Fire Fighter Robot

Vedant Shelar, Parth Patil, Swapnil Jadhav, Sudarshan Bhosale, Suraj Jamadar

Vedant G. Shelar, Computer Science and engg., Sanjay Ghodawat Institute Parth B. Patil, Computer Science and engg., Sanjay Ghodawat Institute Swapnil S. Jadhav, Computer Science and engg., Sanjay Ghodawat Institute
Sudarshan S. Bhosale, Computer Science and engg., Sanjay Ghodawat Institute
Guide: Mrs. Suraj S. Jamadar (Lecturer), Computer Science and engg., Sanjay Ghodawat Institute

---

Abstract - In today's fast-paced world, fire hazards pose significant risks to life, property, and the environment. Traditional fire detection systems often rely on human intervention, resulting in delays and increasing the damage caused by fire incidents. Our project, the IoT-Based Automatic Fire Detection and Extinguisher Robot, addresses this challenge by combining modern sensor technology, robotics, and IoT to provide an autonomous and real-time solution. The robot is equipped with flame and temperature sensors to detect fires early. Once detected, it activates its movement mechanism using DC motors to approach the fire, while a servo-controlled water pump sprays water to extinguish the flames. In addition to firefighting, the robot features obstacle detection with ultrasonic sensors, ensuring safe navigation in complex environments. The system uses Bluetooth and Wi-Fi for remote control via an Android app, sending real-time fire alerts. Powered by an ESP32 microcontroller, it's an efficient, scalable solution for residential, commercial, and industrial fire safety.

***Key Words*:** IoT, Fire Detection, Robotics, Automation, Fire Safety.

1. INTRODUCTION

Fire hazards are a leading cause of damage to property and life. Early detection and prompt action are crucial to minimizing risks. Traditional fire systems often depend on human intervention or static devices like smoke detectors. However, they may have limitations in mobility, coverage, and response time. The Automatic Fire Detection and Extinguisher Robot aims to address these limitations by combining fire detection and extinguishing in a single mobile unit. The robot uses flame and temperature sensors to detect and autonomously extinguish fires, while ultrasonic sensors ensure safe navigation. The ESP32 microcontroller controls the system, and users can remotely operate the robot via an Android app.

2. LITERATURE REVIEW

2.1 Study of existing system

Recent advances in technology have introduced automatic fire suppression systems, such as sprinklers that are activated by heat. While effective in certain cases, these systems are limited by their fixed positions, which may not cover all areas where fire may occur. Another existing solution includes surveillance-based fire detection using cameras and sensors, but they also rely on manual decision-making to activate extinguishing mechanisms. Autonomous firefighting drones have been developed for large-scale industrial or outdoor applications; however, they are costly and not feasible for small-scale or residential use. Additionally, these systems do not typically integrate IoT functionality, which limits their ability to provide real-time alerts and remote control. The lack of mobility and real-time remote control in most existing fire detection systems creates a gap that our project aims to address with the IoT-based fire detection and extinguisher robot.

2.2 Findings from literature review

Recent research emphasizes the increasing role of IoT in fire detection and suppression systems. IoT-based solutions allow for remote monitoring and control through cloud platforms, enabling real-time notifications and data analysis for fire incidents. These systems can be integrated with mobile applications, offering users the ability to monitor their property from anywhere and receive instant alerts when a fire is detected. Additionally, robotic fire suppression systems have been explored in various studies, where autonomous robots equipped with sensors and water-dispensing mechanisms can navigate hazardous environments to fight fires. This approach significantly reduces the risks posed to human firefighters and enhances the efficiency of fire

suppression. The integration of artificial intelligence (AI) for decision-making in fire detection systems has also been explored, improving the accuracy of fire detection and response. However, challenges related to cost, power consumption, and scalability remain, indicating the need for further research to develop more affordable and energy-efficient solutions.

3. Problem statement

Fire outbreaks pose a significant threat to life, property, and the environment, particularly in residential, industrial, and commercial settings. Traditional fire detection systems, which often rely on manual intervention or basic alarms, lack the capability for immediate response, leading to delayed firefighting efforts. This delay results in greater damage and heightened risks to human safety. Additionally, existing fire suppression systems, such as fixed sprinklers and alarms, are limited in their coverage, immobile, and often restricted to specific areas. These systems fail to provide comprehensive protection, especially in complex or large-scale environments where fires can spread quickly.

With the advancement of Internet of Things (IoT) and robotics technologies, there is an increasing demand for an autonomous, mobile solution that can detect fires in real-time, respond immediately by extinguishing the fire, and provide remote monitoring. Current systems do not integrate both fire detection and suppression in a mobile unit that can be controlled and monitored remotely. This lack of a complete, affordable, and scalable solution leaves many environments vulnerable to fire hazards. Therefore, the need arises for a cost-effective, IoT-based automatic fire detection and extinguisher robot capable of early fire detection, autonomous navigation, real-time alerts, and efficient fire suppression, all within a single, versatile system.

4. Project Scope

The **IoT-based Automatic Fire Detection and Extinguisher Robot** aims to develop an autonomous mobile system that can detect and extinguish fires in real-time while providing **remote monitoring and control** capabilities through IoT technology. The project focuses on creating a versatile solution suitable for use in residential, commercial, and industrial environments. The robot will be equipped with **flame and temperature sensors** for early fire detection and **ultrasonic sensors** for **obstacle avoidance**, enabling it to safely navigate toward the fire source.

The robot's **water pump** is controlled by a **servo motor** that allows precise aiming of the water stream, improving the accuracy of fire suppression. Additionally, the robot includes a **rescue pod** that can be opened or closed via the mobile app, offering a solution for potential evacuation or rescue operations.

The system's primary controller is an **ESP32**, which processes data from the sensors and executes commands to control the motors, water pump, and rescue pod. The robot communicates wirelessly using the **Bluetooth and Wi-Fi capabilities** of the ESP32, allowing real-time alerts and remote control through an **Android app**. This feature enables users to monitor the robot's status and receive notifications when a fire is detected, even from remote locations.

The scope of the project includes designing, developing, and testing both the hardware and software components of the system to ensure its efficiency and reliability. The robot will be versatile enough to operate in various environments, making it a scalable and affordable solution for improving fire safety in homes, offices, and industrial areas. Future work could include enhancing the **navigation system** and expanding the robot's ability to cover larger or more complex environments.

5. Project Scope

Quick Detection and Response: The primary objective is to ensure early fire detection through **flame and temperature sensors**. The system will detect the presence of fire in real-time, allowing the robot to act immediately to prevent the fire from spreading. The robot's **obstacle detection** capability using **ultrasonic sensors** ensures safe navigation while moving towards the fire, minimizing damage and reducing the risk of fire-related hazards.

Autonomous Fire Extinguishing: The proposed system will autonomously navigate toward the fire source using **DC motors** and **ultrasonic sensors** and extinguish the fire with a **servo-controlled water pump**. This eliminates the need for human intervention, ensuring that the fire is suppressed quickly and safely even in dangerous or hard-to-reach locations.

Remote Monitoring and Control: The integration of **IoT technology** through the ESP32 enables users to monitor the robot's status and receive real-time alerts via a mobile app. The robot can be controlled manually or switched to autonomous mode, providing flexibility in how it responds to fire incidents.

Rescue Pod Feature: The robot includes a **rescue pod** that can be opened remotely through the app, allowing it to assist in evacuations or transport materials during fire emergencies.

6. DFD Diagram

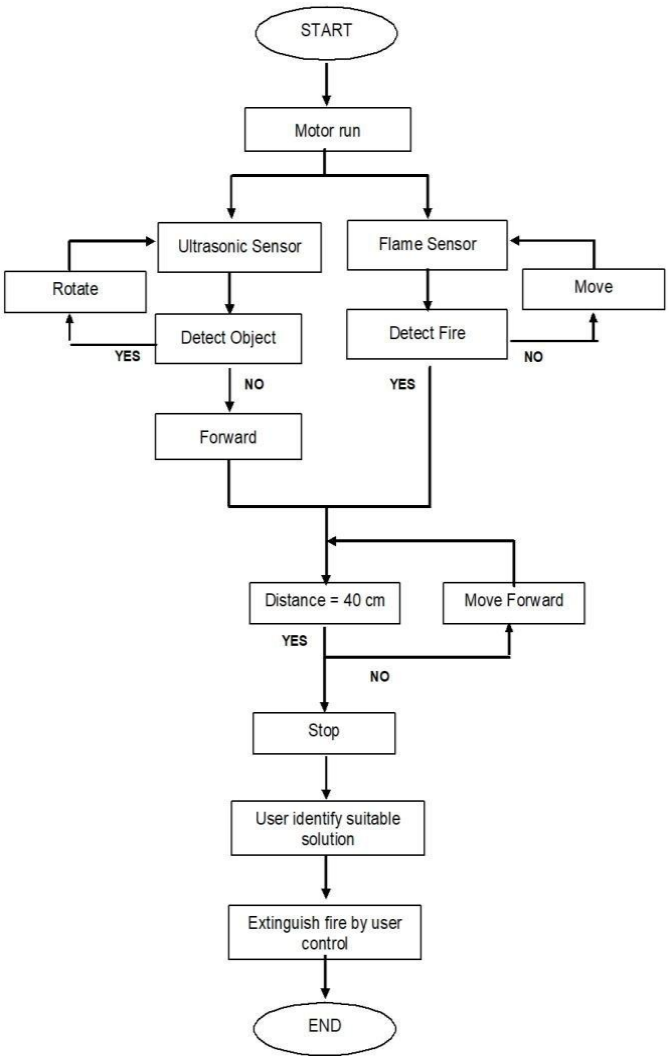
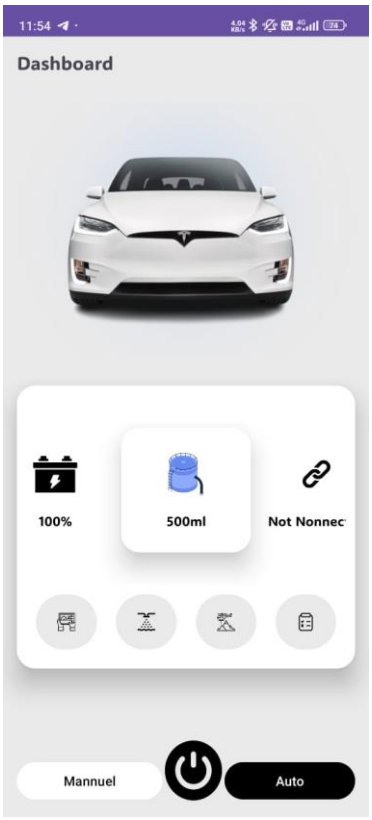
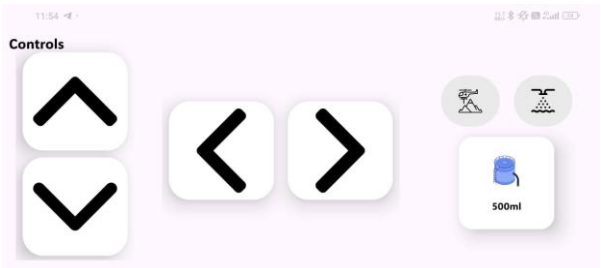
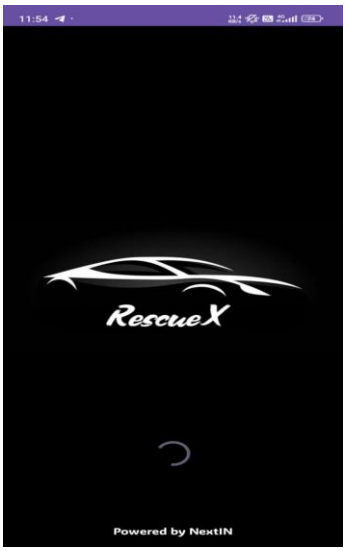


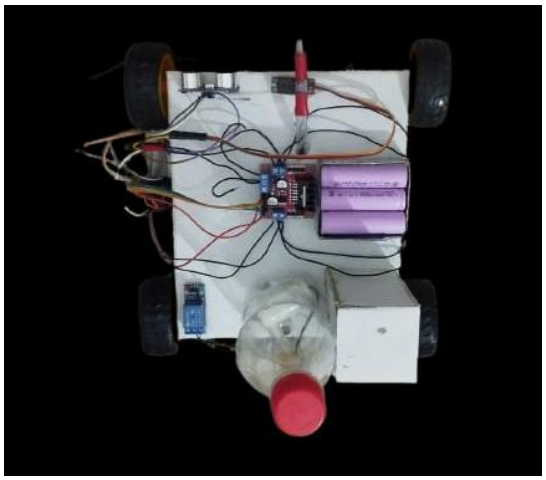
Fig.1 Flow chart of flow of fire fighter robot

7. APP TO COTROL THE ROBOT

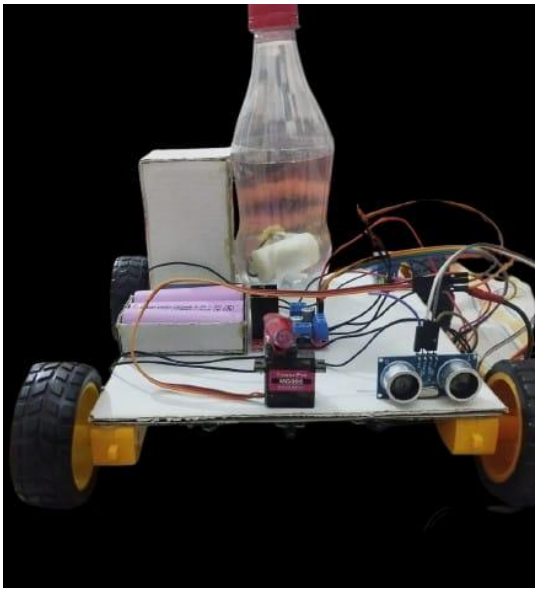


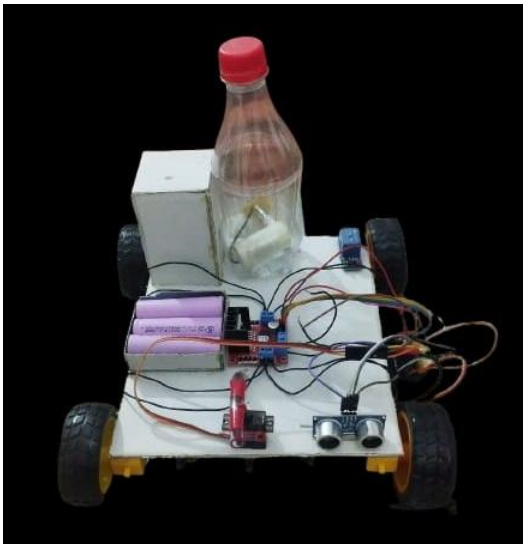






8. COMPLETED ROBOT SNAPSHOTS





9. ARCHITECTURE/COMPONENT STURCTURE

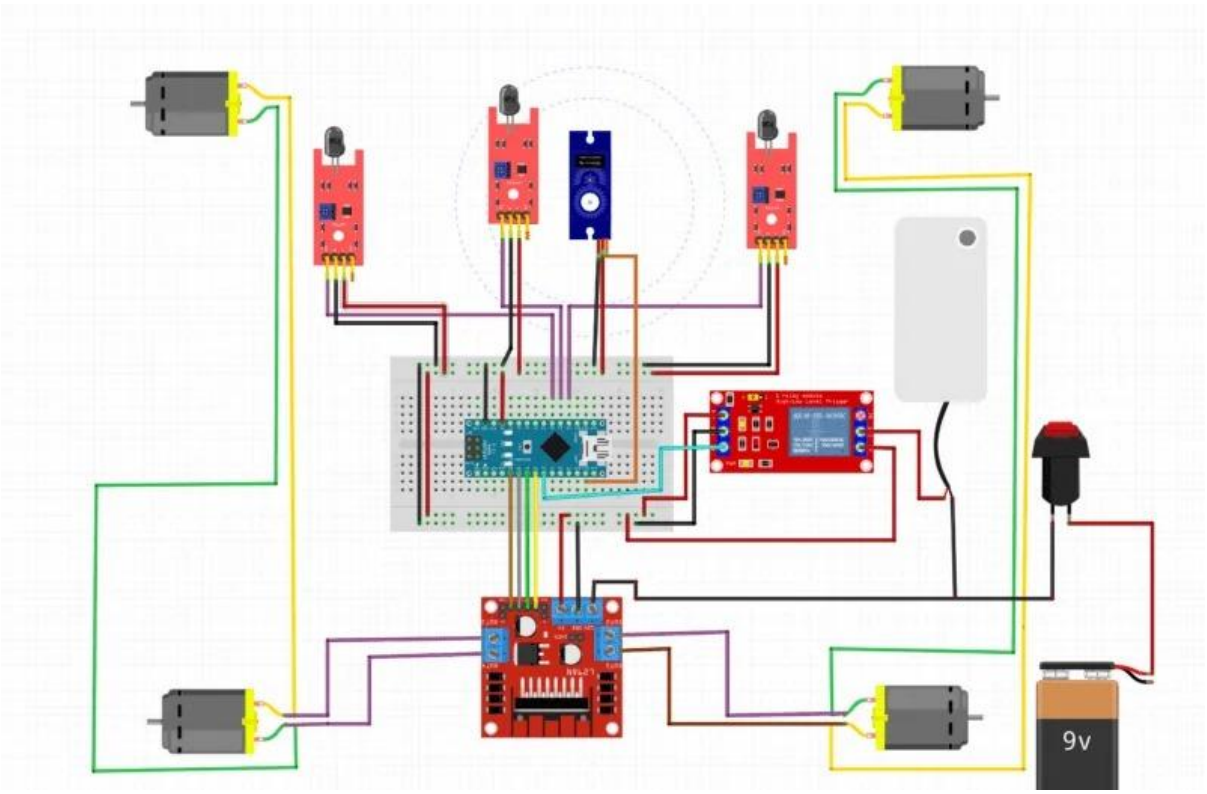


Fig.2 Component Architecture of fire fighter robot

CONCLUSIONS

The automatic fire detection and extinguisher robot project represents a significant step forward in enhancing fire safety measures through the integration of IoT technology. By providing early detection and immediate response capabilities, this innovative solution aims to minimize the risk of fire-related incidents, ultimately safeguarding lives and property. The robot's continuous monitoring and data collection functionalities not only enhance its effectiveness but also contribute to a deeper understanding of fire hazards, paving the way for improved safety protocols in various environments.

Despite the many advantages, including increased efficiency and reduced human risk, challenges such as high development costs, technical complexities, and maintenance requirements must be addressed. Nevertheless, the potential impact of this technology on fire safety is substantial, and with the right strategies in place, it can lead to a safer future.