. The manual work is reduced and technicians need not walk along through the power line to know the location of the fault. The GSM can sends messages instantly to the power station a. The proposed method is effective in detecting and intimating the faults in the distribution line and making the street lights smarter by providing the control to the lights based on the natural light and vehicle movements.

FUTURE ENHANCEMENT

In the future, enhancements to the IoT-based automated streetlight infrastructure could include predictive maintenance using machine learning, improved fault localization accuracy, dynamic adjustments based on real-time energy demand from smart grids, enhanced communication protocols for broader coverage, integration of environmental sensors for better optimization, and ensuring scalability and interoperability for future integration with smart city initiatives. These upgrades would collectively boost efficiency, resilience, and intelligence, creating safer and more sustainable urban environments.

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