

Review Paper on Fire Fighting Robot Using Arduino

¹Shital Satpute, ²Priyanka Muneshwar, ³Omkar Ade, ⁴Gaurav Shende, ⁵Adin Shaikh, ⁶Vaibhav Thakare, ⁷Manjusha Hedau

^{1,2,3,4,5,6} Students, Dept. of EE, Jagadambha College of Engineering & Technology, Yavatmal, Maharashtra

⁷Assistant professor, Dept. of EE, Jagadambha College of Engineering & Technology, Yavatmal, Maharashtra

ABSTRACT—Fire hazards pose significant risks to life, property, and the environment. Traditional fire detection systems often rely on human intervention, leading to delays in response time and exacerbating the damage caused by fire incidents. Our project, Fire Fighting Robot using Arduino, addresses this challenge by utilizing a combination of modern sensor technology, robotics, and IoT to provide an autonomous and real-time solution. Undoubtedly, firefighting stands as a crucial profession, yet it inherently carries significant risks. The potential for substantial damage arises when human intervention is absent in promptly detecting fires. This project introduces a robust fire-fighting robot designed to detect and combat fires autonomously. The robot is equipped with an ESP32 microcontroller at its core, four BO motors for movement, and an L293D motor driver for precise motor control. Integration of a single-channel relay module and a 6V DC water pump enables efficient fire suppression. Powered by a 3.7V battery, this versatile robot promises a proactive approach to firefighting scenarios, showcasing adaptability and advanced sensing mechanisms to swiftly identify and combat fires.

Keywords- IoT Technology, Autonomous Navigation, Fire Detection, Obstacle Avoidance.

I. INTRODUCTION

Fire is a destructive force that can cause severe damage to property and pose a significant threat to human life. In many cases, firefighters face numerous risks while attempting to extinguish fires, especially in hazardous conditions such as nuclear power plants, oil refineries, gas tanks, and domestic fires. Additionally, firefighters are often confronted with various difficulties, particularly when fires occur in tight and limited areas. The concept of firefighting, akin to an imaginative gameplay, involves firefighters rescuing victims and swiftly extinguishing fires. Often, widespread fire

incidents originate from minor flames, escalating into substantial devastation. The development of a sophisticated fire-fighting robot emerges as a pivotal innovation. This paper embodies the amalgamation of precision engineering and intelligent design, aiming to address the critical need for automated fire response systems. With the utilisation of an ESP32 microcontroller as its nerve centre, this robot stands poised with four BO motors, an L293D motor driver, and a suite of sensors, poised to detect and combat fires efficiently. This introduction marks the genesis of a proactive solution to revolutionise firefighting approaches.

II. LITERATURE REVIEW

1. Tawfique Rakib et al. (2021) presented a comprehensive design and fabrication of an autonomous firefighting robot that integrates multiple sensors for effective fire detection and suppression. Their model features a robust base platform constructed from kerosene wood, equipped with an LM35 temperature sensor and flame sensors to accurately detect the presence of fire and elevated heat levels within the environment. The robot employs a PID controller to regulate its movement and response dynamics, ensuring stable navigation toward fire sources. Additionally, the system includes a 1-liter water container to extinguish detected fires, demonstrating a practical approach to automated firefighting. The study highlights the potential of combining sensor fusion and control strategies to enhance the robot's ability to detect and respond to fire hazards autonomously, contributing valuable insights to the development of intelligent fire safety solutions.

2. Saravanan P. et al. (2021) developed an Android-controlled integrated semi-autonomous firefighting robot using the ATmega2560 microcontroller, designed to enhance user interaction and system functionality. The

robot is structured into three functional units—navigation, fire detection, and control—which work in coordination to achieve semi-autonomous operation. The navigation unit enables basic movement and steering based on commands received from an Android interface, while the fire detection unit integrates sensors to identify fire sources and trigger appropriate responses. Communication between the Android application and the microcontroller allows users to remotely control the robot's operations in real time, enhancing flexibility and responsiveness. This model demonstrates the effective integration of mobile technology with embedded systems to create a user-friendly firefighting robot capable of assisting in hazardous environments.

3. Shakthi Priyanka et al. (2020) presented an Android-controlled fire-fighting robot based on the Arduino UNO R3 microcontroller, emphasizing simple and cost-effective remote operation. In their design, the robot's movements and firefighting actions are controlled through an Android application that communicates wirelessly with the Arduino platform. The system integrates basic fire detection sensors to identify flames and trigger the extinguishing mechanism, enabling users to navigate and operate the robot in potentially hazardous environments without direct exposure to danger. This study demonstrates the feasibility of combining mobile control technology with a widely accessible microcontroller to create an intuitive and functional fire-fighting robotic system, making it suitable for educational and practical applications in basic fire response scenarios.

4. Nagesh M. S. et al. (2021) proposed a fire extinguishing robot that utilizes DTMF (Dual Tone Multi-Frequency) technology for remote navigation, allowing the robot to be controlled via tone signals transmitted over a mobile network. The system integrates a flame sensor to detect the presence of fire and trigger the extinguishing mechanism, enabling timely response to fire incidents. By relying on DTMF for movement commands, the robot can be maneuvered without the need for complex wireless modules, making the design cost-effective and straightforward. This approach highlights the use of readily available communication methods for robotic control, demonstrating a practical solution for basic fire-fighting tasks in environments where conventional control technologies may be limited.

5. Sushrut Khajuria et al. (2022) presented an Arduino-based fire fighter robot that employs RF (Radio Frequency) remote control for operating both the robot's

movement and its water pump mechanism, enabling wireless control without line-of-sight limitations. The design integrates essential fire detection sensors to identify flame presence and activate the pump for fire suppression, while the RF remote provides intuitive directional and functional commands to the robot. This approach emphasizes simplicity and reliability by utilizing affordable and readily available RF technology, making the system practical for basic firefighting applications where cost and ease of control are key considerations. The study contributes to the field by demonstrating how wireless communication can effectively enhance the maneuverability and responsiveness of fire-fighting robots.

6. Chaithanya K. et al. (2025) proposed an IoT-based fire-fighting robot built around the ESP32 microcontroller, capable of operating in both automatic and manual modes to enhance flexibility and responsiveness in fire emergency scenarios. The system integrates the Blynk IoT platform for remote monitoring and control, allowing users to view live data and send operational commands through a smartphone interface. In automatic mode, the robot uses onboard sensors to detect fire conditions and make real-time decisions, while manual mode enables direct user control for navigation and actuation. By leveraging IoT connectivity, this design offers improved accessibility and situational awareness compared to traditional remote-controlled robots, demonstrating a practical application of cloud-enabled robotics for fire safety.

7. Swapnil Shivaji Jadhav et al. (2024) proposed a fire-fighting robot using IoT and a mobile application, focusing on automatic fire detection and safe navigation. The system incorporates ultrasonic sensors for obstacle detection, enabling the robot to move intelligently in complex environments while avoiding collisions. For communication and control, both Bluetooth and Wi-Fi technologies are used, allowing the robot to be operated remotely through an Android mobile application. This dual communication approach enhances flexibility by supporting short-range and internet-based control. The proposed model highlights the effective integration of IoT, wireless communication, and sensor-based navigation to improve the efficiency, safety, and responsiveness of robotic fire-fighting systems.

8. Kishor Sawarkar et al. (2025) presented a fire-fighting robot using Arduino, focusing on precise fire detection and targeted suppression. The proposed system employs IR flame sensors to accurately identify the presence and direction of fire. To enhance extinguishing efficiency,

the robot is equipped with a servo-controlled water nozzle, which allows directional control of water flow toward the fire source. This mechanism minimizes water wastage while improving suppression accuracy. The study demonstrates a simple yet effective robotic solution for fire-fighting applications, highlighting the use of low-cost sensors and actuators to achieve reliable fire detection and controlled response in hazardous environments.

9. DR. T. Menakadevi et al. (2024) proposed an ESP32-based fire-fighting robot designed for autonomous operation in hazardous environments. The system integrates three flame sensors to ensure accurate fire detection and enhance reliability by minimizing false alarms. Controlled by the ESP32 microcontroller, the robot is capable of detecting fire and activating its extinguishing mechanism automatically, without requiring human intervention. This design emphasizes fully autonomous operation, combining sensor-based detection with smart control to improve response time, safety, and efficiency in fire emergency situations. The study demonstrates the potential of ESP32 and multi-sensor integration in developing intelligent, low-cost robotic solutions for proactive fire management.

10. Mr. Girme Ashwin et al. (2025) proposed a firefighter robot using IoT and robotics, designed to autonomously detect and respond to fire incidents. The system employs IR flame sensors for accurate fire detection, enabling the robot to identify fire locations reliably. For mobility, the robot is equipped with BO motors and rubber wheels, allowing it to navigate efficiently across different surfaces and reach the detected fire source. The integration of IoT and robotic control ensures that the robot can operate with minimal human intervention, enhancing safety and response speed during fire emergencies. This study highlights a practical and cost-effective approach to combining sensor-based detection with mobile robotics for effective firefighting applications.

III. METHODOLOGY

An ESP32 microcontroller orchestrates the entire system, serving as the central processing and control unit for all hardware components. Four BO motors, driven by the L293D motor driver, enable smooth, stable, and agile movement, allowing the robot to navigate efficiently across different surfaces and avoid obstacles in hazardous environments. An ESP32-CAM module is mounted on the robot to provide a real-time live video feed through a web-based dashboard, enabling the user

to remotely monitor the affected area and control the robot's movement with precision.

The system is capable of activating a single-channel relay module connected to a 6V DC water pump, ensuring immediate and targeted fire suppression upon detection or user command. This rapid response minimizes fire spread and reduces potential damage. Additionally, the robot operates on a battery-powered supply, making it portable and suitable for deployment in areas where wired power sources are unavailable. All components work in close coordination to enable swift fire detection, efficient navigation, and accurate firefighting action, making the robot a reliable and intelligent solution for enhancing fire safety in industrial, residential, and emergency response environments.

BLOCK DIAGRAM

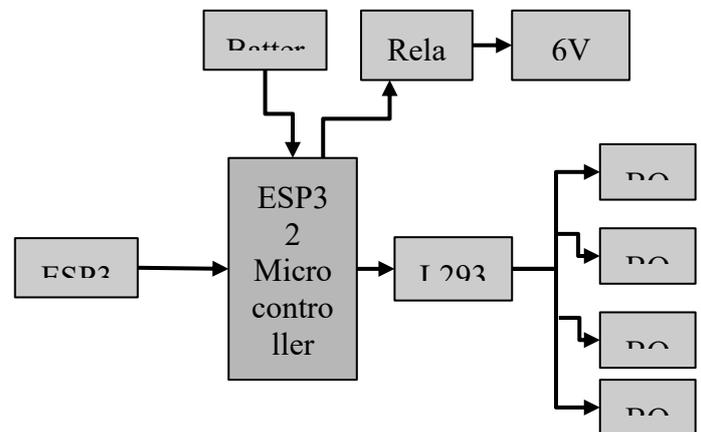


Fig. 1 Shows the System Block Diagram of the System

DESCRIPTION

In this block diagram, we have used the NodeMCU ESP32 as a microcontroller. And an ESP32 Camera module as an input device. Four BO Motors, L293D Motor Driver, 6V DC Water Pump, and a Relay is connected as an output device to the microcontroller. A battery is used for power supply.

FLOW CHART



Fig. 2 Shows the Flowchart of the System

CIRCUIT DIAGRAM

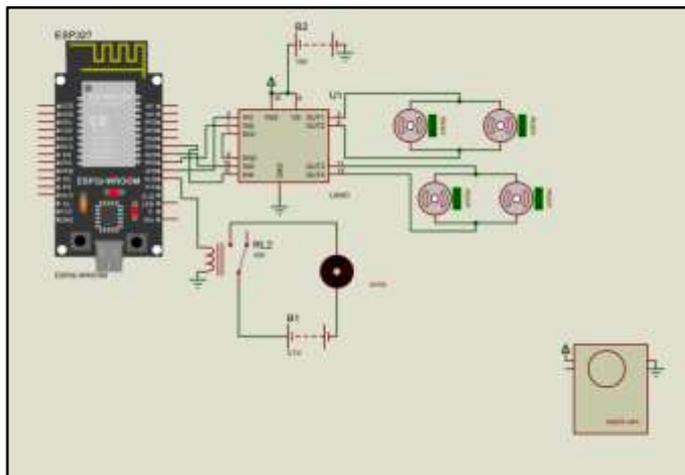


Fig. 3 Shows the Circuit Diagram of the System

WORKING

The robot begins operation by continuously monitoring its surroundings while moving autonomously in the environment. As it navigates, it avoids obstacles in real time by adjusting its direction to ensure smooth and safe movement. Simultaneously, the live visual feed allows the operator to observe the area remotely and take control if required. When a fire is detected, the robot immediately halts its motion and triggers the firefighting action by activating the water pump, directing water precisely toward the affected spot. After the fire is extinguished, the pump is turned off, and the robot

resumes monitoring, ensuring continuous protection with minimal human intervention.

IV. SYSTEM REQUIREMENT

HARDWARE REQUIREMENT

1. NodeMCU ESP32 Module
2. BO Motor *4
3. L293D Motor Driver
4. Single Channel Relay Module
5. 6V DC Water Pump
6. 3.7V Battery *4
7. Wheels*4

SOFTWARE REQUIREMENT

1. Arduino IDE
2. Proteus

V. EXPERIMENTAL SETUP & RESULT

EXPERIMENTAL SETUP

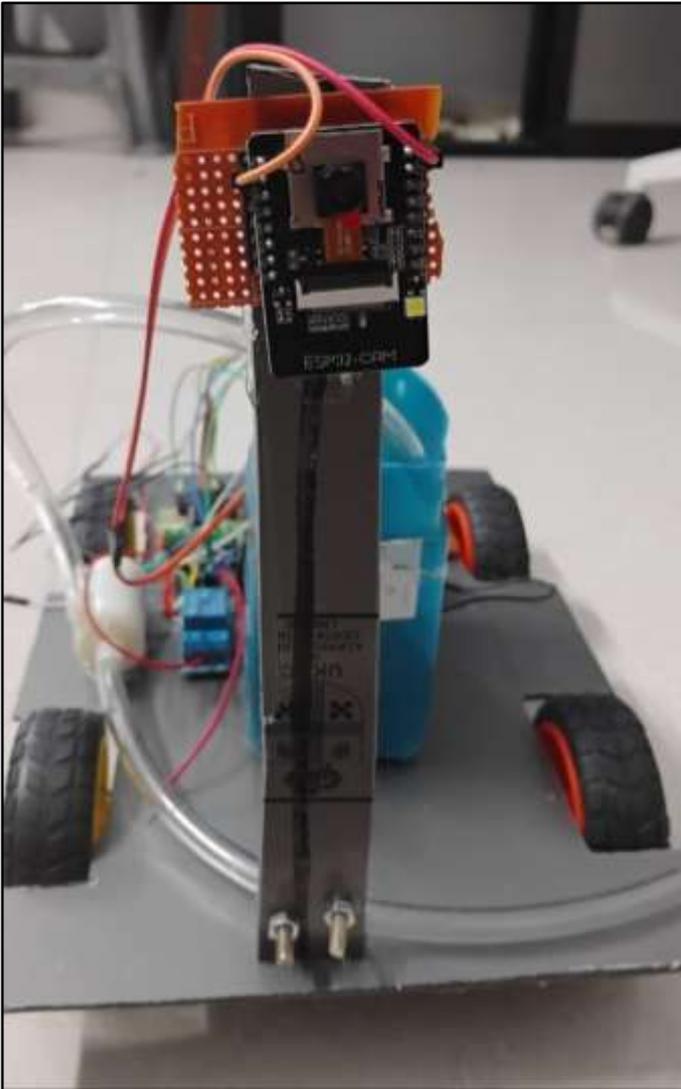


Fig. 4 Shows the Experimental Setup of the System

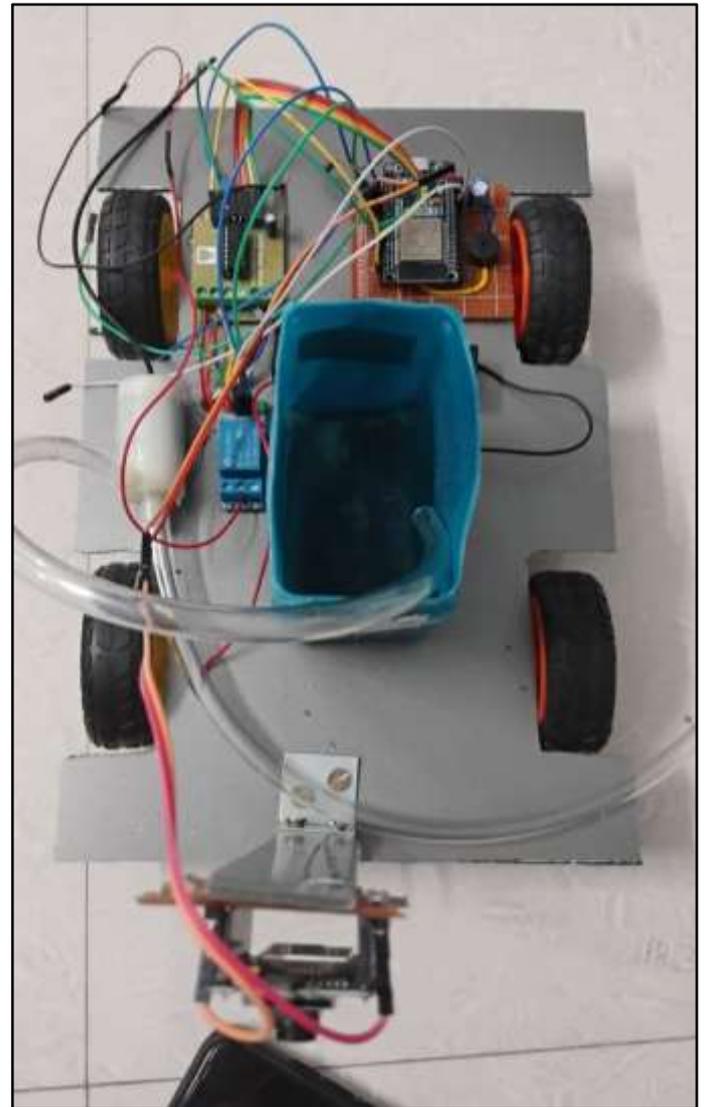


Fig. 5 Shows the Front View of Experimental Setup

RESULT

The Fire-Fighting Robot using Arduino successfully demonstrated reliable real-time fire response and remote monitoring capabilities. The ESP32 microcontroller effectively coordinated all system operations, ensuring smooth motor control, accurate obstacle avoidance, and timely activation of the firefighting mechanism. The L293D-driven BO motors enabled agile navigation in dynamic environments, while the ESP32-CAM provided a clear live video feed through the web-based dashboard for remote supervision and control. Upon fire detection, the single-channel relay precisely activated the 6V DC water pump, delivering immediate and targeted fire suppression. Overall, the integrated system proved efficient in detecting fires, maneuvering safely around obstacles, and executing rapid firefighting actions with minimal human intervention.

VI. CONCLUSION

The development of this multifaceted fire-fighting robot represents a significant stride towards proactive fire safety measures. By precise motor control mechanisms, and intelligent decision-making through the microcontroller, this system showcases a promising solution to the challenges of early fire detection and rapid intervention. The integration of an agile water deployment system underscores the system's capability to swiftly identify and mitigate fire hazards. This innovation stands as a testament to the potential of robotics and sensor technology in revolutionising firefighting strategies, offering a proactive approach to safeguard lives and property in the face of fire emergencies.

VII. REFERENCES

1. Tawfique Rakib, M. A. Rashid Sarkar, "Design and fabrication of an autonomous firefighting robot with multi sensor fire detection using PID controller", ICIEV Volume 23 issue-1 JUNE 2021.
2. Saravanan P., Soni Ishawarya, "Android controlled integrated semi-autonomous firefighting robot", International journal of innovative science Engg. and Technology 2021.
3. Shakthi Priyanka,R. Sangeetha, "Android controlled fire fighting robot", International journal of innovative science Engg. and Technology,Volume 3, 2020.
4. Nagesh MS, Deepika T V, Stafford Michahial, Dr M Shivakumar, "Fire Extinguishing Robot", International Journal of Advanced Research in Computer and Communication Engineering,Vol. 5, Issue 12, December 2021.
5. Sushrut Khajuria, Rakesh Johar, Varenayam Sharma, Abhideep Bhatti, "Arduino Based Fire Fighter Robot", International Journal of Scientific Engineering and Research (IJSER),Volume 5 Issue 5, May 2022.
6. Chaithanya K., Vidya H R, Gagana S , Nisarga, Dechakka M P. " IOT Based Fire Fighting Robot". IJCRT | Volume 13, Issue 5 May 2025
7. Swapnil Shivaji Jadhav, Sudarshan Shahu Bhosale, Vedant Gorakhnath Shelar, Parth Balavant Patil, Suraj Sayyad Jamadar. "Fire Fighter Robot Using IOT and Mobile Application". IJRISE. Nov 2024.
8. Kishor Sawarkar, Ashraf Shaikh, Vedant Gurav, Purva Naik and Sakshi Patil, Rajiv Gandhi Institute of Technology, Versova, Mumbai." Fire-Fighting Robot Using Arduino". JETIR May 2025, Volume 12, Issue 5. 2025.
9. DR.T.Menakadevi, P.Dinesh Kanna, M.Gokulnath. "ESP-32 BASED FIRE FIGHTING ROBOT". ALOCHANA JOURNAL (ISSN NO:2231-6329) VOLUME 13 ISSUE 12 2024.
10. Mr.Girme Ashwin, Ms.Kadam Nikita , Ms.Kale Mrunali, Ms.Snehal Sable. "FIREFIGHTER ROBOT USING IOT & ROBOTICS". International Journal of Engineering Technology and Management Sciences. Issue: 3 Volume No.9 May - June – 2025.