IOT ENABLED FIRE EXTINGUISHING ROBOT

A PROJECT REPORT

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In partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

in

INFORMATION TECHNOLOGY

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM

(An Autonomous Institution Affiliated to Anna University, Chennai)

APRIL 2025

K.L.N. COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University, Chennai)

BONAFIDE CERTIFICATE

Certified that is project report **"IOT ENABLED FIRE EXTINGUISHING ROBOT"** is the bonafide work of **"Ms.K.ANBARASI(Reg.No.910621105009), Ms.R.ASHA (Reg.No.910621105011), M s . M.ISHRATH MASHUDA(Reg.No.910621105030)"** who carried out the project work under my supervision during JANUARY 2025 - APRIL 2025.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

Any work would be unfulfilled without a word of thanks. We hereby take pleasure in acknowledging the persons who guided me throughout our work.

First and foremost, thanks are to the omnipotent for providing us with his abundant blessings all throughout. We all extend our heartfelt thanks to **Er. K.N.K. KARTHIK, B.E.,** President of our college and **Dr.A.V. RAMPRASAD, M.E., Ph.D.,** Principal for provisioning us with the all required.

We esteem our self to articulate our sincere thanks to **Dr.P.GANESH KUMAR, M.E.,Ph.D.,** Head of the Information Technology for leading us towards the zenith of success.

We express our grateful thanks to our **Supervisor Dr. P. GANESH KUMAR, M.E., Ph.D.,** and **Project Coordinator Dr. S. ILANGOVAN, M.E., Ph.D.,** for their invaluable guidance and motivation. Their assistance and advices had been very helpful throughout our project. I would like to thank all teaching and non-teaching staffs of our department who had been the sources of encouragement and ideas. I thank them for lending their support whenever needed.

ABSTRACT

The **IoT-Enabled Fire Extinguishing Robot** is a compact and cost-effective solution designed to enhance fire safety by autonomously detecting and extinguishing fires while providing real- time updates to users. Utilizing flame sensors and smoke detectors, the robot accurately identifies fire sources and navigates towards them using motorized wheels equipped with obstacle detection sensors for smooth movement. Upon detecting a fire, it activates an integrated water spraying unit or CO_2 extinguisher to effectively suppress the flames. The system leverages IoT connectivity to send real-time alerts and fire status updates to the user's mobile device, enabling remote monitoring and control through a dedicated mobile application. Suitable for residential, commercial, and industrial settings, this project combines IoT and robotics to facilitate early fire suppression, thereby reducing fire-related risks and damages. It represents a significant advancement in fire safety technology by integrating fire detection, autonomous navigation, suppression, and real-time communication into a single efficient system. The project contains the following Sustainable Development Goal: Industry, Innovation, and Infrastructure, and Sustainable Cities and Communities.

Keywords: Internet of Things, Sensor-Based Automation, Real-Time Fire Monitoring, Flame Sensor Technology, Obstacle Avoidance Robot.

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1.INTRODUCTION

1.1 INTRODUCTION

Fire accidents are a significant threat to life, property, and the environment, leading to substantial economic losses and, in severe cases, loss of human lives. Traditional fire detection and suppression systems often rely on manual intervention, which can be delayed due to human error, accessibility challenges, or hazardous environments. Rapid response and efficient fire suppression are crucial to minimizing damage and preventing the spread of fire. This project presents an IoT-Enabled Fire Extinguishing Robot designed to autonomously detect and extinguish fires while providing real-time alerts and status updates to users. The robot utilizes flame sensors and smoke detectors to identify fire sources and autonomously navigates towards the fire using motorized wheels equipped with obstacle detection. An integrated water spraying unit or CO_2 extinguisher is activated to suppress the flames. The system's IoT connectivity ensures remote monitoring and control through a dedicated mobile application, enhancing user safety and situational awareness.

1.2 PROBLEM STATEMENT

Fire accidents pose serious threats to life, property, and the environment, often escalating rapidly due to delayed human intervention and limited coverage of traditional fire safety systems. Conventional methods, such as manual extinguishers and fixed sprinklers, are constrained by accessibility and mobility issues, putting human lives at risk, especially in hazardous environments. To address these challenges, there is a need for an autonomous, mobile fire extinguishing solution capable of early fire detection, navigation, suppression, and real-time communication.

1.3 PROJECT OBJECTIVE

The objective of this project is to design and develop an IoT-Enabled Fire Extinguishing Robot capable of autonomously detecting and extinguishing fires while providing real-time alerts and status updates to users. By integrating flame sensors, obstacle detection, and an efficient fire suppression system with IoT connectivity, the robot aims to enhance fire safety through early fire detection, accurate navigation, and remote monitoring, ultimately minimizing fire-related risks and damages in residential, commercial, and industrial environments.

1.4 SCOPE OF THE PROJECT

1.4.1 EXISTING SYSTEM

Traditional fire safety systems, such as manual extinguishers, fixed sprinklers, and smoke detectors, are limited by fixed installation points and require human intervention, leading to delayed responses and increased risks in hazardous conditions. These systems also lack mobility, intelligent navigation, and real-time communication, making them less effective in preventing fire spread. Additionally, advanced automated systems are often expensive and unsuitable for small-scale applications, highlighting the need for a more adaptable and efficient fire safety solution.

1.4.2 PROPOSED SYSTEM

In the proposed system, The Fire Fighting Robot, powered by Arduino, is an efficient and affordable solution designed to autonomously detect and extinguish fires while providing real-time user updates. Equipped with flame sensors, it identifies the fire’s presence and direction, navigates using motorized wheels, and activates a water spraying unit to suppress flames. This system integrates detection, suppression, and remote monitoring, enhancing fire safety in residential, industrial, and various other environments.

1.5 SOFTWARE LIFE CYCLE MODELS

SOFTWARE LIFE CYCLE

The period of time that start when a software is conceived and end when the product no longer available for use. The Software Life Cycle typically includes:

- Requirement phase
- Design phase
- Implementation phase
- Test phase
- Installation and checkout phase
- Operation and maintenance phase

REQUIREMENT PHASE

The goal is to understand exact requirements of the customer and document them properly.

DESIGN PHASE

The goal is to transform the requirements specification into a structure that suitable for implementation in some programming language.

IMPLEMENTATION PHASE

Design representations are translated into actual programs (Design is implemented).

TEST PHASE

After a system has been developed, it is very important to check if it the customer requirements. For this purpose, testing of the system is done. The major activities are centered around the examination and modification the code.

INSTALLATION AND CHECKOUT PHASE

Implementation of system means putting up system on user’s site.Acceptance testing ensures that the system meets all the requirements. If it fulfills the needs then the system is accepted by the customer and put into use.

OPERATION AND MAINTENANCE PHASE

The purpose of this phase is to preserve the value of software over time. This phase may span for 5 to 50 years whereas development may be 1 to 3 years. Software and Hardware maintenance is a very broad activity that includes error correction, enhancement of capabilities, deletion of obsolete, capabilities, and optimization. This is very crucial for the system’s life.

1.5.1 TYPES

The common lifecycle models are

- Spiral model
- Waterfall model
- Throwaway prototyping model
- Evolutionary prototyping model
- Incremental/iterative development
- WIN/WIN Spiral model

1.5.2 V - MODEL

V-Model also referred to as the Verification and Validation Model. In this, each phase of SDLC must complete before the next phase starts. It follows a sequential design process same as the waterfall model. Testing of the device is planned in parallel with a corresponding stage of development.

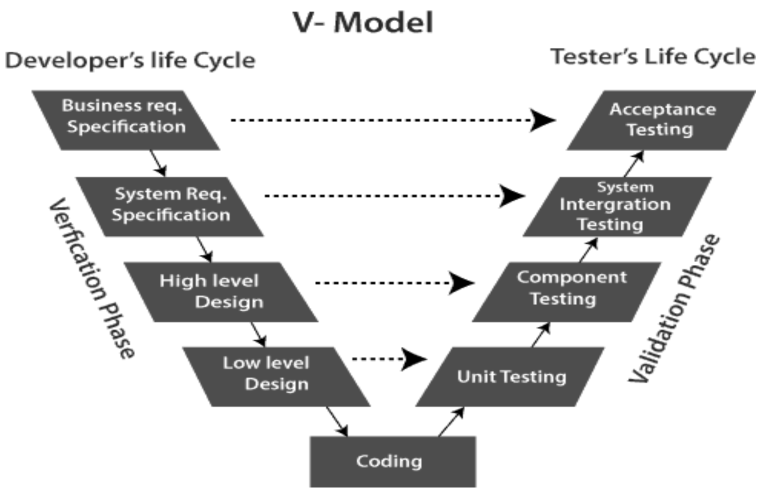

Fig 1.5.2.1 V - model

1.5.3 REASON FOR CHOOSING THIS MODEL

- Clear structure and discipline.
- Testing starts early, reducing chances of defects.
- Ideal for projects with well-defined, stable requirements.
- Each phase has a clear deliverable and review process.

2.LITERATURE SURVEY

2.1 INTRODUCTION

The literature review has been done to know about the different types of communications used according to time and technology changes.

2.2 LITERATURE REVIEW

[1] S. F. Sulthana, C. T. A. Wise, C. V. Ravikumar, R. Anbazhagan, G. Idayachandran and G. Pau, (2023)- "Review Study on Recent Developments in Fire Sensing Methods," - in *IEEE Access* vol. 11, pp. 90269-90282.

It was observed that advancements in machine learning, IoT, sensor technology, and signal processing have significantly improved fire detection methods by reducing detection time and false alarms. Enhanced computing power and affordable image sensors now support real-time, video-based fire detection. Technologies like IoT and Wireless Sensor Networks improve accuracy in distinguishing fire from non-fire scenarios. Unmanned Aerial Vehicles (UAVs) also offer promising solutions for remote fire monitoring. The paper reviews current fire detection methods, their technologies, challenges, and future research directions, while analyzing key fire indicators such as flame, smoke, temperature, and gases in relation to various sensors.

[2] M. P. Suresh, V. R. Vedha Rhythesh, J. Dinesh, K. Deepak and J. Manikandan, (2022) - "An Arduino Uno Controlled Fire Fighting Robot for Fires in Enclosed Spaces," - Sixth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), Dharan, Nepal.

The Fire Fighting Robot using Arduino provides a cost-effective solution for early fire suppression in domestic environments. It integrates hardware, electronic circuits, and software to detect and extinguish fires autonomously. The system features a flame sensor, water tank, and servo-controlled nozzle to cover maximum area. Controlled by an Arduino Uno, the robot navigates hazardous areas, reducing risks for firefighters. Its primary function as an unmanned support vehicle helps contain fires until professional assistance arrives. While there is scope for improvement, this project demonstrates a promising step toward safer, automated firefighting and rescue operations.

[3] M. Tamaki and C. Premachandra, (1 May 2021) - "Development of a Low-Cost Low-Energy Intelligent Reminder System for Unextinguished Gas Stoves," - in IEEE Consumer Electronics Magazine, vol. 10, no. 3, pp. 29-33.

The smart reminder system for unattended gas stoves enhances kitchen safety and convenience as part of IoT-based home automation. Unlike conventional systems that immediately extinguish flames, this system monitors user presence and provides periodic alerts, only extinguishing the flame if the user fails to return. It integrates multiple sensors and low-power modules to allow users to multitask without compromising kitchen safety. A functional prototype was developed and validated through experiments, confirming its effectiveness in preventing fire hazards while supporting busy lifestyles. This innovative approach demonstrates a balance between safety and uninterrupted cooking activities.

[4] M. A. Hossain, H. S. Roy, M. F. K. Khondakar, M. H. Sarowar and M. A. Hossainline,(2021) - "Design and Implementation of an IoT Based Firefighting and Affected Area Monitoring Robot," - 2nd International Conference on Robotics, Electrical and Signal Processing Techniques DHAKA, Bangladesh.

This study proposes an IoT-based fire-fighting and affected area monitoring robot to assist firefighters in critical situations. The robot is equipped with sensors, including a flame sensor to detect fire, a gas sensor for flammable gases, a PIR sensor for human presence, and a temperature-humidity sensor for environmental data. It operates in both manual and autonomous modes, using Wi-Fi for data transmission and cloud storage for analysis. The system allows real-time monitoring and has been tested extensively, demonstrating excellent fire-extinguishing capabilities in emergencies. This innovative approach enhances fire safety and remote monitoring in hazardous environments.

[5] M. Kanwar and L. Agilandeeswari,(2018) - "IOT Based Fire Fighting Robot," - 7th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) Noida, India.

This study presents an IoT-based firefighting robot designed to detect and combat fires while safeguarding human lives and property. The robot provides real-time fire location visualization and communication with trapped individuals through an automatic receiver. Instructions for movement, water, or carbon dioxide pump activation can be sent remotely. Equipped with sensors, the system identifies fire types and monitors carbon monoxide levels, generating analytical graphs. This data is vital for informing safety authorities about hazardous gas exposure and guiding appropriate recovery actions. The robot offers an efficient and advanced solution to assist firefighters and improve emergency response efforts.

2.3 SUMMARY

The papers referred above are being used to study the evolution of technologies used in IoT-enabled fire extinguishing robots. They help in understanding how different components and systems have advanced over time. By analyzing variations in specifications, one can trace improvements in efficiency, accuracy, and responsiveness. These insights are valuable for identifying current trends and potential areas for innovation. Overall, the review aids in building a solid foundation for future development and research.

3. SYSTEM ANALYSIS

3.1 INTRODUCTION

This chapter contains the detailed description of the requirement used in the entire project. They are segregated into functional and non-functional requirements.

3.1.1 REQUIREMENT ANALYSIS

The requirement analysis for the IoT-enabled fire extinguishing robot involves identifying the functional, non-functional, and system-level needs to ensure optimal performance in detecting and extinguishing fires in various environments.

3.1.2 FUNCTIONAL REQUIREMENTS

INPUT

The input of this system is the signal that are generated from the flame sensor , temperature sensor and ultrasonic sensor .

PROCESS

According to the given input, the code gets the information and checks the whether the information from the user as obstacles being detections are done.

OUTPUT

The user will be given access to the robot movement , and water pump control for fire extinguishing.

3.1.3 NON FUNCTIONAL REQUIREMENT

3.1.4 USER FRIENDLY

Since the project is developed in Arduino code, an open source software makes it easy to write code and upload it to the board.

PLATFORM INDEPENDENT

The Project is implement during Arduino IDE, it is Platform independent.

3.1.3 HARDWARE REQUIREMENTS

- Arduino (ESP32)
- Flame Sensor
- Motor Driver Module(L293D)
- Ultrasonic Sensor(HC-SR04)
- DC-DC Buck Converter (LM2596)
- Relay Module
- DC Gear Motor (60 RPM)
- Water Pump
- Charging Module(TP4056)
- GPS Module
- Battery (Lithium ion -2000mAh)
- Wooden Board

3.1.4 SOFTWARE REQUIREMENTS

- Windows/Linux OS
- RAM (8 – 16 GB)
- Arduino IDE

3.2 MODULE DESCRIPTION

3.2.1 MICROCONTROLLER MODULE

The microcontroller acts as the brain of the robot, processing input from sensors and controlling outputs like motors, water pump. Programmed using Embedded C/C++, it enables real-time fire detection, suppression, and alert messaging, ensuring autonomous and efficient operation. It manages decision-making logic and coordinates all modules for seamless functioning. The module ensures accurate timing and synchronization between sensor data and control actions. It supports serial communication for easy integration with external devices and modules like IoT platforms.

3.2.2 FIRE DETECTION MODULE

The fire detection module uses flame sensors and temperature or smoke sensors to detect the presence and intensity of fire. It continuously monitors the environment and sends real-time data to the microcontroller, enabling quick detection and activation of the fire suppression system. The sensors are positioned to provide wide-area coverage for accurate fire source localization. The module is designed for high sensitivity to detect even small fires in the early stages. It operates reliably in various indoor and outdoor conditions, making it effective in diverse environments.

3.2.3 MOVEMENT CONTROL MODULE

The Movement Control Module is responsible for controlling the DC motors that drive the robot’s movement. It utilizes an H-Bridge configuration to manage both the speed and direction of the robot efficiently. This module ensures sufficient current supply to the motors for consistent operation. By coordinating motor functions precisely, it enables smooth and obstacle-free navigation across different surfaces.

3.2.4 HEAT MONITORING MODULE

The Heat Monitoring Module measures the surrounding temperature levels to detect changes indicative of a fire. It plays a crucial role in confirming the presence of fire and preventing false detections by validating temperature spikes. This module converts the sensed temperature into analog or digital signals, which are processed by the Arduino. By analyzing these values, it helps determine the intensity and proximity of the fire, enabling more accurate and timely activation of the suppression system.

3.2.5 OBSTACLE AVOIDANCE MODULE

The Obstacle Avoidance Module detects obstacles in front of the robot using ultrasonic sound waves to ensure safe and collision-free movement. It prevents the robot from crashing into walls, furniture, or other objects by sensing distances accurately. The module operates through Trigger and Echo pins connected to the Arduino, which calculate the distance to nearby objects. This functionality supports autonomous navigation, allowing the robot to move smoothly while avoiding any hindrances in its path.

3.2.6 POWER SUPPLY MODULE

The Power Supply Module provides essential power to all modules and components of the robot, ensuring seamless operation. It utilizes a 12V Li-ion battery to deliver a stable and reliable power source, suitable for extended performance. This module ensures continuous energy supply required for critical firefighting actions, including sensor monitoring, motor control, and communication functions.

3.2.5 FIRE EXTINGUISHING MODULE

The fire extinguishing module is responsible for suppressing flames once a fire is detected. It uses a water pump extinguisher, controlled by the microcontroller, to accurately target and extinguish the fire. The system includes a motorized spraying mechanism that ensures focused and efficient coverage. It is compact and fits securely on the robot's chassis without affecting mobility. The module is optimized for quick response and low power consumption, making it suitable for continuous and autonomous operation.

3.2.6 COMMUNICATION MODULE

The communication module is responsible for sending real-time fire alerts and status updates to the user through IoT-based platforms. It ensures that users are promptly notified about fire incidents, even when they are not physically present near the robot. This module enables remote monitoring and control through a mobile application or SMS alerts. It supports wireless connectivity for long-range communication without dependency on local networks. The system is designed for reliability and quick data transmission during emergencies, improving situational awareness and response time.

3.2.7 LOCATION TRACKING MODULE

The location tracking module is used to identify and share the real-time position of the robot during operation. It typically uses a GPS module to obtain accurate geographic coordinates, which are transmitted to the user via the communication system. This helps users monitor the robot's movement and fire location remotely. The module assists in efficient navigation by updating the robot's position continuously. It is especially useful in large areas where manual tracking is difficult, and ensures better control and deployment of the robot during emergencies.

3.2.8 STRUCTURAL SUPPORT MODULE

The structural support module provides the physical framework that holds all components of the robot securely in place. It forms the base structure of the robot and supports a 2-wheel drive system for better stability and maneuverability. Designed using durable and lightweight materials, it ensures smooth movement across different surfaces. The chassis accommodates all sensors, motors, and electronic modules in a compact and organized manner. Its heat-resistant and vibration-proof construction ensures reliable operation in fire-prone environments.

4. SYSTEM DESIGN

4.1 DATA FLOW DIAGRAM

A Data Flow Diagram is a graphical representation that shows how data flows through a system. It illustrates how inputs are transformed into outputs through various processes, data stores, and external entities.

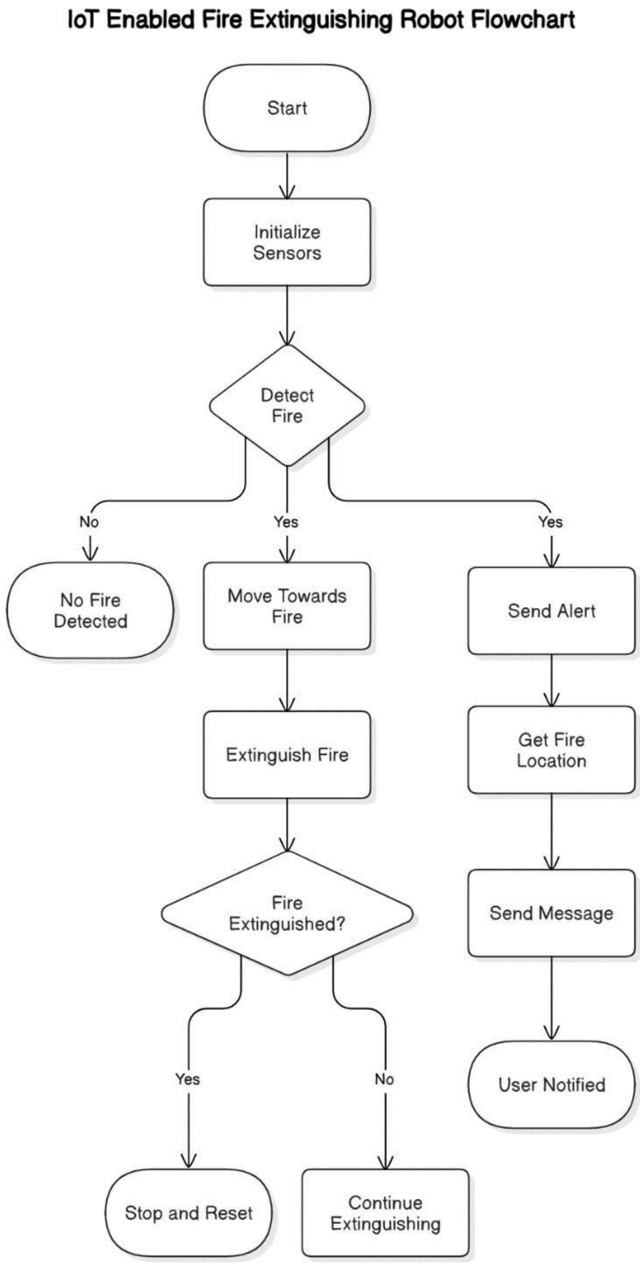

Fig 4.1 Dataflow Diagram

4.2 UML DIAGRAMS

Unified Modeling Language (UML) is a standardized modeling language used in software engineering for visualizing, specifying, constructing, and documenting the components of a software system.

4.2.1 USE CASE DIAGRAM

A use case diagram illustrates the interactions between external actors and the system, showing how users interact with the system and its main functions.

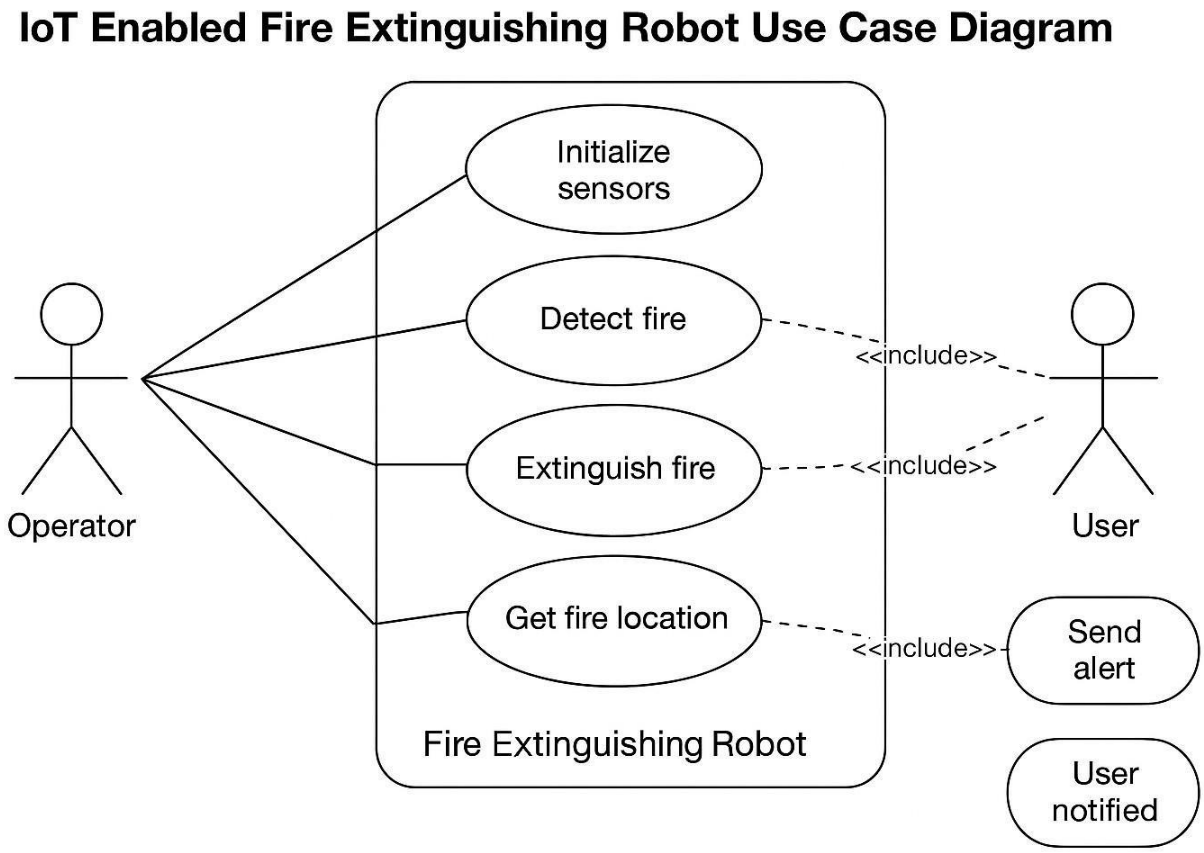

Fig 4.2.1 Use case diagram

4.2.2 CLASS DIAGRAM

A class diagram in software engineering visually represents the structure of a system by showing its classes, attributes, operations, and relationships.

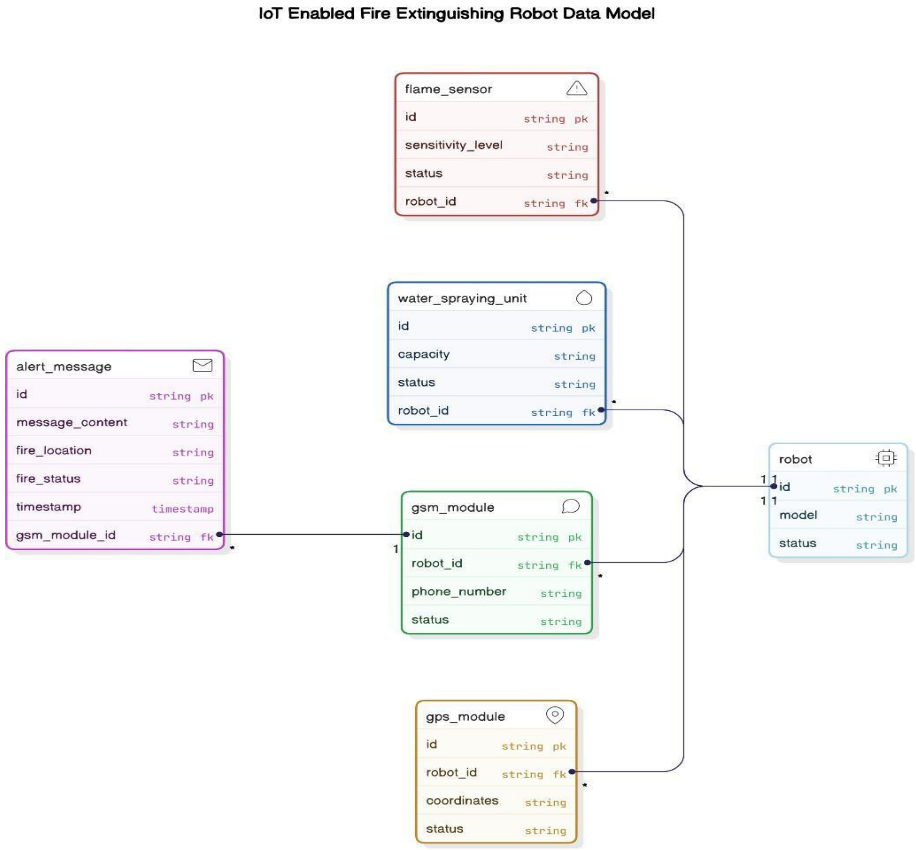

Fig 4.2.2 Class Diagram

4.2.3 SEQUENCE DIAGRAM

A sequence diagram illustrates interactions between objects in a chronological sequence.

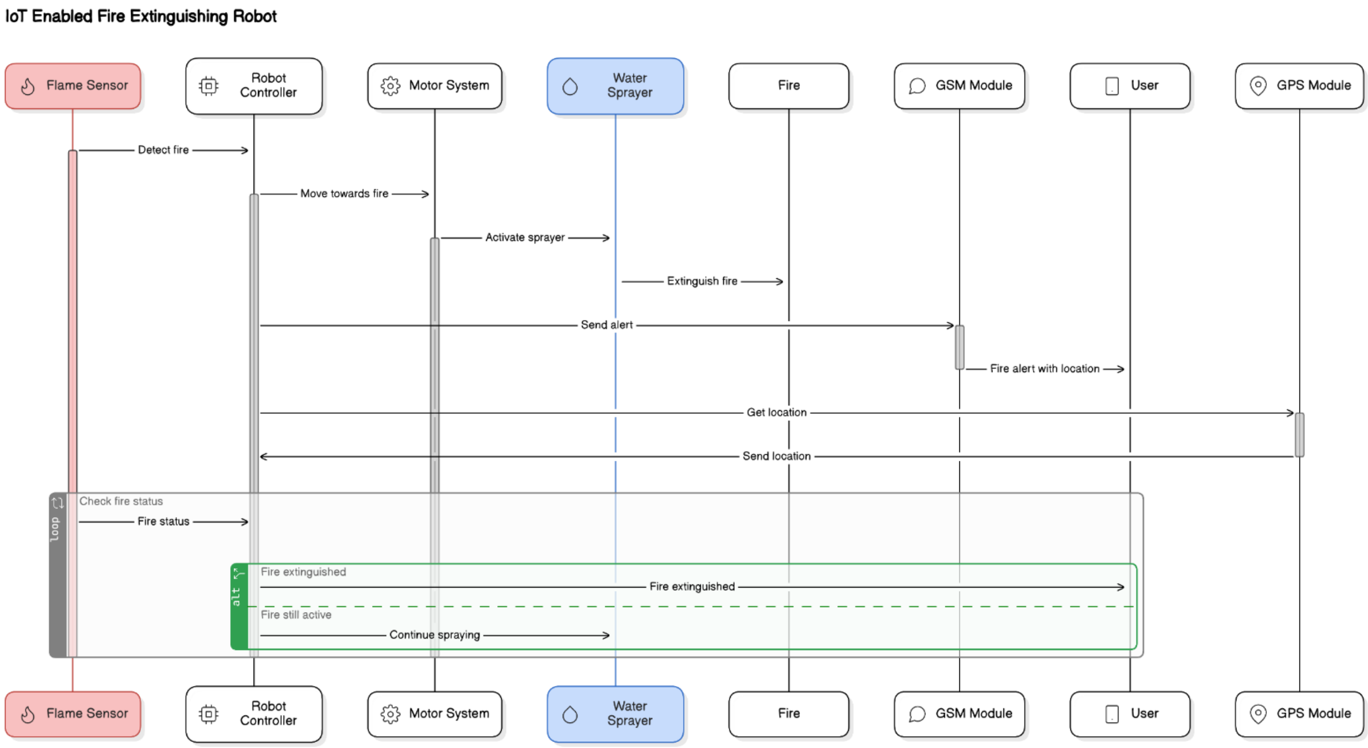

Fig 4.2.3 Sequence diagram

4.2.4 COLLABORATION DIAGRAM

A collaboration diagram in software engineering illustrates interactions between objects and their relationships to accomplish a specific task or behavior.

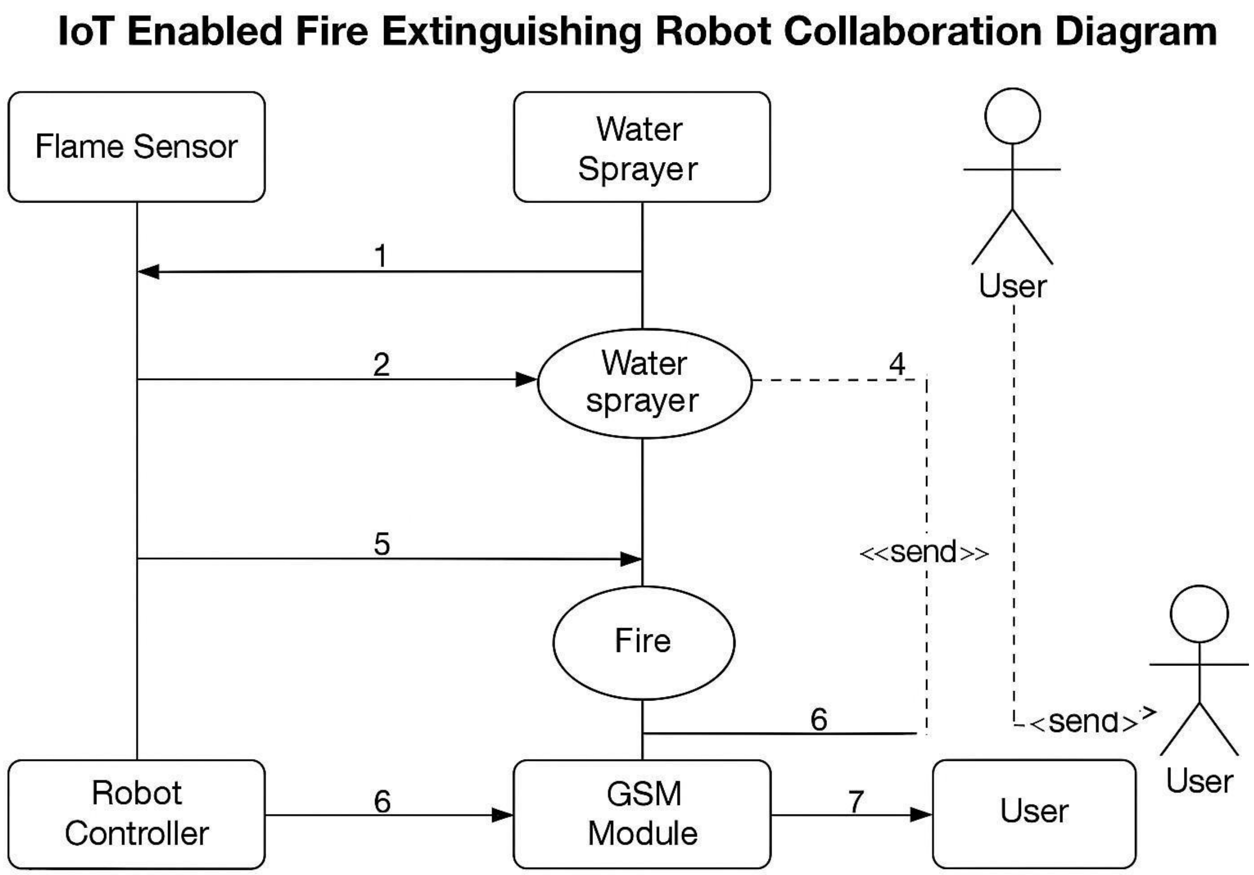

Fig 4.2.4 Collaboration Diagram

4.2.5 ACTIVITY DIAGRAM

An Activity Diagram in UML (Unified Modeling Language) is a graphical representation of the workflow or activities within a system or a specific use case.

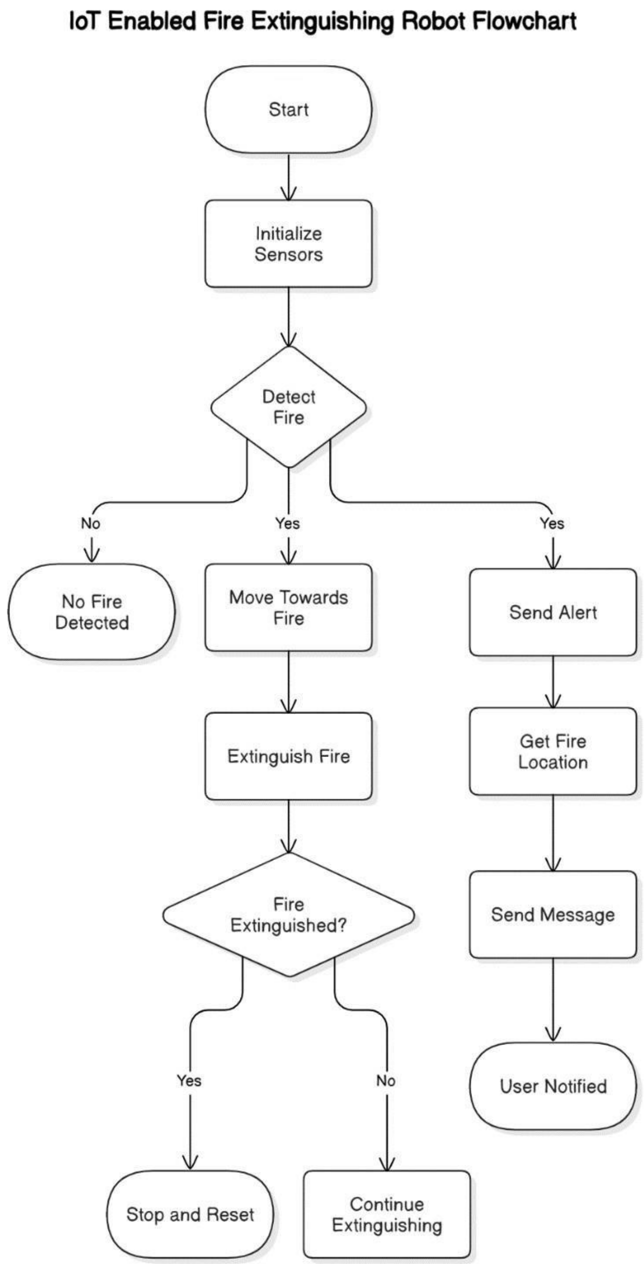

Fig 4.2.5 Activity diagram

5. IMPLEMENTATION

SOFTWARE IMPLEMENTATION

```
#define BLYNK_TEMPLATE_ID "TMPL3KxPzRxPe"
#define BLYNK_TEMPLATE_NAME "Fire Alert"

#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
#include <TinyGPSPlus.h>

// Motor Pins
#define IN_A1 13
#define IN_A2 12
#define IN_B1 14
#define IN_B2 27

#define RELAY_PIN 33
#define FLAME_SENSOR_PIN 18
#define TRIG_PIN 23
#define ECHO_PIN 22

// Blynk Auth and WiFi credentials
char auth[] = "ihoPUMhVbjIT_uAS7stWpyL5oWar6qae";
char ssid[] = "Your_SSID";
char pass[] = "Your_PASSWORD";
TinyGPSPlus gps;
HardwareSerial gpsSerial(2); // UART2 -> GPIO16(RX), GPIO17(TX)
```

```
bool flameReported = false;

  void setup() {
   Serial.begin(115200);
   gpsSerial.begin(9600, SERIAL_8N1, 16, 17); // RX=16, TX=17

   pinMode(IN_A1, OUTPUT);
   pinMode(IN_A2, OUTPUT);
   pinMode(IN_B1, OUTPUT);
   pinMode(IN_B2, OUTPUT);
   pinMode(RELAY_PIN, OUTPUT);
   pinMode(FLAME_SENSOR_PIN, INPUT);
   pinMode(TRIG_PIN, OUTPUT);
   pinMode(ECHO_PIN, INPUT);

   stopMotor();
   digitalWrite(RELAY_PIN, HIGH); // Initially relay ON

   Blynk.begin(auth, ssid, pass);
  }
  void loop() {
   Blynk.run();
   readGPS();
   bool flameDetected = digitalRead(FLAME_SENSOR_PIN) == LOW;
   if (flameDetected) {
    Serial.println("Flame Detected!");
    stopMotor();
    digitalWrite(RELAY_PIN, LOW);
```

```
    if (!flameReported && gps.location.isValid()) {
      float lat = gps.location.lat();
      float lon = gps.location.lng();

      // Send GPS data to Blynk
      Blynk.virtualWrite(V4, lat);
      Blynk.virtualWrite(V5, lon);
      Blynk.virtualWrite(V6, 1); // Turn on LED widget
      Blynk.logEvent("fire_alert", "Fire Detected at location!"); // Use Blynk web to set
event
      flameReported = true;
    }
  } else {
    flameReported = false;
    digitalWrite(RELAY_PIN, HIGH);
    long distance = getDistanceCM();

    if (distance > 0 && distance < 20) {
      turnLeft();
    } else {
      moveForward();
    }

    Blynk.virtualWrite(V6, 0); // Turn off LED if no fire
  }

  delay(200);
}
```

```
// ------------------- Motor Functions  --------------------
void moveForward() {
digitalWrite(IN_A1, HIGH);
digitalWrite(IN_A2, LOW);
digitalWrite(IN_B1, HIGH);
digitalWrite(IN_B2, LOW);
}

void turnLeft() {
  digitalWrite(IN_A1, LOW);
  digitalWrite(IN_A2, HIGH);
  digitalWrite(IN_B1, HIGH);
  digitalWrite(IN_B2, LOW);
}

void stopMotor() {
  digitalWrite(IN_A1, LOW);
  digitalWrite(IN_A2, LOW);
  digitalWrite(IN_B1, LOW);
  digitalWrite(IN_B2, LOW);
}
// ------------------- Distance --------------------
long getDistanceCM() {
  digitalWrite(TRIG_PIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
```

```
  long duration = pulseIn(ECHO_PIN, HIGH, 30000);
  long distance = duration * 0.034 / 2;

  if (duration == 0) return -1;
  return distance;
}

// ------------------- GPS --------------------
void readGPS() {
  while (gpsSerial.available()) {
    gps.encode(gpsSerial.read());
  }
}}
```

6. TESTING

6.1 TESTING OBJECTIVES

- Testing is a process of executing software with the intent of finding errors.
- Good testing has a high probability of finding as -yet- undiscovered errors.
- Successful testing discovers unknown errors.
- If did not find any errors, need to ask whether our testing approach is good.

6.2 TESTING

The process of evaluating a particular product to determine whether the product contain any defects.

6.3 SOFTWARE TESTING

Software Testing is a process of evaluating a system by manual or automatic means and verify that it satisfies specified requirements or identify differences between expected and actual results.

6.4 BASIC TYPES OF TESTING

- Black Box Testing
- White Box Testing
- Unit Testing
- Integration Testing
- System Testing
- Regression Testing
- Verification and Validation Testing

6.4 TESTING TECHNIQUES USED

6.4.1 UNIT TESTING

- Roughly equivalent to chip-level testing for hardware.
- Its testing done to each module, in isolation, to verify its behaviour.
- Typically, the unit test will establish some sort of artificial environment and
- then invoke routines in the module being tested.
- It then checks the results returned against either some known value or against
- the results from previous runs of the same test (regression testing).
- When the modules are assembled we can use the same tests to test the system as a whole.

6.4.1.1 ADVANTAGES

- Easy to locate the bug.
- Exhaustive testing up to some extent.
- Interaction of multiple errors can be avoided.

6.4.1.2 REASON FOR CHOOSING UNIT TESTING:

- For each function, the testing is done.
- The processes like Query Evaluation, unanimity estimation can be tested.
- The minute changes that may lead to fault can be identified and fixed.

6.4.2 INTEGRATION TESTING

- To check the application against its design.
- To check that the application works.
- Integration Testing

  - Testing of subsystems as a whole.

  - Units assumed to have been tested and passed.

6.4.2.1 APPROACH

Check program, inter program communications, batch-flow, online dialog.

6.4.2.2 TYPICAL TESTS

- Application integration
- Job Streams
- Internal component-to-component interfaces
- Resource availability and contention
- Networks, Internet, communications, etc.
- Support functions
- Interfaces with other application
- Batch Processes
- System-level design features

7. SCREENSHOTS

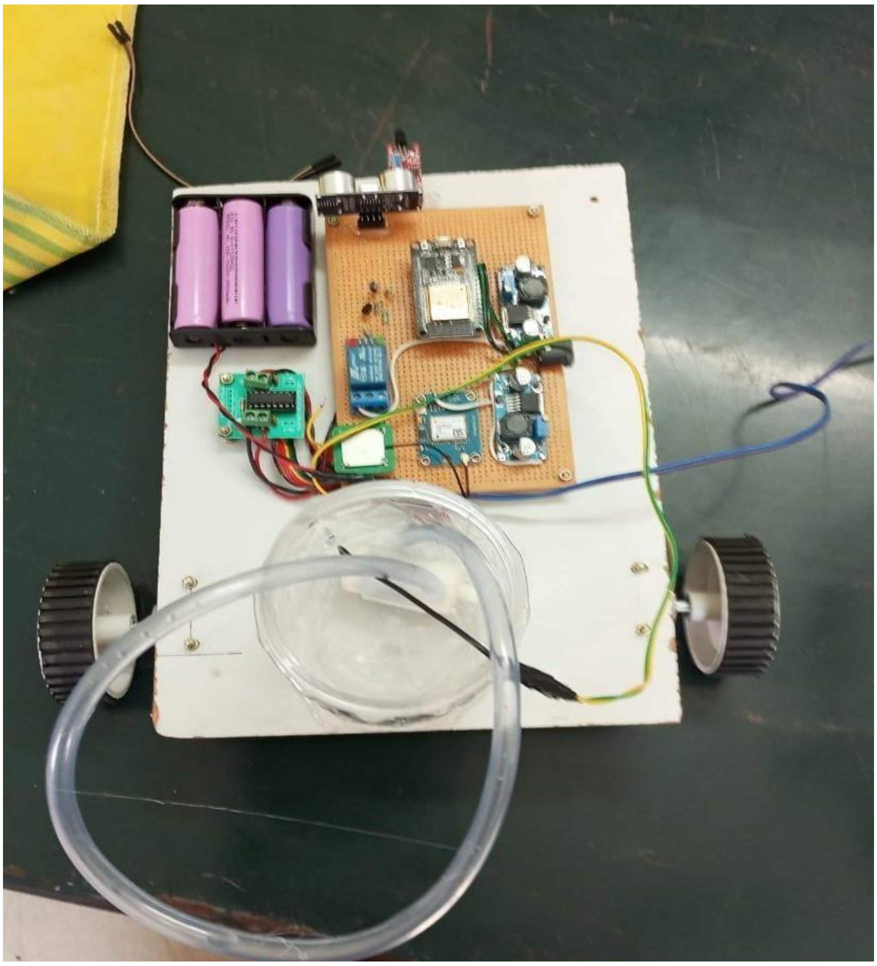

Fig 7.1 Prototype

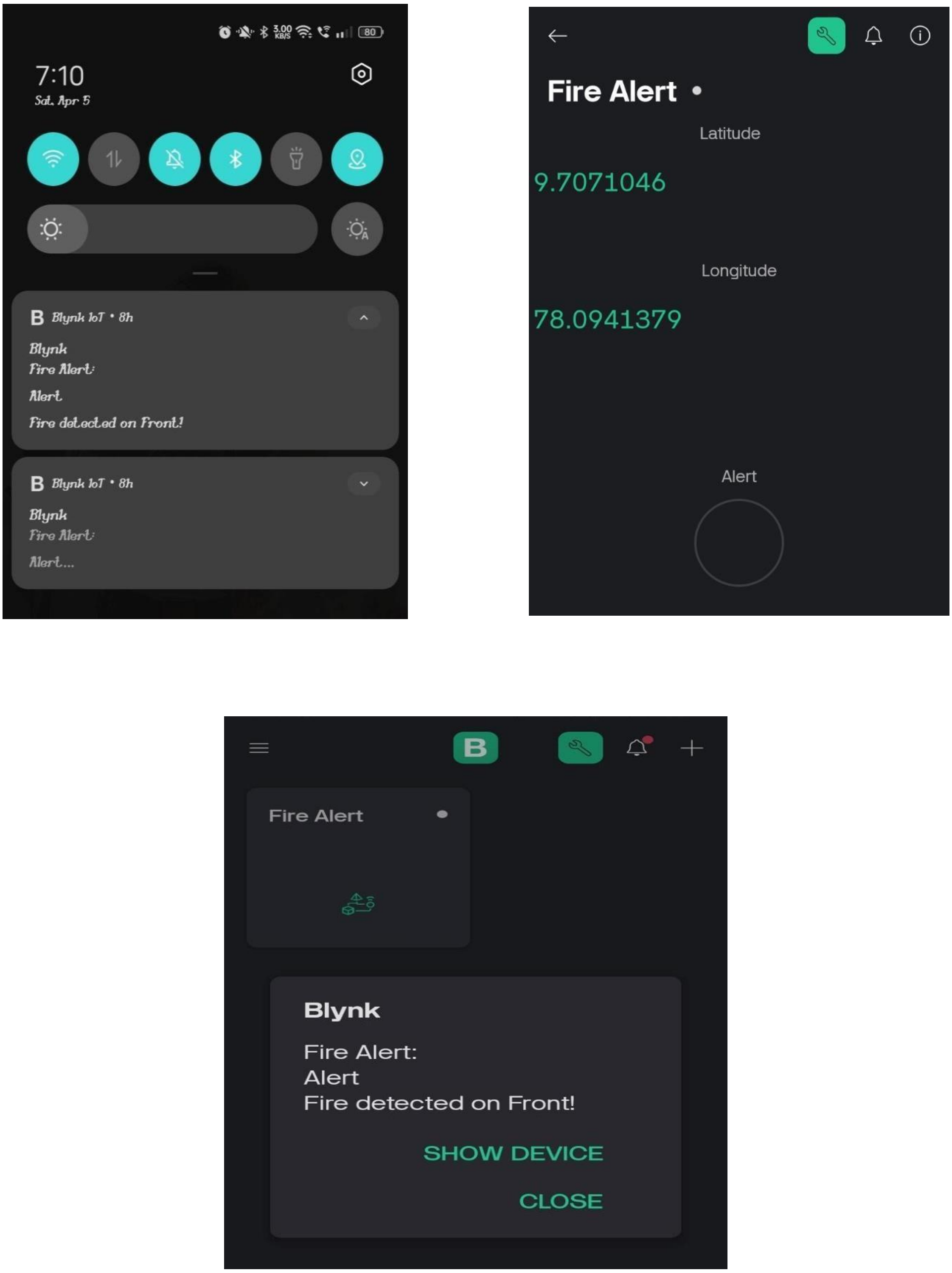

Fig 7.2 Screenshot of Blynk Notification.

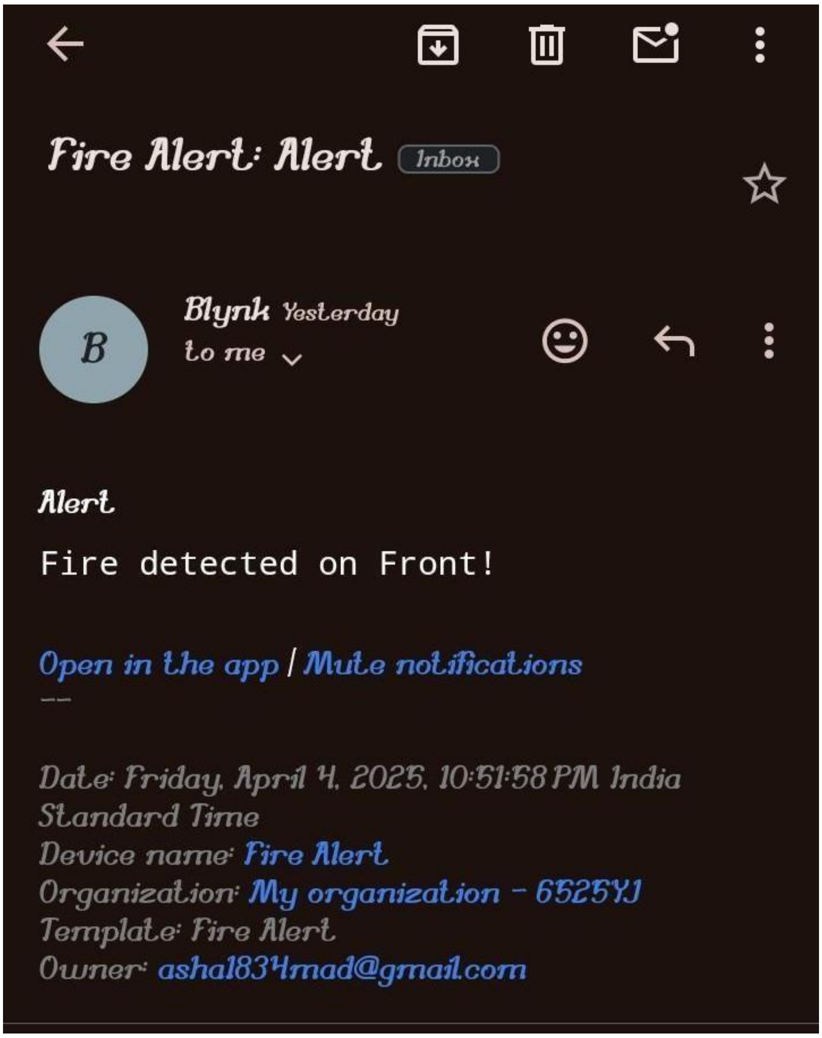

Fig 7.3 Screenshot of email notification.

8. CONCLUSION

8.1 CONCLUSION

The development of an IoT-Enabled Fire Extinguishing Robot represents a transformative synergy of technology and emergency response, offering the potential to revolutionize fire management through advanced sensor integration, autonomous mobility, and real-time communication capabilities. By addressing the challenges of accurate fire detection, safe navigation in hazardous environments, and autonomous fire suppression, this innovation holds the promise of minimizing risks to human firefighters, enhancing overall response times, and safeguarding lives and property. This project contains Sustainable Development Goal: Industry, Innovation, and Infrastructure, and Sustainable Cities and Communities, highlighting its contribution to building resilient and safe environments through smart and sustainable solutions.

8.1 FUTURE ENHANCEMENT

- As these robots continue to evolve and find their place in the realm of disaster management, they underscore the remarkable potential of technology to mitigate the devastating impact of fires on communities and urban landscapes.
- **AI-Based Fire Detection**: Integration of AI-powered image processing for more accurate and faster fire detection.
- **Advanced Suppression Mechanisms**: Implementation of CO_2-based systems to effectively suppress electrical and chemical fires.

9. APPENDIX

ABOUT THE SOFTWARE

ARDUINO IDE

Arduino software, often referred to as the Arduino Integrated Development Environment (IDE), serves as the foundation for programming and interacting with Arduino microcontroller boards. This user-friendly platform is compatible with Windows, macOS, and Linux, making it accessible to a wide range of users. Users write code in a simplified version of C and C++, and the IDE provides libraries to simplify hardware interactions. The Arduino IDE supports a variety of Arduino- compatible boards, including classic models like the Uno, Nano, and Mega. After writing and verifying the code, users can upload it to the Arduino board via a USB connection, where it's compiled and executed.

The software includes a Serial Monitor for debugging and data communication. Arduino boasts a vibrant and extensive community, offering a plethora of resources, tutorials, and projects online, making it an ideal choice for both beginners and experienced electronics enthusiasts. Furthermore, the open-source nature of the Arduino platform encourages collaboration and innovation, contributing to its widespread popularity in the maker and DIY communities.

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