Report On Fire Fighting Robot

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CSE-234 Project Report

Project Title: Fire Fighting Robot.

Course:

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Abstract:

The Internet of Things (IoT)-based Fire Fighting Robot is an innovative system designed to enhance fire safety by detecting, monitoring, and responding to fire hazards in real time. The robot is equipped with multiple sensors, including flame sensors and temperature sensors, which allow it to accurately identify the presence and intensity of fire. An autonomous navigation mechanism enables the robot to move towards the source of the fire without human intervention, ensuring timely action even in hazardous environments where manual firefighting may be risky. The system integrates IoT connectivity, enabling continuous monitoring and instant alerts to be sent to users via a smartphone application or cloud platform. Upon detecting a fire, the robot not only notifies the user but also activates its built-in water pump system to automatically attempt to extinguish the flames. This dual functionality of alerting and firefighting significantly reduces response time and minimizes potential damage. The project showcases the practical implementation of embedded systems, IoT-based communication, and robotics to develop a low-cost, efficient, and scalable fire safety solution suitable for both residential and commercial applications. By combining automation with remote monitoring, the IoT-based Fire Fighting Robot represents a step forward in creating intelligent safety systems capable of addressing emergency situations effectively.

1. Introduction

Fire accidents continue to be one of the most devastating hazards, posing severe risks to both human life and valuable property. In many cases, fires spread rapidly, leaving little time for manual intervention and causing massive destruction before help arrives. Traditional fire detection systems, such as smoke detectors and alarm units, play an important role in raising alerts, but they are limited to only notifying occupants of a potential hazard. They lack the capability to take direct action against the fire, which often delays the overall response time. This delay can be critical, especially in homes, offices, and industries where quick intervention is necessary to minimize losses.

To address these limitations, this project introduces an IoT-enabled Fire Fighting Robot, designed not only to detect fire hazards but also to actively respond to them in real time. The robot is equipped with flame and temperature sensors that continuously monitor the environment to identify fire outbreaks with high accuracy. Once a fire is detected, the robot establishes IoT communication to instantly notify users through a smartphone or web application, ensuring remote awareness and control. Simultaneously, the robot navigates autonomously towards the fire source using its mobility system and activates a water spraying mechanism to suppress or extinguish the flames.

By integrating IoT technology, embedded systems, and robotics, this solution goes beyond

conventional alarm systems to provide an active, intelligent, and automated firefighting approach. The robot is designed to be compact, cost-effective, and scalable, making it suitable for deployment in homes, offices, laboratories, and industrial environments. This project highlights how modern technologies can be combined to create innovative safety systems capable of protecting lives and property more efficiently.

2. Objectives

- Detect fire in indoor environments using flame sensors.
- Move autonomously toward the source of fire.
- Trigger alarms and notify users via IoT platforms.
- Spray water to extinguish the fire.
- Provide remote monitoring via smartphone applications.

3. System Architecture

3.1 Components Used

- Flame Sensor – Detects infrared light from flames.
- ESP8266/ESP32 Microcontroller – Controls the system and provides Wi-Fi connectivity.
- DC Water Pump – Sprays water for fire extinguishing.
- Motor Driver (L298N) – Controls DC motors for movement.
- DC Motors with Wheels – Enables mobility toward fire.
- Buzzer – Alerts during fire detection.
- Battery Power Supply – Powers all components.
- Smartphone App (Blynk/IFTTT) – Receives notifications and monitors robot status.

3.2 Block Diagram

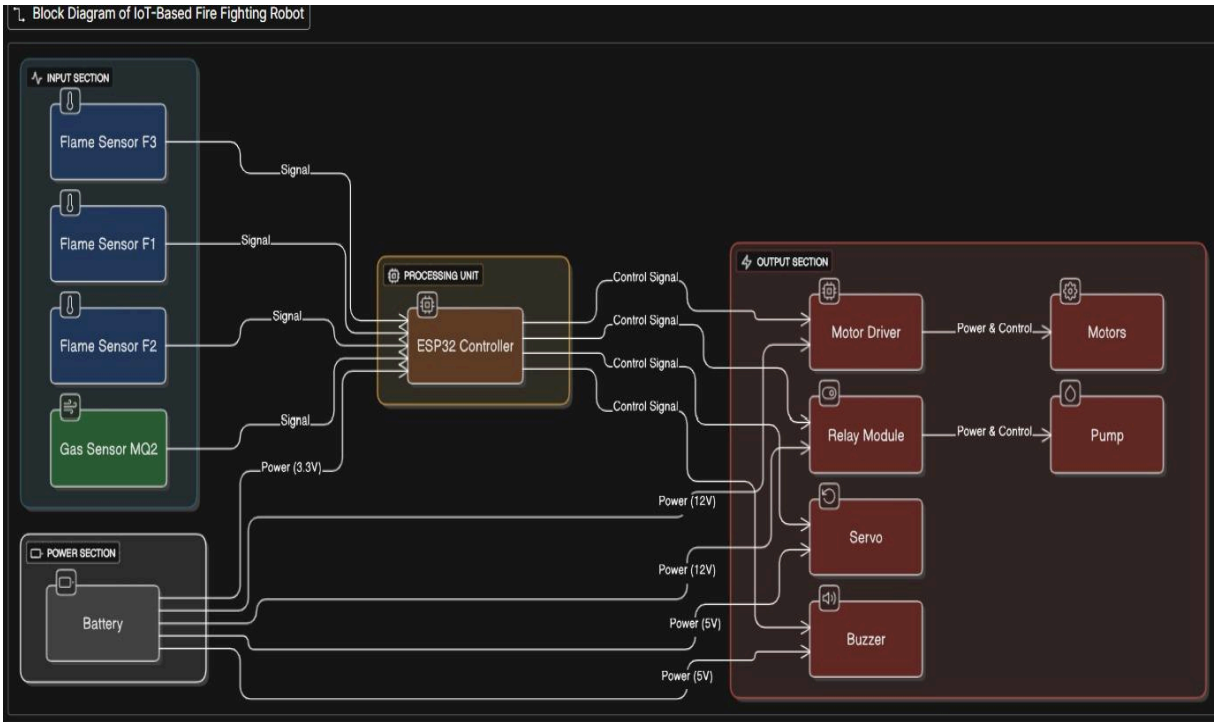


Fig 1 : Diagram of IoT-Based fire fighting robot

4. Methodology

4.1 Hardware Design

- Flame sensor continuously scans for fire.
- Motors controlled by L298N driver for movement.
- Water pump connected to relay to spray water on fire.

4.2 Software Design

- Firmware developed using Arduino IDE.
- IoT communication via Blynk/IFTTT.
- Simple navigation algorithm coded for autonomous movement.

4.3 Communication Protocol

- Data transmitted over Wi-Fi (ESP8266/ESP32).
- Smartphone receives real-time alerts.

5. Implementation

- Fire detection triggers buzzer alarm.
- Notification sent to mobile application.
- Robot moves forward toward flame source.
- Water pump activates to extinguish fire.

5.1 Sensor Data Acquisition

• Periodic readings from DHT11, PIR, and LDR sensors were sent to Firebase. • Data was processed and thresholds were set for automated actions (e.g., turning on lights when motion is detected).

5.2 Mobile Application Features

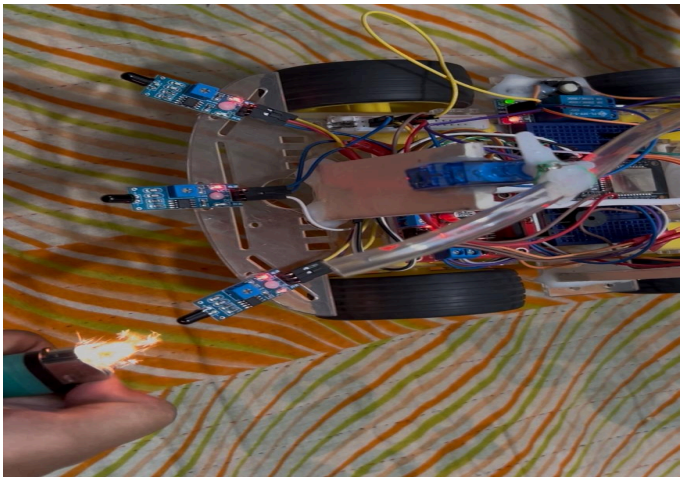
• Dashboard displaying real-time sensor data.
• Buttons for manual control of appliances.
• Notification alerts for events like motion detection or extreme temperatures.

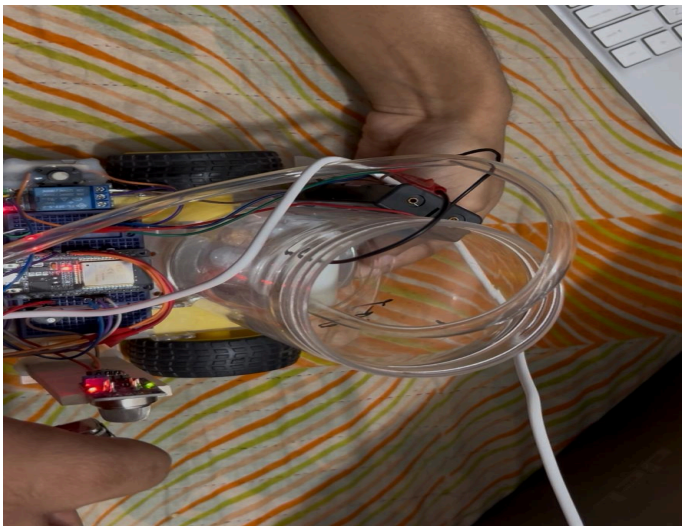
5.3 Security Features

• Authentication implemented using Firebase Auth.
• Encrypted communication to protect user data.

6. Results

- Successfully detected flames using sensor.
- Robot moved autonomously toward fire.
- Real-time notifications delivered to smartphone.
- Water spray mechanism extinguished small flames effectively.





7. Challenges and Solutions

Challenge 1: Limited navigation (only straight movement).

Solution: Plan to integrate ultrasonic sensors for obstacle avoidance.

Challenge 2: Limited water capacity.

Solution: Use a refillable or larger water tank in future versions.

Challenge 3: Only flame detection.

Solution: Future integration of smoke/gas sensors.

8. Future Scope

- AI/ML-based fire detection for higher accuracy.
- Integration of camera module for live monitoring.
- GPS/room mapping for efficient navigation.
- Voice control and smart home integration.

9. Conclusion

The IoT-based Fire Fighting Robot successfully demonstrates the potential of integrating robotics, embedded systems, and IoT technologies to create a proactive fire safety solution. Unlike traditional fire alarm systems that are limited to raising alerts, this robot is capable of performing three critical functions—detecting fire hazards, notifying users in real time, and actively responding to extinguish flames. Its ability to operate autonomously makes it a practical and cost-effective system for residential, commercial, and small-scale industrial environments where immediate response is crucial.

Although the current prototype implements a basic navigation and water-spraying mechanism, it serves as a foundation for more advanced developments. Future enhancements may include improved navigation algorithms using AI, integration of thermal imaging cameras for precise fire detection, cloud-based data analytics for predictive fire monitoring, and multi-robot coordination for large-scale firefighting. With these upgrades, the system can evolve into a highly reliable and intelligent autonomous firefighting network.

Overall, this project highlights how the fusion of IoT and robotics can significantly reduce human risk, minimize property damage, and contribute to safer living and working spaces. It demonstrates not only the technical feasibility but also the social relevance of developing smart, autonomous fire response systems for the future.

10. References

- YouTube.
- ChatGPT.
- Google.