**Journal on Electronic and Automation Engineering**

**Vol: 4(2), June 2025**

**REST Publisher; ISSN: 2583-6951 (Online)**

**Website: https://restpublisher.com/journals/jeae/**

**DOI: https://doi.org/10.46632/jeae/4/2/14**

# Arduino – Based Fire Fighting Robot

***Ashok Reddy A, Ramakrishna D, Lokeswar Reddy K, Yugandhar Kumar J, Beena Sindhuri J**

*Annamacharya Institute of Technology &Science(AITK), Kadapa, Andhra Pradesh, India.*

**Corresponding author Email: ashokannapureddy20@gmail.com.*

***Abstract:*** *This project develops an Arduino-based firefighting robot for autonomous fire detection and suppression. Utilizing IR sensors, a servo-controlled water pump, and motor drivers, the robot navigates, detects flames, and extinguishes them. The system's design, implementation, and testing are detailed, highlighting the use of the Arduino UNO microcontroller and key components like the TCRER650 and MG90S servo motor. The robot's programming incorporates algorithms for efficient path finding and targeted water delivery, ensuring minimal water wastage. Real-time sensor data is processed to differentiate between ambient heat and actual flames, enhancing reliability. The modular design allows for future integration of wireless communication for remote monitoring and control. This research contributes to the growing field of accessible robotics for emergency response, focusing on practical and scalable solutions. This work demonstrates the potential of cost-effective, Arduino-driven solutions for small to medium-scale fire emergencies, paving the way for future enhancements in autonomous fire fighting robotics.*

***Keywords:*** *Fire Fighting Robot, Autonomous navigation, Infrared (IR) sensors, Fire detection and extinguishing, Robotics and automation.*

## 1. INTRODUCTION

The rapid advancements in technology and the increasing need for safety have led to the development of innovative solutions in various fields. One such field is fire fighting, where the integration of robotics and automation has shown great potential. This project focuses on the design and implementation of an Adriano-Based Fire Fighter Robot, an autonomous mobile robot designed to detect and extinguish fires. The robot utilizes infrared (IR) sensors to detect fire and a water pump controlled by a servo motor to extinguish it. The primary objective of this project is to create a cost-effective, efficient, and user-friendly solution for small-scale fire emergencies. Fire incidents pose a significant threat to both life and property. Traditional fire fighting methods often involve manual intervention, which can be dangerous and time-consuming. In many cases, the delay in responding to a fire can result in severe damage and loss. Additionally, certain environments, such as industrial settings and hazardous areas, are not easily accessible for human fire-fighters. There is a need for an autonomous system that can quickly detect and respond to fire incidents, minimizing the risk to human life and property.

## 2. LITERATURE SURVEY

A study conducted by Kim et al. (2018) explored the use of infrared sensors and ultrasonic sensors for fire detection and navigation in fire fighting robots. The study highlighted the importance of sensor fusion in improving the accuracy and reliability of fire detection. By combining data from multiple sensors, the robot was able to detect fires more accurately and navigate its environment more effectively. In another study, Zhang et al. (2019) investigated the use of machine learning algorithms for fire detection and localization in fire fighting robots. The study demonstrated the potential of using convolutional neural networks (CNNs) to analyse thermal images and identify fire sources. The use of CNNs allowed the robot to detect fires with high accuracy, even in challenging conditions with low visibility. A research paper by Chen et al. (2020) examined the integration of gas sensors in fire fighting robots for detecting flammable gases. The study emphasized the importance of sensor calibration and maintenance in ensuring accurate gas detection. The researchers also discussed the potential benefits of combining gas sensors with other types of sensors to enhance the overall effectiveness of fire fighting robots. The work of Liu et al. (2021) focused on the development of a fire fighting robot equipped with a water cannon and thermal imaging camera. The study highlighted the advantages of using thermal imaging for fire detection and targeting. The robot's water cannon were capable of delivering a precise and powerful stream of water to extinguish fires, demonstrating the potential for effective fire suppression.

## 3. EXISTING METHOD

One notable real-world example is the use of the Colossus robot, developed by Shark Robotics, during the 2019 Notre-Dame Cathedral fire in Paris. This project highlighted the robot's capabilities in a high-stakes, extremely challenging environment. The Colossus, a heavy-duty, remotely operated robot, was deployed to navigate the burning cathedral, which was filled with intense heat, smoke, and structural instability. Its robust design, including tracked locomotion and powerful water cannon, allowed it to access areas that were too dangerous for fire-fighters. The robot was used to deliver water directly to the heart of the fire, helping to cool and suppress flames, and it also assisted in preventing the fire from spreading to critical areas of the structure. The use of Colossus demonstrated the potential of fire fighting robots to significantly enhance safety and effectiveness in complex and hazardous fire situations, proving its value in preserving valuable historical structures and protecting human lives. This real-time deployment showcased the robot's ability to operate under extreme conditions, providing crucial support to human fire-fighters and contributing to the successful containment of the fire.

## 4. PROPOSED METHOD

This proposed firefighting robot system is designed for rapid fire detection and localized suppression in indoor environments. Utilizing an Arduino Uno as its central processing unit, the robot integrates an IR sensor array for efficient flame detection. Upon sensing a fire signature, the Arduino triggers a series of actions. The robot's mobility is achieved through gear motors, enabling it to navigate towards the fire source. A compact water tank, integrated into the robot's main body, supplies the fire suppression system. A servo motor, controlled by the Arduino, precisely directs a spray nozzle to target the detected flames. The system prioritizes localized suppression, minimizing water usage and potential damage. The Adriano's programming allows for customizable response patterns, including adjustable spray durations and motion algorithms, based on the intensity and location of the fire. The robot's compact design and responsive system make it suitable for deployment in confined spaces, offering a proactive approach to fire safety. Future iterations will incorporate a wireless communication module, allowing for remote monitoring and control via a mobile application. Additionally, the integration of a smoke sensor will enhance the robot's ability to detect fires in their early stages, and an obstacle avoidance system using ultrasonic sensors will improve navigation in complex environments. Finally, the inclusion of a feedback system, reporting water tank levels and fire suppression status, will ensure optimal operational awareness.

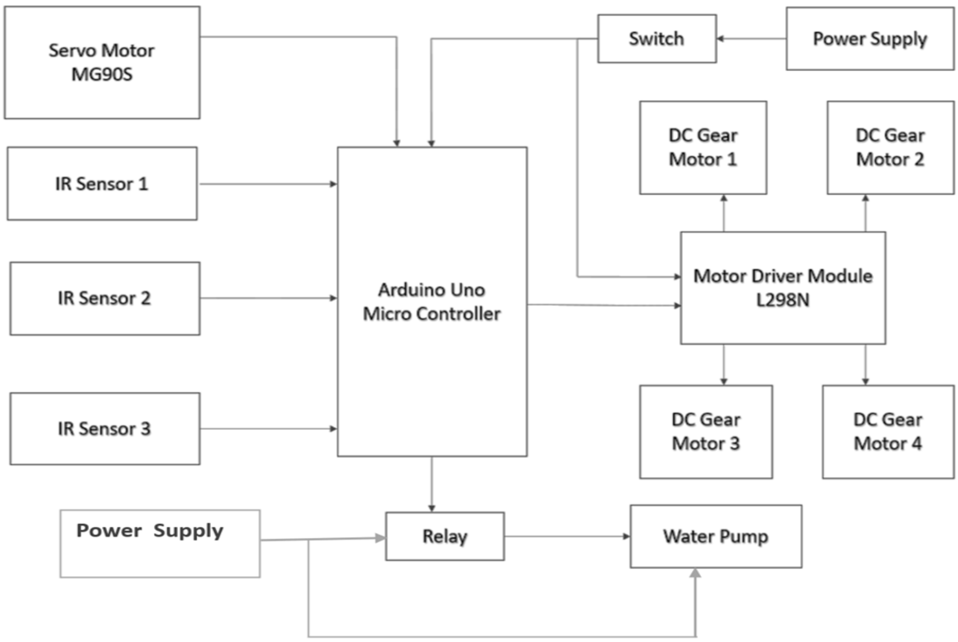


**FIGURE 1.** Block diagram of proposed system.

**Working:** The fire-fighting mobile robot operates autonomously to detect and extinguish fires in small to medium-sized environments. The robot continuously scans its surroundings using infrared (IR) sensors, which detect the infrared radiation emitted by flames. Once a fire source is detected, the robot activates its navigation system and begins moving toward the fire using motor-driven wheels controlled by an L298N motor driver. The on-board microcontroller (Adriano UNO) processes sensor data and adjusts the robot's path accordingly to avoid obstacles and reach the fire source accurately. When the robot is within range, it activates a water pump mechanism mounted on an MG90S servo motor, which directs a stream of water toward the flame. After extinguishing the fire, the robot resumes its monitoring mode, ready to respond to any further threats. This automated cycle ensures quick response, minimal human intervention, and improved safety in environments like homes, offices, and industrial facilities.

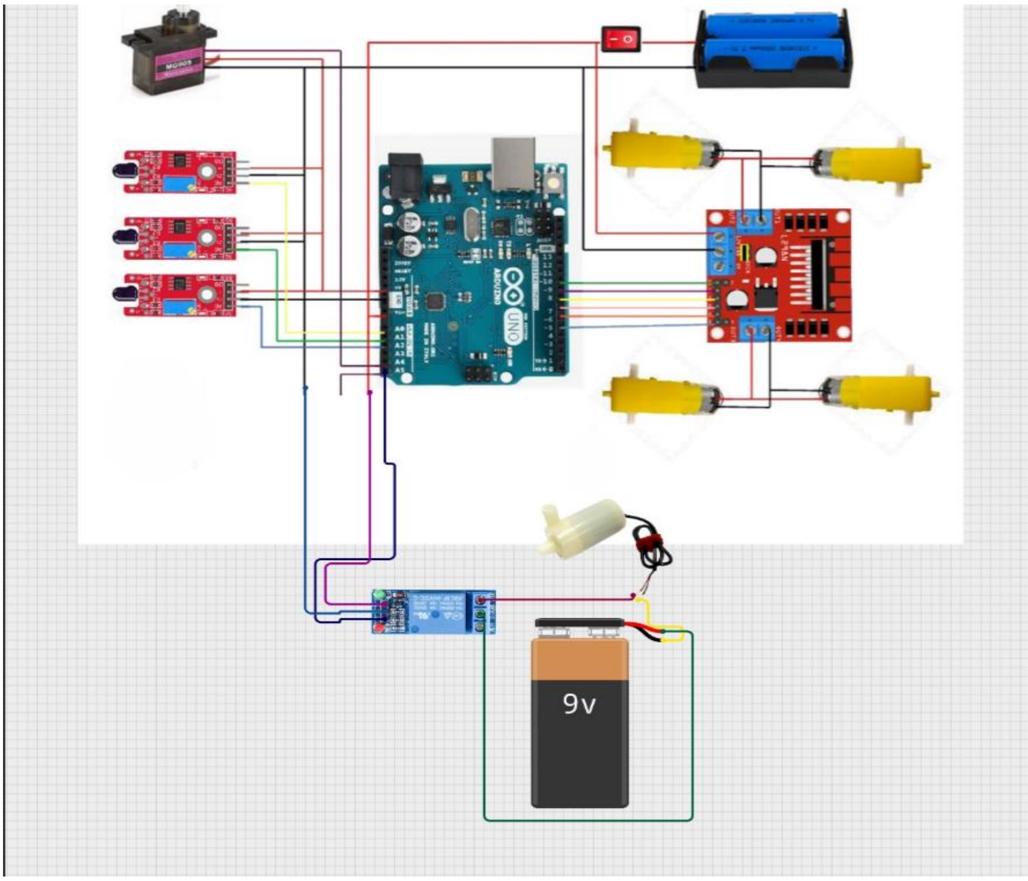


**FIGURE 2.** Schematic diagram of fire fighting robot.

## 5. RESULT

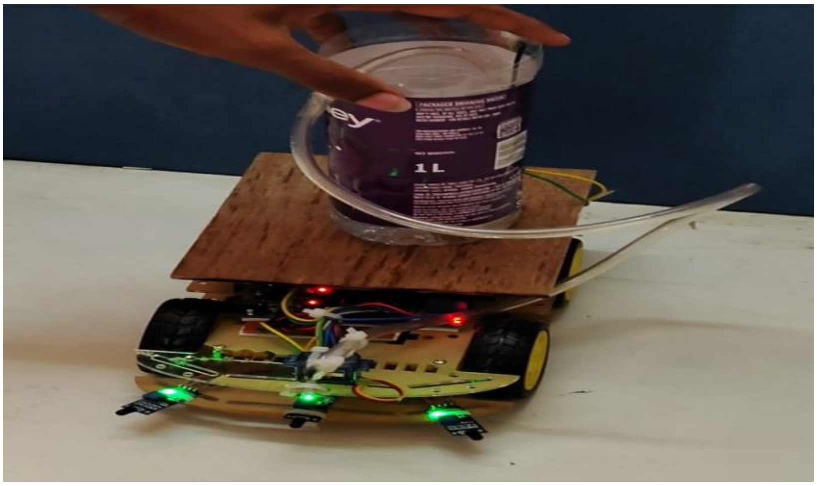

**FIGURE 3.** Detecting the fire through IR Sensor

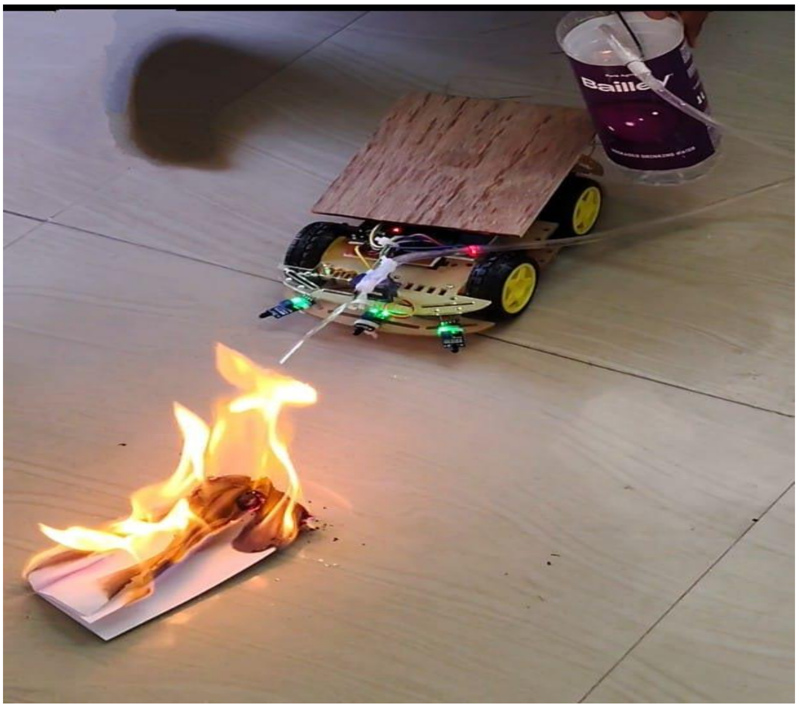


**FIGURE 4.** Spraying the water on fire

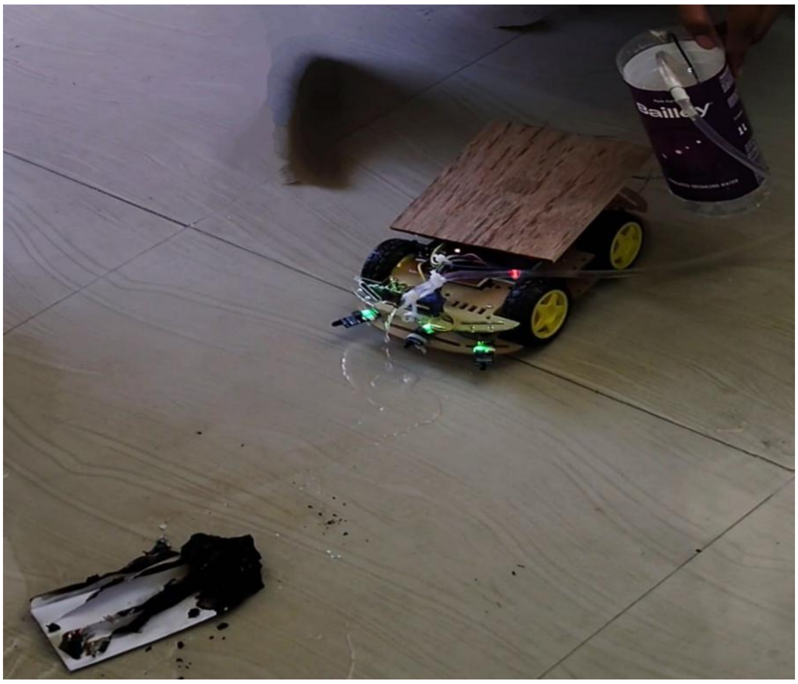


**FIGURE 12.** Extinguishing the fire.

## 6. CONCLUSION

The Adriano-Based Fire Fighter Robot represents a significant stride in the integration of robotics and automation in fire fighting applications. Conceived with the primary objective of developing an autonomous mobile robot capable of detecting and extinguishing small fires, the project successfully combined readily available hardware components with custom software algorithms to create a functional prototype. Utilizing the Adriano UNO microcontroller as the core processing unit, the robot employs infrared (IR) flame sensors for fire detection, DC motors for movement, a servo motor for nozzle control, and a water pump for extinguishing flames. The robot's design encapsulates a comprehensive system that integrates sensor inputs, decision-making processes, and actuator controls. Through meticulous hardware implementation and software development, the project achieved a synergy between mechanical and electronic components, resulting in a device that can autonomously navigate its environment, detect fire, and respond effectively.

## REFERENCES

[1]. S. A. Basha and S. J. P. Kumar, "Fire Fighting Robot with Multi-Sensor Fire Detection Using ATmega328 Microcontroller,"*International Journal of Engineering and Science Invention*, vol. 7, no. 6, pp. 65-72, Jun. 2018.

[2]. T. Tanaka and M. Yamamoto, "Development of Navigation System for Autonomous Mobile Robots Using Sensor Fusion,"*IEEE Transactions on Industrial Electronics*, vol. 67, no. 5, pp. 4005-4013, May 2020.

[3]. STMicroelectronics, "L298N Dual Full-Bridge Driver Datasheet," Rev. 11, May 2019. [Online]. Available: L298N Datasheet. [Accessed: Oct. 12, 2023].

[4]. Tower Pro, "Micro Servo MG90S Datasheet," [Online]. Available: MG90S Datasheet. [Accessed: Oct. 12, 2023].

[5]. Keyes, "KY-026 Flame Sensor Module Datasheet," [Online]. Available: KY-026 Flame Sensor. [Accessed: Oct. 13, 2023].

[6]. ElectroPeak, "How to Use Flame Sensor with Arduino," [Online]. Available: Flame Sensor Tutorial. [Accessed: Oct. 14, 2023].

[7]. Arduino Project Hub, "Controlling DC Motors with L298N Dual H-Bridge and Arduino," [Online]. Available: Motor Control Tutorial. [Accessed: Oct. 14, 2023].

[8]. Arduino Libraries, "Servo - Arduino Reference," [Online]. Available: Servo Library. [Accessed: Oct. 15, 2023]

**Copyright@ REST Publisher** 