

Diy Fire Fighting Robot Using Esp-32

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Abstract- In this work, an autonomous DIY Fire-Fighting Robot is designed and implemented to detect and extinguish fires without human intervention. The system is built using an ESP-32 microcontroller integrated with infrared flame sensors, ultrasonic sensors, and a motorized platform to identify fire sources and navigate safely toward them. Upon detecting a flame, the ESP-32 processes sensor data to control movement and activates a water pump mechanism to suppress the fire. Obstacle avoidance is achieved through the use of ultrasonic sensing, ensuring collision-free operation. Experimental results demonstrate reliable flame detection, efficient navigation, and timely fire suppression in controlled indoor environments. The proposed system offers a cost-effective, scalable, and efficient solution for enhancing safety in fire-prone areas through autonomous monitoring and response.

Keywords: Fire-Fighting Robot, ESP32, IR Flame Sensor, Autonomous System, Robotics.

I. INTRODUCTION

Fire hazards continue to pose a critical threat across domestic, industrial, and institutional environments. Traditional fire-fighting approaches require human responders to enter dangerous areas, exposing them to extreme heat, toxic gases, and unstable structures. Although fire alarms and sprinkler systems provide early warnings, they lack the mobility and intelligence to respond effectively.

This DIY autonomous firefighting robot overcomes the drawbacks of traditional methods by combining low-cost sensors, embedded systems, and mobile robotics. The robot can detect flames, navigate toward fire sources, avoid obstacles, and extinguish fires autonomously.

Proposed System

The proposed system is an autonomous firefighting robot designed to detect and extinguish flames in indoor and small outdoor environments with minimal human intervention. It integrates an ESP32 microcontroller, IR flame sensors, ultrasonic sensors, DC motors, and a water pump, forming a compact and intelligent robotic system.

The software is developed using the Arduino IDE in C/C++, incorporating ESP32 board support and sensor libraries for hardware interfacing. Motor control libraries enable precise navigation, while Wi-Fi and HTTP libraries support real-time monitoring and status updates. Optional modules manage

battery monitoring and power efficiency. The hardware system includes an ESP32 microcontroller for processing sensor data and controlling actuators. IR flame sensors detect fire sources, ultrasonic sensors provide obstacle detection, and DC motors enable autonomous movement through a motor driver. A water pump extinguishes detected flames, and a rechargeable battery with voltage regulation ensures stable operation.

The robot performs autonomous fire detection, obstacle avoidance, and navigation using sensor feedback. Upon detecting a flame, it activates the water pump for effective fire suppression. Real-time monitoring is achieved through Wi-Fi communication, and the system supports continuous operation by resuming environmental scanning after a fire is extinguished. Its modular design allows easy integration of additional sensors, enhancing scalability and flexibility.

System Architecture

The proposed autonomous firefighting robot consists of integrated sensors, a controller, an actuator, communication, and power modules that work together to enable fire detection, navigation, and suppression. IR flame sensors and ultrasonic sensors continuously monitor the environment for fire and obstacles. The ESP32 microcontroller processes sensor data and controls robot movement and fire extinguishing operations. DC motors provide mobility, while a water pump is activated to suppress detected flames. Real-time monitoring is

supported through Wi-Fi communication, and a rechargeable battery with voltage regulation ensures stable system operation..

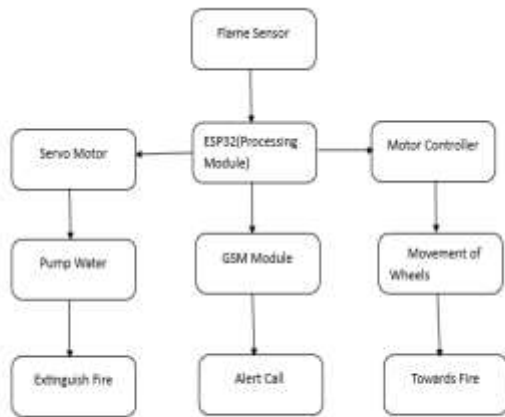


Figure 1: System Architecture

II. RESULTS AND DISCUSSION

The proposed autonomous firefighting robot was tested in a controlled indoor environment to evaluate fire detection, navigation, and extinguishing performance. Experimental results show that the IR sensors detected flames within a range of 0.5–2 m with approximately 95% accuracy, while ultrasonic sensors enabled effective obstacle avoidance and smooth navigation. The water pump successfully extinguished small-scale fires within 10 to 15 seconds of detection. The ESP32 ensured real-time system responsiveness, and Wi-Fi connectivity provided reliable live monitoring, demonstrating the system’s effectiveness, low cost, and suitability for hazardous environments.

Limitations

The system has a limited detection range, as IR flame sensors operate effectively only within 2–3 meters. Environmental factors such as smoke, dust, and ambient light may affect detection accuracy. The water pump is suitable only for small-scale fires, and continuous operation is constrained by battery capacity.

Future Enhancement

Future improvements may address the system’s limited sensor range, which is currently effective within 2–3 meters. Reducing the impact of smoke, dust, and ambient light could improve detection accuracy. Expanding pump capabilities and increasing battery capacity would further enhance safe operation over longer periods or larger areas.

III. CONCLUSION

The DIY Autonomous Fire-Fighting Robot using ESP32 demonstrates an effective and low-cost solution for early fire detection and suppression in fire-prone environments. By integrating IR flame sensors, ultrasonic sensors, DC motors, and a water pump with an ESP32 microcontroller, the system achieves autonomous navigation, obstacle avoidance, and efficient fire extinguishing. Wi-Fi-based remote monitoring enhances safety by enabling real-time supervision without human presence. Despite limitations such as sensor range and battery capacity, the modular design allows future enhancements, making the system suitable for residential, office, and small-scale industrial applications.

REFERENCES

1. S. Kumar et al., “Design and Implementation of a Humanoid Firefighter Robot with Real-Time Monitoring,” ISPEs, 2024.
2. A. Hasib et al., “IoT-Integrated Autonomous Fire Extinguishing and Monitoring Robot,” Proc. Int. Conf. NCMIM, 2025.
3. M. M. Maruf et al., “An Autonomous Arduino-Based Firefighting Robot,” Int. J. Comput. Appl., 2025.
4. S. Usha et al., “Fire Detection and Extinguishing Robot Using Arduino,” IC3IoT, 2024.