A

Project Report on

GSM Based Forest Fire Alerting System

Submitted in partial fulfilment of the requirements

of the degree

Bachelor of Engineering in

Electronics and Telecommunication Engineering

by

1. Rajvardhan Satish Shinde (72155979E)
2. Suyash Amruta Khade (72155831D)
3. Rameshwar Dnyaneshwar Navgire (72155946J)
4. Amar Santosh Karande (72155819E)

Guide:

Dr. A. S. Mane

Department of Electronics and Telecommunication Engineering

Government College of Engineering and Research, Avasari (Kh),

Tal: Ambegaon, Dist: Pune

(SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE)

Year 2023-24

CERTIFICATE

This is to certify that the report entitled 'GSM based forest fire alerting System' submitted in the partial fulfillment of the requirement for the award of Bachelor of Engineering in Electronics and Telecommunication at Government College of Engineering and Research Avasari (Kh), affiliated to the Savitribai Phule Pune University, Pune and is record of their work submitted by,

1. Rajvardhan Satish Shinde (72155979E)
2. Suyash Amruta Khade (72155831D)
3. Rameshwar Dnyaneshwar Navgire (72155946J)
4. Amar Santosh Karande (72155819E)

Dr.A.S. Mane
Guide,
Electronics and Telecommunication Engineering.

Dr.M.S. Nagmode
Head of the Department,
Electronics and Telecommunication Engineering.

Date:

Place:

This report entitled

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1. Rajvardhan Satish Shinde (72155979E)
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is approved for the degree of

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Government College of Engineering and Research, Avasari (Kh)
(Savitribai Phule Pune University, Pune)

Examiners	Name	Signature
1. External Examiner	_____	
2. Internal Examiner	_____	
3. Guide	_____	

Date:

Place:

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Name :	PRN No:	Signature:
Rajvardhan Satish Shinde	72155979E	
Suyash Amruta Khade	72155831D	
Rameshwar Dnyaneshwar Navgire	72155946J	
Amar Santosh Karande	72155819E	

Date:

Place:

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ABSTRACT

The GSM-based Forest Fire Alerting System represents a crucial technological advancement in the realm of forest fire management, utilizing the widespread coverage and communication capabilities of the Global System for Mobile Communications (GSM) network. This innovative system is specifically engineered to detect and promptly respond to forest fires, providing an essential framework for early warning, rapid intervention, and coordinated emergency response.

By integrating a network of strategically placed sensors and monitoring stations, the system continuously collects real-time data on crucial environmental parameters, including temperature, humidity, and air quality, within forested areas. Through the analysis of these environmental indicators, the system employs sophisticated algorithms to detect anomalies and potential fire outbreaks, triggering immediate alerts to relevant authorities and nearby communities.

The GSM-Based Forest Fire Alerting System is characterized by its efficient communication infrastructure, enabling seamless transmission of critical information to designated stakeholders, emergency response teams, and local communities. Leveraging the ubiquity of GSM networks, the system facilitates the swift dissemination of evacuation notices, fire containment strategies, and real-time updates, fostering a coordinated and effective response to forest fire emergencies.

This abstract provides a concise overview of the GSM-Based Forest Fire Alerting System, emphasizing its role as a pivotal tool in forest fire prevention and management. By harnessing the power of GSM technology, this system not only enhances early detection and intervention but also fosters improved coordination among relevant stakeholders, thereby minimizing the detrimental impact of forest fires on both the environment and human life.

The microcontrollers of the Arduino can be programmed using C and C++ languages. When a code is written in Arduino IDE software and connected to aboard through a USB cable, Arduino boards have a lot of applications in the present-day scenario, so we have decided to do a small project on them.

Keywords: GSM, Arduino IDE, Arduino Nano, USB Cable

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List of Abbreviations

GSM- Global System of Mobile Communication

SIM- Subscriber Identity Module

LCD- Liquid Crystal Display

IDE- Integrated Development Environment.

PCB- Printed Circuit Board.

I2C- Inter Integrated Circuit.

DC- Direct Current

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CHAPTER 1

INTRODUCTION

Forest fires, also known as wildfires, refer to uncontrolled fires that occur in forestedareas, grasslands, or other natural landscapes. These fires can spread rapidly, causing significant damage to ecosystems, wildlife, and human infrastructure. Forest fires can bea natural part of certain ecosystems, playing a role in maintaining biodiversity and renewing the landscape. However, when they occur unnaturally or become unmanageable, they pose a serious threat to the environment, economy, and public safety.

1.1 Causes of Forest Fires:

1.1.1 **Natural Causes:** Some forest fires are initiated by natural events such as lightningstrikes, volcanic eruptions, or spontaneous combustion in peat bogs. Lightning strikes, in particular, are a common natural cause of forest fires in many regions.

1.1.2 **Human Activities:** A significant proportion of forest fires are caused by human activities. These activities can include campfires left unattended, discarded cigarettes, burning debris, fireworks, equipment use, and arson. Negligence, such as not fully extinguishing a campfire, or intentional acts of arson, can lead to devastating consequences.

1.1.3 **Drought and Heat:** Periods of prolonged drought and heat can create the ideal conditions for forest fires to ignite and spread quickly. Drier vegetation, combined with high temperatures and low humidity, increases the likelihood of fires starting and becoming uncontrollable.

1.1.4 **Forest Management Practices:** In some cases, forest management practices, such as prescribed burns, can unintentionally escalate into uncontrolled fires. While prescribed burns are intended to reduce the risk of larger, more destructive fires, they can sometimes get out of control due to changing weather conditions or human error.

1.1.5 **Climate Change:** Climate change is considered a significant contributing factor to the increased frequency and intensity of forest fires in many parts of the world. Rising temperatures, altered precipitation patterns, and prolonged droughts create favorable conditions for the ignition and spread of wildfires.

Understanding the various causes of forest fires is crucial for implementing effective preventive measures and developing strategies for mitigating their impact on the environment and communities. Efforts to prevent and manage forest fires include early detection, proper land management practices, community education, and the use of advanced technologies for firefighting and fire suppression

1.2 Need of System

A GSM (Global System for Mobile Communications) based forest fire alerting system is essential for early detection and prompt response to forest fires. It offers several advantages that are crucial for effective forest fire management. Some of the key needs and benefits of a GSM-based forest fire alerting system include:

1.2.1 **Timely Alerting:** With a GSM-based system in place, authorities can receive immediate alerts about potential or ongoing forest fires. This timely information enables rapid deployment of firefighting resources, minimizing the time taken to respond to the fire and reducing the risk of its escalation.

1.2.2 **Remote Monitoring:** GSM-based forest fire alerting systems can be deployed in remote forest areas where human surveillance might be limited. These systems can continuously monitor the environment for any signs of fire, providing real-time data to the relevant authorities, even in areas that are challenging to access.

1.2.3 **Improved Communication:** GSM technology allows for effective communication between different stakeholders involved in firefighting operations, including firefighters, forest rangers, and local communities. It facilitates the dissemination of critical information and instructions, ensuring a coordinated response to the fire incident.

1.2.4 **Data Collection and Analysis:** A GSM-based forest fire alerting system can gather valuable data related to fire occurrences, including location, intensity, and other environmental factors. Analyzing this data over time can provide insights into fire patterns, helping in the development of more effective preventive measures and firefighting strategies.

1.2.5 **Cost-Efficiency:** Implementing a GSM-based forest fire alerting system can be cost-effective compared to traditional surveillance methods. It can reduce the need for constant human monitoring and surveillance, leading to more efficient allocation of resources and better utilization of firefighting equipment.

1.2.6 **Integration with Geographic Information Systems (GIS):** Integrating the GSM-based system with GIS technology can enhance the effectiveness of the alerting system by providing precise location information, which can aid in efficient resource allocation and navigation for firefighting teams.

By addressing these needs, a GSM-based forest fire alerting system can play a vital role in minimizing the damage caused by forest fires and protecting both the environment and human lives.

1.3: Objective of System

The objective of a GSM-based forest fire alerting system is:

1.3.1 Provide early detection and prompt notification of forest fires.

1.3.2 Enabling swift response measures to minimize damage to the environment and human lives.

1.3.3 This system aims to facilitate effective communication, remote monitoring, and data collection for efficient forest fire management and prevention.

1.3.4 To minimize the destruction caused by forest fires.

CHAPTER 2

LITERATURE SURVEY

2.1 Literature Review

Numerous solutions have been proposed and implemented for this problem. Most common systems used in field work are video surveillance systems. Video cameras are sensitive to smoke only in day time. Fire sensitive cameras at night, using IR thermal imaging cameras for heat flux detecting and using backscattering of laser light, detect the smoke particles. This fire alert system has a few limitations because of environmental conditions like dust particles, mist, shadows and so on. Another method is automated picture capturing of fires in forest. Capturing can be done by the cameras which are placed on top of towers. A motor was introduced to give a coverage view on the forest and for its movement (Basu et al., 2018). Captured pictures are processed using program or MATLAB simulation and matching with references taken at beginning stage. This alert system has limitation of false caution rate and visual cameras installed on towers are of high cost. Another method of fire detection is by using satellite systems. Base station collects the information sent by the satellite and runs an algorithm to recognize the facts (Basu et al., 2018). The raw data of satellites are processed and then Advanced Very High Resolution Radiometer instrument is utilized to recognize hotspots. In South Korea, forest fire surveillance system was proposed by using wireless sensor networks. Wireless sensor networks detect humidity and an application analyses the collected information (Hariyanwal et al., 2013; Kumar et al., 2017). In this methodology, there is some loss of information during communication. By using temperature sensor and GPS modem, forest fire detection can be possible (Basu et al., 2018). Here, temperature sensor collected data were sent to base station by both primary and main antennas (Alahi et al., 2017). Continuous power supply was difficult for too many antennas and sensors. In addition to the above limitations climatic changes may affect the system.

2.1.1 Overview of Forest Fire Alerting Systems: A comprehensive understanding of the different types of forest fire alerting systems, including their mechanisms, components, and functionalities, as well as the specific role of GSM technology in enhancing the efficiency of these systems.

2.1.2 Technological Framework: An examination of the technological framework underlying GSM-based forest fire alerting systems, exploring the integration of GSM technology with other communication and monitoring technologies, such as GPS, GIS, and remote sensing, to enable real-time monitoring and data transmission.

2.1.3 System Architecture and Design: A review of the system architecture and design considerations, focusing on the development of sensor networks, data transmission protocols, and communication interfaces that facilitate seamless connectivity and information exchange between field devices and control centers.

2.1.4 Data Collection and Analysis: An evaluation of the methods employed for data collection, including the use of various sensors and data processing techniques to gather and analyze critical information related to fire occurrences, environmental conditions, and geographical parameters.

2.1.5 Communication Protocols and Networking: An analysis of the communication protocols utilized in GSM-based forest fire alerting systems, assessing their reliability, security, and efficiency in transmitting alerts and warnings to relevant stakeholders, as well as facilitating coordinated responses during emergency situations.

2.1.6 Case Studies and Implementations: A review of case studies and real-world implementations of GSM-based forest fire alerting systems in different geographical regions, highlighting the challenges, successes, and lessons learned from the deployment and operation of these systems in diverse forest ecosystems.

2.1.7 Evaluation of Effectiveness: An assessment of the overall effectiveness of GSM-based forest fire alerting systems in terms of their impact on early detection, response time, coordination among firefighting agencies, community engagement, and the reduction of environmental and socioeconomic losses caused by forest fires.

By conducting a comprehensive literature review, researchers can gain valuable insights into the current state of GSM-based forest fire alerting systems, identify areas for further research and improvement, and contribute to the development of more advanced and efficient forest fire management strategies.

2.2 Present system available in market

Several systems are available for forest fire detection, employing various technologies to detect, monitor, and combat forest fires. These systems often work in tandem to provide comprehensive coverage and early warning of potential fire outbreaks. Here are some of the different systems commonly used for forest fire detection:

2.2.1 Satellite-Based Systems:

Satellite-based fire detection systems use remote sensing technologies to identify and monitor wildfires from space. They can detect and track fires over large geographical areas, providing real-time data on fire hotspots, intensity, and spread. Advanced satellites equipped

with infrared sensors can detect thermal anomalies and changes in land surface temperatures, allowing for the early identification of potential fire outbreaks.

2.2.2 Remote Sensing Technologies:

Remote sensing technologies, including aerial surveillance and unmanned aerial vehicles (UAVs) equipped with sensors, cameras, and other detection devices, are used to monitor and detect forest fires from above. These systems provide high-resolution images and data that help identify fire-prone areas, assess fire behavior, and facilitate quick response and intervention.

2.2.3 Ground-Based Sensor Networks:

Ground-based sensor networks consist of a series of strategically placed sensors that detect changes in environmental conditions such as temperature, humidity, and smoke. These sensors can be integrated into a network that relays real-time information to a central monitoring station, enabling swift response to potential fire incidents.

2.2.4 Weather Monitoring Systems:

Weather monitoring systems play a crucial role in forest fire detection by providing meteorological data such as temperature, humidity, wind speed, and precipitation. Understanding weather patterns and changes is essential for predicting fire behavior and implementing proactive measures to prevent and manage forest fires effectively.

2.2.5 Community-Based Reporting Systems:

Community-based reporting systems involve the active participation of local communities in detecting and reporting potential fire incidents. These systems often rely on community engagement, education, and awareness programs to encourage timely reporting of wildfires and facilitate coordinated responses from relevant authorities.

Implementing a combination of these forest fire detection systems can significantly enhance early warning capabilities, improve response times, and help minimize the damage caused by wildfires. Effective integration of technology, community involvement, and comprehensive monitoring strategies is essential for successful forest fire management and prevention.

CHAPTER 3

SYSTEM DEVELOPMENT

3.1: Block Diagram

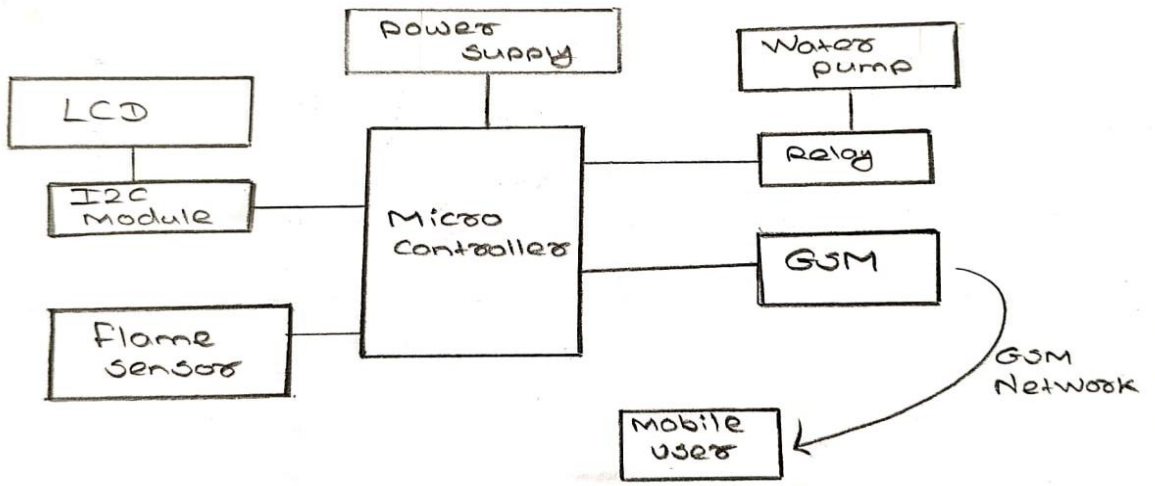

Fig. 3.1 Block Diagram

As shown in the schematic block diagram, the project consists of Flame sensor, Arduino Nano & SIM800L GSM as its primary components. The fire can be detected by the flame sensor which gives a digital output that corresponds to the Fire status and is received by the Arduino Nano. When the sensor detects fire in the atmosphere, it will give digital output 1 and if Fire in not detected the sensorwill give digital output 0. Arduino will receive the sensor output as digital input. If the sensoroutput is high, then the buzzer will start tuning along with the LCD that will show that “Fire detected: Yes”. If the sensor output is low then buzzer will not be tuning, and the LCD will show that “Fire detected: No”. If fire is detected then message through GSM Module is received by the user.

3.2 Hardware

3.2.1 Arduino Nano

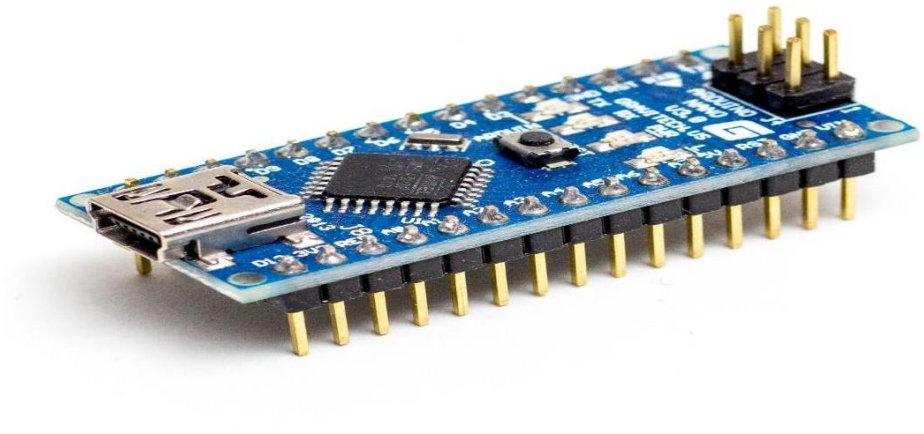

Fig. 3.2.1 Arduino Nano

The **Arduino Nano** is an open-source breadboard-friendly microcontroller board based on the **Microchip** ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.

The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery.

TECHNICAL SPECIFICATIONS:

1. Microcontroller: Microchip ATmega328P
2. Operating voltage: 5 volts
3. Input voltage: 5 to 20 volts
4. Digital I/O pins: 14 (6 optional PWM outputs)
5. Analog input pins: 8
6. DC per I/O pin: 40 mA
7. DC for 3.3 V pin: 50 mA
8. Flash memory: 32 KB, of which 2 KB is used by bootloader
9. SRAM: 2 KB
10. EEPROM: 1 KB
11. Clock speed: 16 MHz

3.2.2 GSM Sim800L module

Fig. 3.2.2 GSM Sim800L module

The **SIM800L** is a GSM module from Simcom that gives any microcontroller GSM functionality, meaning it can connect to the mobile network to receive calls and send and receive text messages, and also connect to the internet using GPRS, TCP, or IP. Another advantage is that the board makes use of existing mobile frequencies, which means it can be used anywhere in the world.

Features and Specifications:

1. Full modem serial port
2. Two microphone inputs and speaker output
3. SIM card interface
4. Supports FM and PWM
5. Sleep mode with 0.7mA current

3.2.3 Flame Sensor

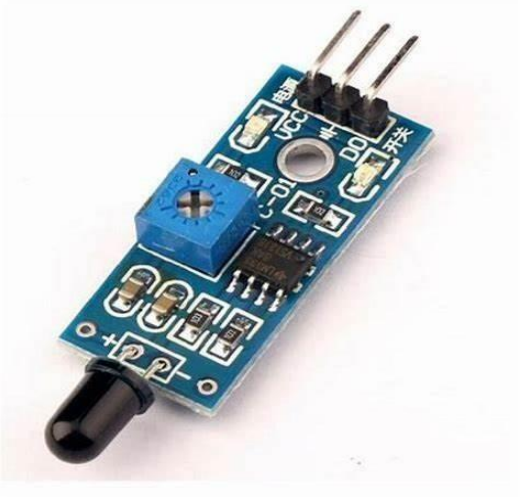

Fig 3.2.3 Flame Sensor

A sensor which is most sensitive to a normal light is known as a flame sensor. That's why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source. This sensor can be easily damaged to high temperature. So this sensor can be placed at a certain distance from the flame. The flame detection can be done from a 100cm distance and the detection angle will be 600. The output of this sensor is an analog signal or digital signal. These sensors are used in fire fighting robots like as a flame alarm.

A flame-sensor is one kind of detector which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The flame detection response can depend on its fitting. It includes an alarm system, a natural gas line, propane & a fire suppression system. This sensor is used in industrial boiler

The pin configuration of this sensor is shown below. It includes four pins which include the following. When this module works with a microcontroller unit then the pins are

1. Pin1 (VCC pin): Voltage supply rages from 3.3V to 5.3V
2. Pin2 (GND): This is a ground pin
3. Pin3 (AOUT): This is an analog output pin (MCU.IO)
4. Pin4 (DOUT): This is a digital output pin (MCU.IO)

3.2.4 I2C Module

Fig 3.2.4: I2C Module

I2C Module has an inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version you have check the black I2C adaptor board on the underside of the module. I2C communication protocol module is used to convert 16 pins of LCD to 4 they are:

1. GND
2. VCC
3. SDA
4. SCL

SPECIFICATION AND FUTURES:

1. 1.Compatible with Arduino UNO, Mega, Micro, Nano, Mini
2. I2C Address: 0x20-0x27(0x20 default).
3. Back lit (Blue with white char colour).
4. Supply voltage: 5V.
5. Interface: I2C/TWI x1,Gadgeteer interface x2
6. Adjustable contrast
7. Size: 82 x 35 x 18 mm (3.2×1.4×0.7 in)
8. White text on the Blue background.
9. Interface Address: 0x27
10. Character Color: White
11. Backlight: Blue

3.2.5 16x2 LCD Display

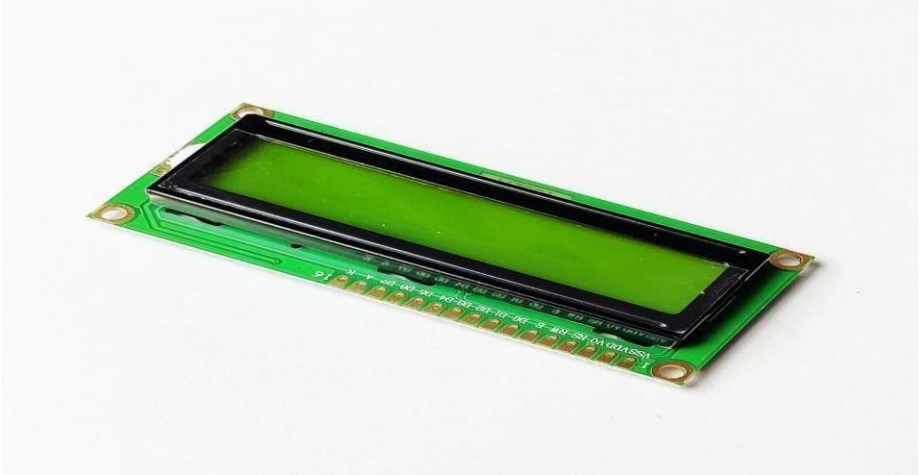

Fig. 3.2.5.1 16x2 LCD Display

In LCD 16×2, the term LCD stands for Liquid Crystal Display that uses a plane panel display technology, used in screens of computer monitors & TVs, smartphones, tablets, mobile devices, etc. Both the displays like LCD & CRTs look the same but their operation is different. Instead of electrons diffraction at a glass display, a liquid crystal display has a backlight that provides light to each pixel that is arranged in a rectangularnetwork.

An electronic device that is used to display data and the message is known as LCD 16×2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots.So the total pixels within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.

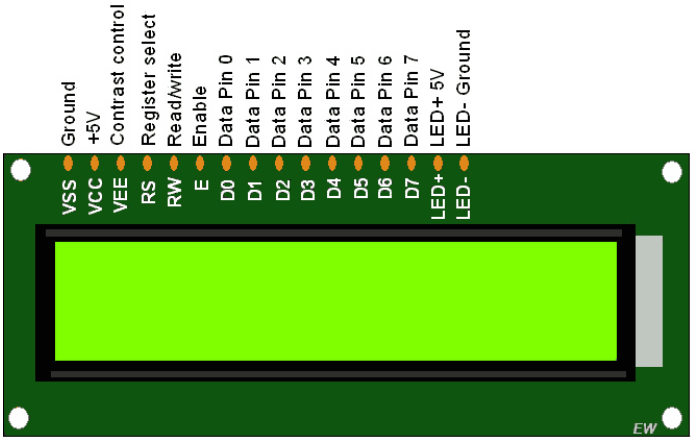

Fig. 3.2.5.2 16 X 2 LCD Display pin configuration

Pin Configuration: -

• Pin1 (Ground): This pin associates the ground terminal.
• Pin2 (+5 Volt): This pin gives a +5V supply to the LCD
• Pin3 (VE): This pin chooses the difference of the LCD.
• Pin4 (Register Select): This pin is utilized to interface an information pin of a MCU and gets either 1 or 0. Here, information mode = 0 and order mode =1.
• Pin5 (Read and Compose): This pin is utilized to peruse/compose information.
• Pin6 (Empower): This empowers the pin should be high to play out the Read/Compose strategy. This pin is associated with the information pin of the microcontroller to continually be held high.
• Pin7 (Information Pin): The information pins are from 0-7 which are associated through the microcontroller for information transmission. The LCD module can likewise work on the 4-bit mode through chipping away at pins 1, 2, 3 and different pins are free.
• Pin8 - Information Pin 1
• Pin9 - Information Pin 2
• Pin10 - Information Pin 3
• Pin11 - Information Pin 4
• Pin12 - Information Pin 5 • Pin13 - Information Pin 6
• Pin14 - Information Pin 7
• Pin15 (Drove Positive): This is a +Ve terminal of the backdrop illumination Drove of the showcase and it is associated with +5V to initiate the Drove backdrop illumination.
• Pin16 (Drove Negative): This is a - Ve terminal of a backdrop illumination Drove of the showcase and it is associated with the GND terminal to enact the Drove backdrop illumination.

3.2.6 5V Single Channel Relay

Fig 3.2.6 5V Single Channel Relay

A single-channel relay module that works with 5V DC is known as a 5V single-channel relay module. The input voltage of this module is taken from any logic chip or microcontroller that gives a digital signal as an output. This module is an electromagnetic switch that is operated electrically to control a circuit by turning it ON/OFF.

The channels are labeled for their function: common (COM), normally closed (NC), and normally open (NO). On the other side of the module, there are three pins – a Ground pin and a VCC pin to power the module, and an input pin IN to control the relay. The input pin is active low, meaning the relay will be activated when you pull the pin LOW, and it will become inactive when you pull the pin HIGH.

Specifications:

- Channel – 1
- Trigger Voltage(VDC) – 5 V
- Switching Voltage (VAC) – 250@10A
- Switching Voltage (VDC) – 30@10A

3.2.7 Jumper wires

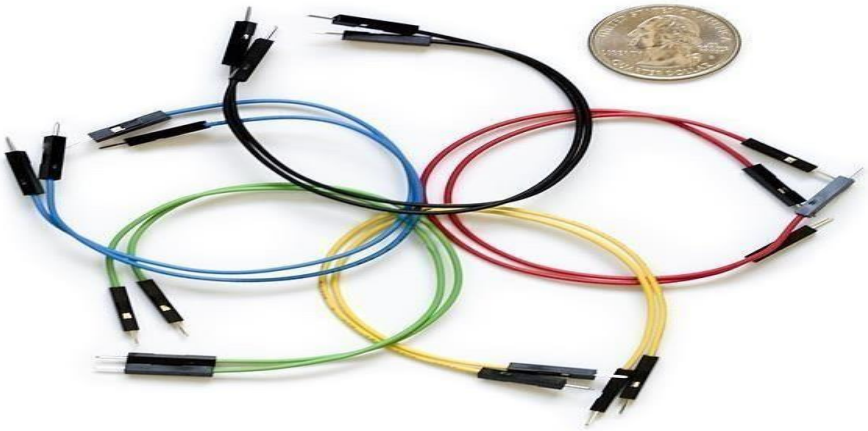

Fig. 3.2.7 Jumper Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires.

3.2.8 Water Pump

Fig 3.2.8 Water Pump

This is a low cost mini submersible type water pump that works on 3-6V DC. It is extremely simple and easy to use. Just immerse the pump in water, connect a suitable pipe to the outlet and power the motor with 3-6V to start pumping water. Great for building science projects, fire-extinguishers, fire fighting robots, fountains, waterfalls, plant watering systems etc.

This motor is small, compact and light. It can be controlled from a micro controller/Arduino using our DC Motor Drivers or one of our Relay Boards. You may use our 5V SMPS Power Supply Adapter to run this pump. You may also use our 6V Solar Panel to run the pump with appropriate a 6V voltage regulator.

3.2.9 Battery

Fig. 3.2.9 Battery

Battery:

The nine-volt battery, or 9-volt battery, is an electric battery that supplies a nominal voltage of 9 volts. Actual voltage measures 7.2 to 9.6 volts, depending on battery chemistry. Batteries of various sizes and capacities are manufactured; a very

common size is known as PP3, introduced for early transistor radios. The PP3 has a rectangular prism shape with rounded edges and two polarized snap connectors on the top. This type is commonly used for many applications including household uses such as smoke and gas detectors, clocks, and toys.

3.2.10 Capacitor:

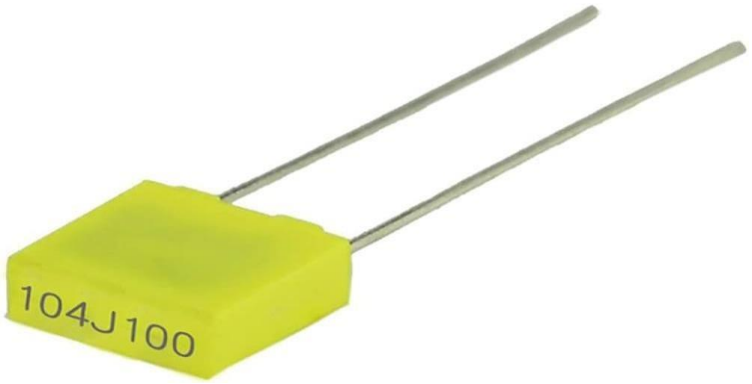

Fig: 3.2.10 Capacitor

Capacitor labelled as "104J100" is a ceramic capacitor with a capacitance of 100nF and a tolerance of ±5%, rated for 100 volts.

3.2.11 Zero PCB:

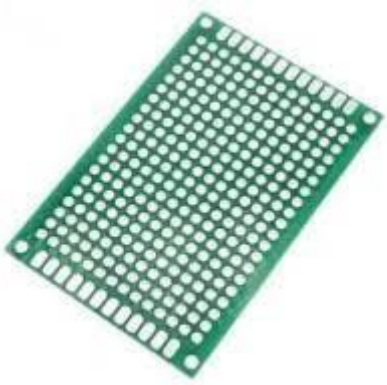

Fig:3.2.11 Zero PCB

Zero PCB is basically a general-purpose printed circuit board (PCB), also known as perfboard or DOT PCB. It is a thin rigid copper sheet with holes pre-drilled at standard intervals across a grid with 2.54mm (0.1-inch) spacing between holes. Each hole is encircled by a round or square copper pad so that component lead can be inserted into the hole and soldered around the pad without short-circuiting the nearby pads and other leads. For connecting the lead of component with another lead, solder these together or join these using a suitable conducting wire.

3.3 Circuit Diagram and Explanation:

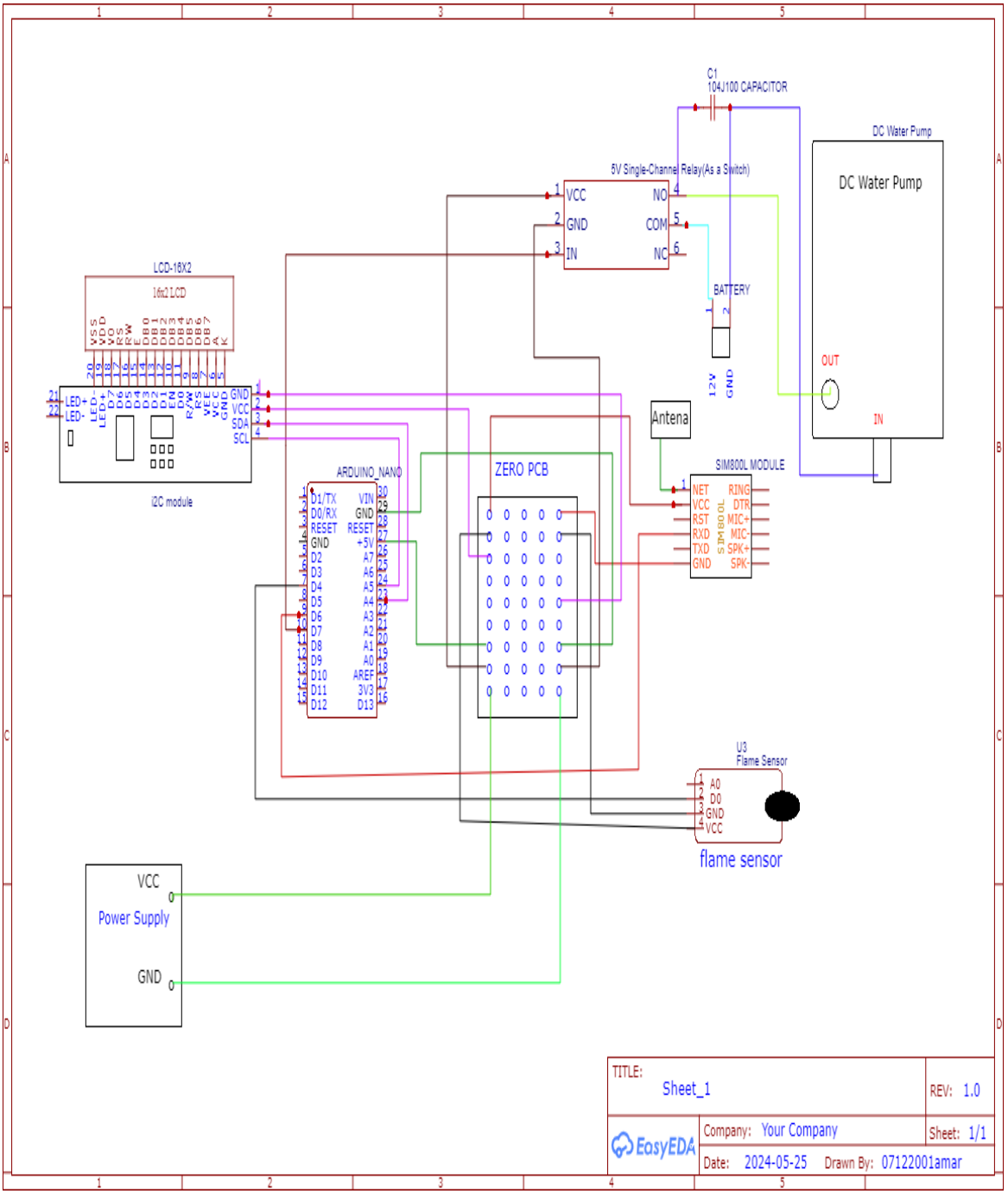

Fig 3.3.1 Circuit Diagram

Working:

The whole design of the system is based mainly based on GSM Sim module. Which is used for sending messages and calling purpose. There is basically two parts included in this project, the first one is hardware & second one is software. The hardware part has various sensors which is used for detecting fire in forsts and send data to Arduino nano .

In that Arduino atmega328p converts the analog values to digital one & LCD display shows the alerting message on display screen. And the GSM send the alerting message to the respected authority.

In software we developed a program based on embedded C language that is used to connects the hardware and software together for displaying and continuously uploading the fir sensor value. In this system LCD is shows the monitoring message on their screen.

The Zero PCB is designing for to provide voltage for all components of detection system. When the system get started DC current given to the kit and Arduino, Flame sensor, relay, GSM sim module and to the LCD. If the fire sensor detects any fire in their area at will shows fire alert message on their screen.

The GSM module continuously sends the Fire alert message to the recipients mobile and the Arduino Nano triggered the relay and the relay switch on motor and the motor is start to spreads the water in their areas and start to distinguish the fire. The motor distinguishes the fire but if he is not distinguishing full of fire but the message sends to officer mobile it comes in forest and distinguish full fire.

By integrating additional components like the LCD and motor, this forest fire alerting system not only detects fires and sends alerts but also provides visual and physical feedback to enhance situational awareness and response capabilities.

Hardware Setup:

1. Connect the flame sensor to one of the digital pins of the Arduino Nano.
2. Connect the relay module to another digital pin of the Arduino Nano.
3. Connect the GSM module to the Arduino Nano, establishing the necessary serial
    a. Communication.
4. Connect the LCD to the Arduino Nano using its appropriate interface I2C.
5. Connect a motor to one of the digital pins of the Arduino Nano and connect to relay module for as switching on and off

Programming:

1. Write the Arduino sketch to read data from the flame sensor.
2. When the flame sensor detects a fire, trigger the relay to activate the warning system.
3. Simultaneously, send an alert message via the GSM module to predefined phone numbers.
4. Display relevant information such as fire status and instructions on the LCD screen.
5. Activate the motor to create waterflow for extinguish the fire.

Alerting Mechanism:

1. When the flame sensor detects a fire, the relay is triggered to activate the motor and alert.
2. The Arduino Nano simultaneously sends a text message alert through the GSM module, notifying authorities or relevant stakeholders about the fire.
3. Information about the fire is displayed on the LCD screen for quick reference.
4. The motor can be activated waterflow for extinguish the fire and potentially aiding in firefighting efforts.

3.3.1 Advantages

A GSM-based forest fire alerting system offers several advantages:

1. **Real-time monitoring:** The system can provide real-time monitoring of forest areas, allowing for early detection and rapid response to forest fires.

2. **Remote operation:** It can be operated remotely, enabling authorities to monitor forests from a distance and receive alerts without the need for constant physical presence.

3. **Cost-effective:** Compared to traditional monitoring methods, such as manned towers or patrols, a GSM-based system can be more cost-effective over the long term.

4. **Scalability:** The system can be easily scaled to cover large forested areas, providing comprehensive coverage and reducing the risk of fires going undetected.

5. **Integration with other systems:** It can be integrated with other systems, such as weather monitoring stations or fire suppression systems, to enhance overall effectiveness.

6. **Timely alerts:** Authorities can receive timely alerts about potential fire outbreaks, allowing them to respond quickly and minimize the damage caused by fires.
7. **Improved response times:** With real-time alerts, response times can be significantly reduced, increasing the chances of containing fires before they spread extensively.

8. **Data collection and analysis:** The system can collect data on fire incidents, which can be used for analysis and to improve future fire prevention and response strategies.

9. **Reduced risk to personnel:** By enabling remote monitoring, the system can help reduce the risk to personnel involved in fire detection and monitoring activities.

Overall, a GSM-based forest fire alerting system can significantly improve the efficiency and effectiveness of forest fire management efforts.

3.3.2 Algorithm

Step 1: System Initialization

1.1 Power up the Arduino Nano

1.2. Initialize communication with all connected sensors.

1.3. Initialize GSM module for SMS communication.

1.4. Set threshold values for temperature and fire detection.

Step 2: Continuous Monitoring Loop

2.1. Continuously read data from flame sensor.

2.2. **If fire is detected:** * Formulate an SMS alert message and send the SMS alert message to pre-defined phone numbers (forest department, firefighters) using the GSM module.

Step 3. System Maintenance

3.1. Implement a timer or schedule for periodic checks on sensor functionality and GSM module connectivity.

3.2. Designate a low battery threshold for the power supply and trigger an alert if battery levels fall below the threshold.

Step 4: Additional Considerations:

4.1 You can incorporate multiple sensors for better fire detection accuracy. For instance, include fire detection alongside temperature and smoke sensors.

4.2 The system can be solar-powered for remote deployments.

4.3 Consider implementing real-time data transmission using cellular data (GPRS) instead of SMS for faster alerts and potential integration with a forest fire monitoring dashboard.

4.4 The GSM module can be programmed to accept acknowledgement messages from receivers to confirm receipt of the alert.

3.3.4 Flow Chart

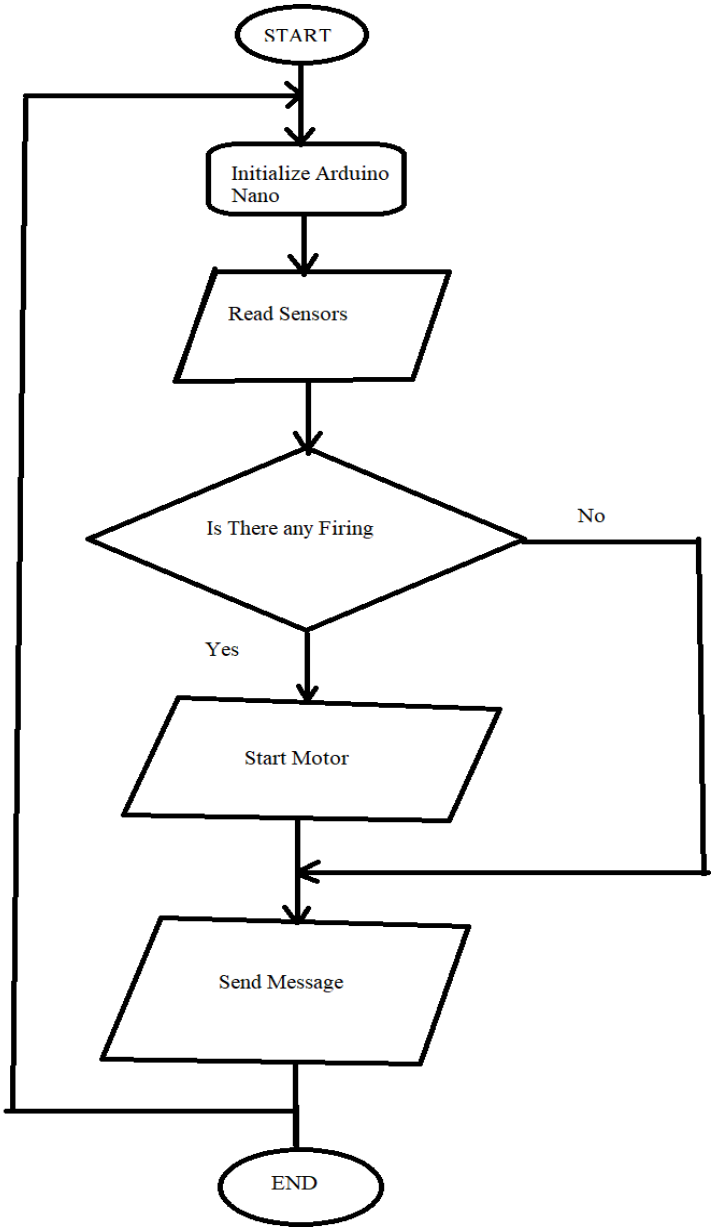

Fig 3.3.4 Flowchart

3.4 Software Used and Code

3.4.1 Easy EDA

EasyEDA is an easier and powerful online PCB design tool that allows electronics engineers, educators, students, makers, and enthusiasts to design and share their projects. This is a design tool integrated LCSC components catalog and JLCPCB PCB service that helps users to save time to make their ideas into real products.

3.4.2 Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload codeto the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

3.4.3 Project CODE:

```
#include <SoftwareSerial.h>

#define GSM_RX 3 // GSM module RX pin connected to Arduino pin 2
#define GSM_TX 2 // GSM module TX pin connected to Arduino pin 3

const int buttonPin = 4; // the number of the pushbutton pin
const int ledPin = 7;
int buttonState = 0;
#include <LiquidCrystal_I2C.h>
// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x27, 16, 2);

SoftwareSerial gsmSerial(GSM_RX, GSM_TX); // Create a software serial port for GSM
module

void setup() {pinMode(ledPin, OUTPUT);
digitalWrite(ledPin, HIGH);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
  lcd.begin();

  // Turn on the blacklight and print a message.
  lcd.backlight();
 // attaches the servo on pin 9 to the servo object
   Serial.begin(9600);
   lcd.setCursor(0,0);          //sets the cursor at row 0 column 0
   lcd.print("FOREST FIRE"); // prints 16x2 LCD MODULE
   lcd.setCursor(2,1);          //sets the cursor at row 1 column 2
   lcd.print("monitoring");
   delay(4000);
   lcd.clear();
   Serial.begin(9600); // Start serial communication for debugging
   gsmSerial.begin(9600); // Start serial communication with GSM module
}

void loop() {
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed. If it is, the buttonState is HIGH:
     if (buttonState ==LOW) {
  // turn LED on:
    digitalWrite(ledPin, LOW);
     lcd.setCursor(0,0);          //sets the cursor at row 0 column 0
     lcd.print("FIRE DETECTED");
```

```
    sendSMS("+919373705391", "FIRE DETECTED"); // Replace +1234567890 with the
recipient's phone number
   delay(5000); // Delay to avoid sending multiple messages for a single tilt event
   sendSMS("+919356073951", "FIRE DETECTED");

  } else {   lcd.setCursor(0,0);          //sets the cursor at row 0 column 0
    lcd.print("MONITORING");
   // turn LED off:
     digitalWrite(ledPin, HIGH);
  }


  delay(1000);
  // Check if the accelerometer is tilted beyond a certain threshold

}

void sendSMS(String number, String message) {
  gsmSerial.println("AT+CMGF=1"); // Set SMS mode to text
  delay(1000);
  gsmSerial.println("AT+CMGS=\"" + number + "\""); // Set the recipient's phone number
  delay(1000);
  gsmSerial.print(message); // Send the message
  delay(1000);
  gsmSerial.write(26); // ASCII code of CTRL+Z
  delay(1000);
}
```

CHAPTER 4

RESULT AND DISCUSSION

4.1 System Testing Result:

When we giving the external power supply to the Arduino Nano that time Arduino starts blinking its internal LED to indicating that the system is start to work also that time we provide supply GSM module, Flame sensors, relay and LCD throughout the Arduino and that time all these sensors internal LEDs ON and they indicating that the system is start to detecting and monitoring fire. Following table shows the Systems multiple parameters conditions when the external supply is applied to it :

Sr. No.	Power Supply ON/OFF	Arduino Nano	LCD Display	Flame Sensor	GSM Sim Module	Relay
1.	ON	ON	ON	ON	ON	ON
2.	OFF	OFF	OFF	OFF	OFF	OFF

Table 4.1 System testing results

4.2 LCD Output

Whenever the supply is ON Arduino provides the supply to the 16X2 LCD display to turn ON and when the LCD is turned on that shows the monitoring message on their screen . Arduino also provides the sensors output values to LCD display to show these values continuously. Following the figure 4.2.1 shows the monitoring message continuously.

Fig 4.2.1 Monitoring message

So, when the flame sensor detect flame in forest in there range it gives instruction to Arduino Nano and shows “FIRE DETECTED” message on the LCD display. Following fig 4.2.2 shows the LCD message.

Fig 4.2.2 Fire Detected Message

After some time when the fire distinguishes, the flame sensor continuously detected and display “MONITORINGTED” message on the display screen s shown in fig 4.2.3

Fig: 4.2.3 Monitoringted message

The implementation of a GSM-based forest fire alerting system yields significant results in enhancing the overall management and mitigation of forest fire incidents. One of the primary outcomes is the system's ability to ensure early detection of fires.

4.3 Mobile Message:

When the fire detected by flame sensor the flame sensor gives instruction to Arduino Nano and the Arduino Nano send “FIRE DETECTED” message on the recipient’s mobile using the GSM sim module which is shown in following fig 4.3.1.

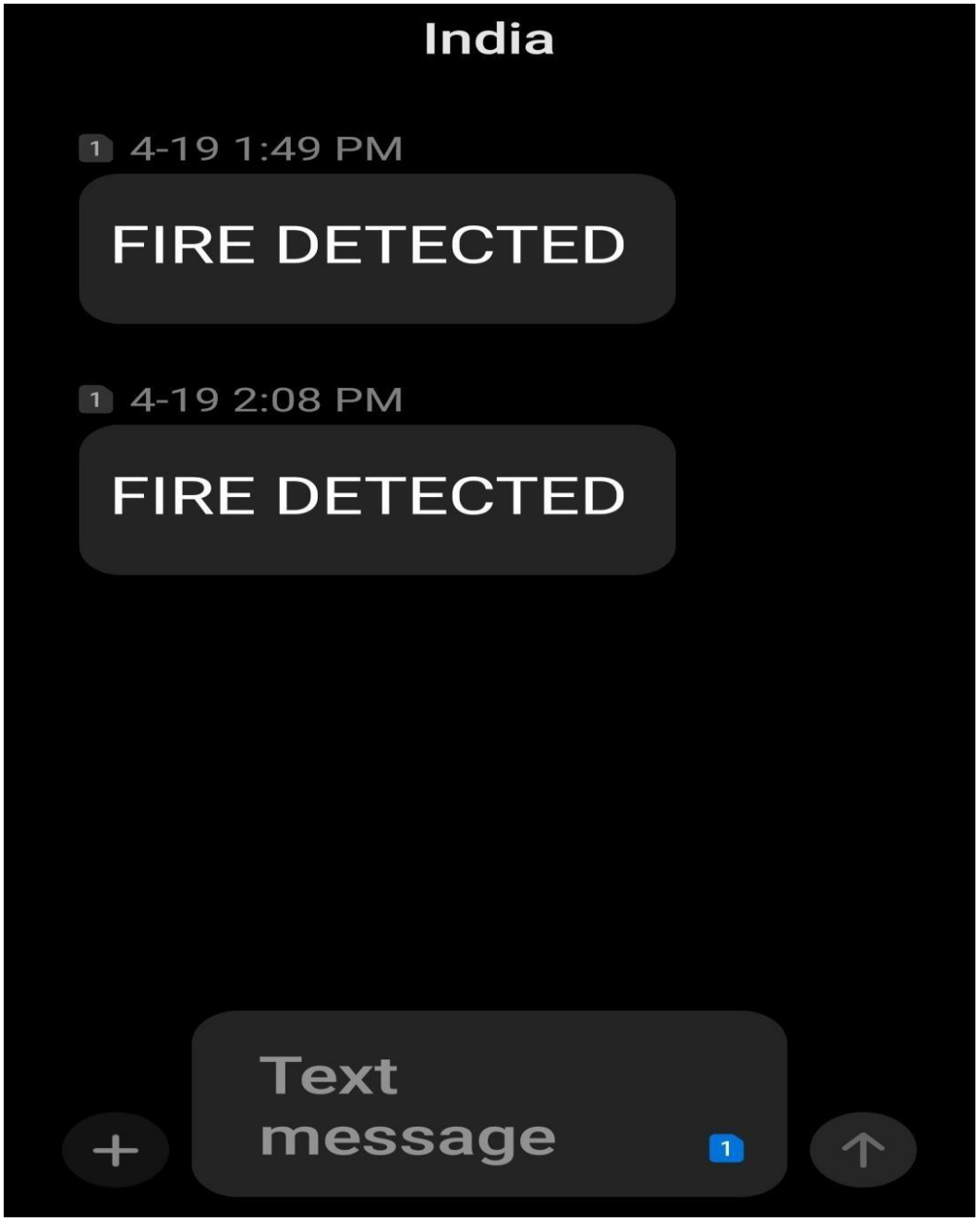

Fig: 4.3.1 Mobile Message

By improving communication and facilitating seamless coordination between firefighting teams, local authorities, and communities, the system enhances the overall efficiency of emergency response efforts.

4.4: Actual Setup of Project: -

We designed and implemented the final setup of our project GSM based forestfire alert system as per above mentioned and this setup fulfill all the requirements, weare solving using this project.

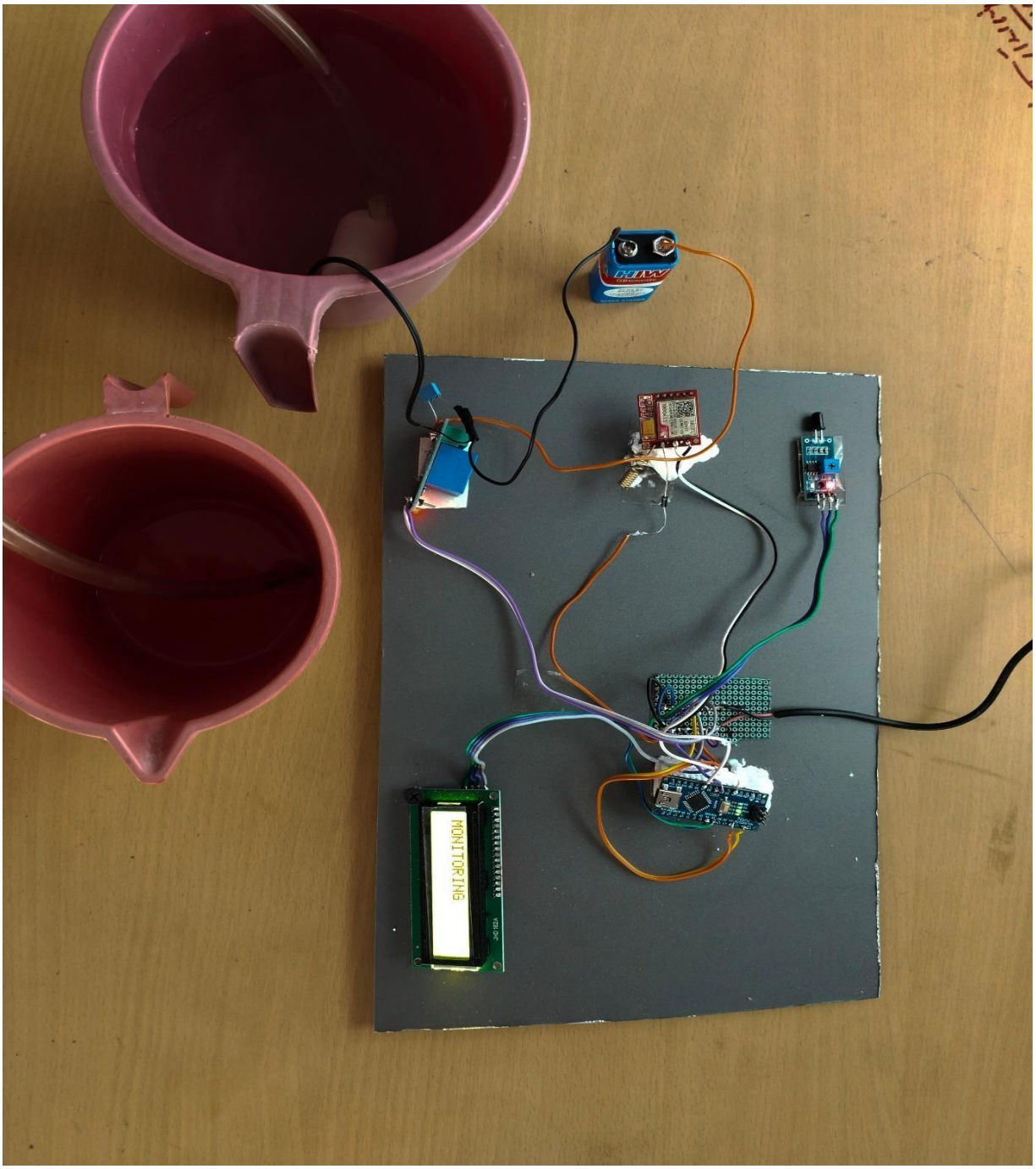

Fig 4.4.1 Final Project Setup

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

In conclusion, the GSM-based forest fire alerting system represents a crucial technological advancement in the realm of forest fire management and prevention. Its ability to provide early detection, timely alerting, and efficient communication has significantly enhanced the overall response to forest fire incidents. By enabling swift mobilization of resources and effective coordination among relevant stakeholders, the system has demonstrated its instrumental role in minimizing the impact of forest fires on both the environment and human lives. The integration of data analysis and insights has further contributed to the development of proactive strategies and long-term management plans, ensuring a more sustainable approach to forest fire prevention and mitigation. The system's comprehensive capabilities, including optimized resource allocation and improved safety measures, have reinforced its position as a critical tool in safeguarding natural ecosystems and biodiversity while protecting communities from the devastating consequences of forest fires. Moving forward, continued research and advancements in GSM-based technologies are essential to further strengthen the system's effectiveness and resilience in addressing the evolving challenges posed by forest fire incidents.

5.2 Future Scope

The future scope of the GSM-based forest fire alerting system holds promising potential for further advancements and integration with cutting-edge technologies. One significant avenue of development lies in the refinement of sensor technology to enable more precise and comprehensive detection of early fire indicators, including the integration of advanced imaging and multispectral analysis for enhanced accuracy. Furthermore, the incorporation of artificial intelligence and machine learning algorithms presents an exciting opportunity to improve the system's predictive capabilities, enabling it to anticipate and prevent potential fire outbreaks more effectively. The integration of satellite-based monitoring and geospatial analysis can enhance the system's coverage and provide a broader perspective on forest fire dynamics, aiding in more comprehensive monitoring and management of larger forested areas. Additionally, the development of more energy- efficient and sustainable power solutions, such as advanced battery technologies and renewable energy sources, can ensure prolonged and uninterrupted operation of the system in remote forested regions. Collaborative research initiatives and partnerships between technology developers, environmental agencies, and governmental bodies are essential to harness the full potential of the GSM-based forest fire alerting system, paving the way for more resilient and adaptive solutions that can effectively address the growing challenges posed by forest fires in the future.

CHAPTER 6

REFERENCES

Here are some references that can provide further information on GSM-based forest fire alerting systems:

- M. N. Choudhary, P. K. Dalela, and S. K. Pattnaik, "Forest Fire Detection and Monitoring System Using GSM Technology," International Journal of Scientific and Research Publications, vol. 4, issue 2, February 2014.

- K. Ghose, A. Ghosh, and S. M. Sarkar, "Design and Development of GSM-Based Forest Fire Detection and Monitoring System," 2018 International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), October 2018.

- M. H. Lee, C. H. Yeh, and C. H. Hsu, "An Integrated System for Forest Fire Detection and Monitoring Using Wireless Sensor Networks," Sensors, vol. 11, no. 8, pp. 7800-7825, August 2011.

- K. Sharma, N. Chandra, and S. N. Singh, "Wireless Sensor Network Based Forest Fire Detection and Monitoring System: A Review," 2017 International Conference on Trends in Electronics and Informatics (ICEI), May 2017.

- P. K. Bhoi, S. K. Lenka, and S. K. Pattnaik, "Design of a GSM Based Forest Fire Monitoring System Using Raspberry Pi," 2016 International Conference on Advances in Computing, Communications and Informatics (ICACCI), September 2016.

CHAPTER 7

APPENDIX

Component Price:

Component	Price
Arduino Nano	632
GSM SIM800L Module	799
Flame Sensor	110
I2C Module	80
5V Single Channel Relay	40
8mm DIP LED Green/Red	69
Jumper Wires	75
16x2 LCD Display	300
9V Battery, Clip Connector	120
5V Buzzer	50
Resisters	60
Water Pump	106