STM JOURNALS

International Journal of
Electronics Automation

Volume 3, Issue 1, 2025
January–June
DOI (Journal): 10.37591/IJEA

https://journals.stmjournals.com/ijea

Research IJEA

Smart Firefighting Robot Using Arduino Uno

Vidyasagar Kori[1,*], Abhishek Kumar Ahirwar[1], Jitendra Kumar Saket[1], Sakshi Bagri[1], D.P.S. Chauhan[2]

Abstract

A fire is dangerous and can have many repercussions. Numerous accidents can be avoided by promptly identifying and putting out a fire. Human resources have been our mainstay thus far. The person's life is often in jeopardy as a result. Consequently, fire safety becomes essential to save lives. The fire extinguishing robot proposed and designed in this work locates the fire and utilizes sprinklers to extinguish it when the pump is activated. This robot detects fires accurately using three flame sensors. Without requiring human assistance, this Arduino-powered fire extinguisher robot model is designed to identify flames and extinguish them on its own. All operations are managed by an Arduino Uno microcontroller. Several sensors, including temperature, smoke, and flame sensors, are built inside the robot and are managed by the Arduino Uno microprocessor. With the help of its water ejector, this model robot can spray water where a fire is starting. Using a servo motor, the water ejector pipe can be moved in the desired direction. When the robot detects a fire, it uses gear motors and a motor driver to control its movement. It will then immediately start the water pump to put out the fire. An embedded system is used in the design and construction of firefighting robots. Within this framework, two flame sensors are used in the fire sensing and extinguishing robot's design for the fire detection system, and a sensor-based approach is used to train the fire detection and extinguishing process. The Arduino Uno, Flame Sensor, Water Dispenser, Bluetooth, and Ultrasonic Sensor are the primary components used in the creation of the firefighting robot. This robot may be controlled via Bluetooth and an Android-based application in the following directions: forward, backward, left, and right. When an obstruction is detected, this robot stops and restarts upon clearance.

Keywords: Firefighting robot, extinguishment mechanism, Arduino Uno, sensors, flame sensor, temperature sensor, movement system, power supply

INTRODUCTION

Human lives are at risk while fighting fires, especially in environments that are hazardous, difficult to access, or unsafe for humans, like industrial buildings, forests, or chemical plants. To address this, automation and robotics can play a crucial role in supporting human firefighters or even carrying out some firefighting tasks autonomously. Fires are one of the most destructive forces of nature, and fighting fires is one of the most dangerous jobs that require immediate response and precision. With the help of an Arduino Uno, the Smart Firefighting Robot can detect and put out fires on its own, providing a safer and more effective method of managing fires in dangerous situations.

The Arduino Uno microprocessor controls several sensors that are integrated inside the robot, including temperature, smoke, and flame sensors.

When the robot detects a fire, it may find its way to the source and use the proper extinguishing agent, such as foam, water, or fire retardant, to stop the fire

***Author for Correspondence**
Vidyasagar Kori
E-mail: vidyasagarkori7@gmail.com

[1]Students, Department of Electrical and Electronics, Vindhya Group of Institutions, Satna, Madhya Pradesh, India
[2]Assistant Professor, Department of Electrical and Electronics, Vindhya Group of Institutions, Satna, Madhya Pradesh, India

Received Date: March 08, 2025
Accepted Date: March 24, 2025
Published Date: April 08, 2025

Citation: Vidyasagar Kori, Abhishek Kumar Ahirwar, Jitendra Kumar Saket, Sakshi Bagri, D.P.S. Chauhan. Smart Firefighting Robot Using Arduino Uno. International Journal of Electronics Automation. 2025; 3(1): 21–27p.

from spreading. Wheels and motors enable the robot to move, while an extinguisher mechanism or water pump system supports its firefighting skills. Rescue operations and firefighting are regarded as extremely risky endeavors. Fire fighters and bystanders hurt inside buildings that pose a risk to rescue and evacuation are dangerous. Since most firefighters lack prior understanding of the infrastructure of danger buildings, they can have significant difficulties entering the building to put out the fire and finding the residents. When working with flames, heat, high CO or CO_2 levels, and physical and emotional stress, firefighters confront significant dangers. Many firefighters have suffered injuries while doing their jobs, which include putting out fires and saving lives.

LITERATURE REVIEW

Robot that fights fires automatically. Electric thermostat technology is used in the "Automatic Fire Fighting Robot" project for managing the fire around-the-clock. This project will yield the greatest results and is cost-effective with an exploratory application [1]. It has a wide range of applications in commercial, industrial, and residential settings. Synchronization of the system is several pieces of equipment, including the Arduino Uno, camera, wireless remote control, GSM module, fire sensor, and water jet. The robot may be operated remotely, automatically, and via live video [2].

Cyber security is used in the development and design of firefighter robotics. This specific application uses a cyber-security robot. There are four ways to go about it initially, microcontrollers are utilized in all additional circuits and parts for this project were coded and managed. The second, DC motor, rated at 12 V and 300 rpm, is used to move the robot left, right, forward, and backward [3, 4]. The third component is made up of two sensors: one that detects smoke and sounds and another that detects fire and sounds an alarm to start the pump [5]. The Saudi Electricity business and a cement business in the Southern Province both use the specified fire extinguishing technique. CRO is used to analyze the outcomes [6].

Design and construction of a self-sufficient firefighting robot that uses PID for multisensory fire detection supervisors: While the robot route to put out the fire, a basic algorithm based on an Arduino is utilized to detect the fire and determine the distance from the fire source [7]. A centrifugal pump is utilized to halt water for extinguishment when a fire is detected, and the robot is close to the fire. For efficient extinguishing, a water spreader is utilized. It is evident that using a water spreader significantly lowers the water's velocity [8].

Robotic firefighting design: The robot used to combat fires has four flame sensors and thermostats that continually check the temperature. When the temperature rises beyond the set threshold, a buzzer alerts the relevant industry people and the neighboring fire station, which is equipped with a GSM module, to the possibility of a fire. ‘Fighting Fires’, the robot continually checks the temperature at four sensors. If a fire occurs, it goes in the direction where the temperature is reported to be the highest of the four sensors and uses a water pump to put out the fire.

An essential component of firefighting robots is fire detection. In order to detect the presence of fire, these robots combine temperature, smoke, and flame sensors. According to research, the key to enabling robots to detect fires in a variety of contexts is sensor fusion, which uses data from several sensors to enhance accuracy and dependability [8, 9].

- *Flame Sensors:* By identifying the distinctive wavelengths that flames produce, flame detection sensors are frequently employed to detect the presence of fire.
- *Temperature Sensors:* Temperature sensors are crucial for tracking heat levels and determining a fire's severity. Systems like infrared sensors have been included to detect heat in low-visibility situations, while thermal sensors are utilized to monitor temperature changes.

After leaving the patrol path, the AFFMP's responsibilities include avoiding obstacles, locating out the fire flame and locating the fire source, more precisely utilizing a front flame sensor. Before the platform was deployed, the input from flame sensors was adjusted to account for the surrounding environment, outside interference, and the motion of the AFFMP to identify the fire source.

RESEARCH METHOD

Designing, creating, and testing a firefighting robot that can increase operational safety, and effectiveness is the main goal of this project.

Effectiveness and Efficiency

- To assess the robot's efficacy in putting out fires with suitable fire suppression equipment, such as foam, water, or specialty chemicals.
- Firefighters can be promptly sent to the scene of the fire thanks to the system. It guarantees that the event receives the appropriate kind of resources. By tracking location and circumstances in real time and reducing firefighter response times, it enhances safety results [10].

Design of the System

- Facilitating real-time dispatch, tracking, and communication between firemen and control centers, the system aims to increase the effectiveness of emergency response.

Hardware Components in System Design

- Arduino Uno microcontroller board.
- Relay: 5 V (DC).
- Connecting wires.
- Water Pump.
- Breadboard.
- Servo Motor
- Flame, Ultrasonic sensor.
- Motor Driver.
- Power Supply.
- DC Motor.

FLOW CHART

Software Tools

A variety of software technologies can be used in the design, development, and implementation of a firefighter emergency response system. Programming languages, frameworks, libraries, and other tools that support various system operations including incident detection, dispatching, communication, and tracking are examples of these technologies and including the Arduino Uno (Figure 1).

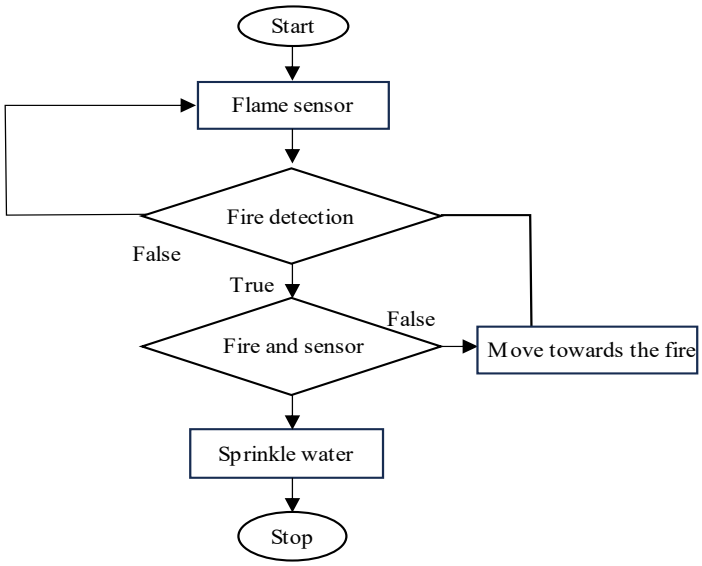


Figure 1. Flow Chart of the proposed system.


```
// Pin Definitions
int flameSensorPin =A0; // Flame sensor input pin (A0)
int motor1Pin1 =3;      // Motor driver pin 1
int motor1Pin2 =4;      // Motor driver pin 2
int motor2Pin1 =5;     // Motor driver pin 3
int motor2Pin2 =6;     // Motor driver pin 4
int waterPumpPin =7;   // Water pump pin (relay or motor control)
int servoPin =9;       // Servo motor pin for spray nozzle (optional)
int flameThreshold =500; // Threshold value for flame sensor (adjustable based on sensor)
including <Servo.h> // Servo motor library for controlling the water nozzle
Servo sprayServo;   // Create servo object to control the water spray nozzle
void setup() {
  // Set motor control pins as outputs
  pinMode (motor1Pin1, OUTPUT).
  pinMode (motor1Pin2, OUTPUT).
  pinMode (motor2Pin1, OUTPUT).
  pinMode (motor2Pin2, OUTPUT).
  pinMode (waterPumpPin, OUTPUT).
    // Set servo pin
  sprayServo. Attach (servo Pin); // Attaching servo to pin 9
  // Start Serial Monitor for debugging
  Serial. Begin (9600);}
void loop () {
  // Read the flame sensor value (analog input)
  int flame Value = analog Read(flameSensorPin).
  // Print the sensor value for debugging
  Serial.println(flameValue).
    // Check if flame is detected
  if (flameValue > flame Threshold)
    // Fire detected, stop the robot and activate water pump
    stopRobot();
    sprayWater();
  } else {
    // No fire detected, move the robot forward
    moveForward();
  }
delay(500);  // Delay to avoid excessive readings
}// Function to move the robot forward
void moveForward() {
  // Set motor pins to move forward
  digitalWrite(motor1Pin1, HIGH);
  digitalWrite (motor1Pin2, LOW);
  digitalWrite (motor2Pin1, HIGH);
  digitalWrite (motor2Pin2, LOW);
}// Function to stop the robot
void stopRobot () {
  // Stop the motors
  digitalWrite (motor1Pin1, LOW);
```

Enhancements

With these improvements, a firefighter robot would be more effective, robust, and able to help in a range of fire-related scenarios, eventually saving lives and enhancing firefighting operations.

CIRCUIT DIAGRAM

Implementation Steps

Implementing a firefighting robot would require a methodical process that involves software development, hardware design, and testing. An overview of the stages involved in building a fireman robot may be found in Figure 2.

Analysis of Requirements

- Specify the fireman robot's aims and objectives.
- Determine the environment (buildings, industrial facilities, etc.) in which the robot will work.
- Identify the essential characteristics (such as obstacle avoidance, navigation, fire detection, and suppression).
- Examine the necessary safety features, such as smoke detection, emergency shutdown, and real-time notifications.

Design of Robot Control Systems

- To operate the robot, pick a microcontroller or single-board computer (such as an Arduino or Raspberry).
- Wireless Communication: RF or Wi-Fi modules for monitoring or remote control.
- Transmission of Data: To return sensor data to a control station.
- Autonomous Navigation: Use algorithms (such as SLAM, PID control, etc.) to assist the robot in navigating over obstacles.
- Make sure it can find it and go close to the fire.

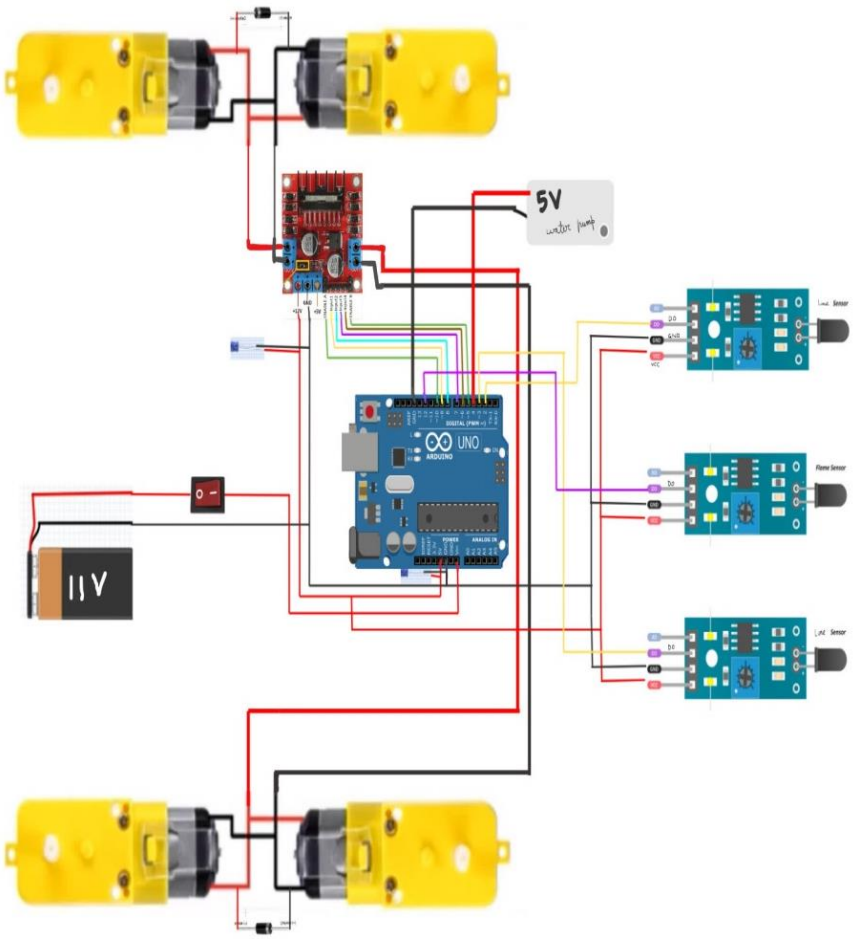
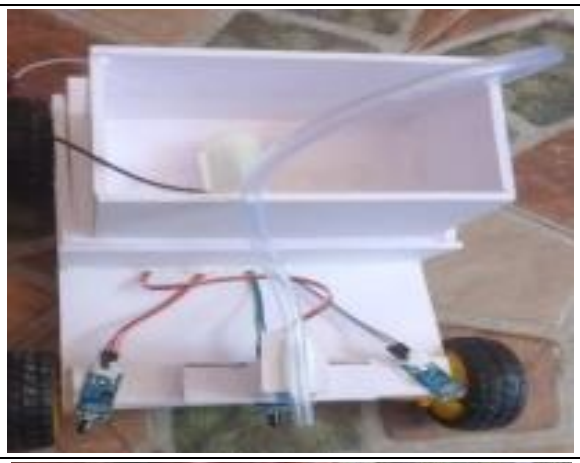


Figure 2. Circuit Diagram.

Robot Navigation

- Implement a SLAM (Simultaneous Localization and Mapping) system to help the robot map the environment.
- Use indoor localization techniques (e.g., beacons) for position tracking.
- Provides high-precision 3D maps of the environment, helping robots navigate and avoid obstacles.
- It is crucial for detecting hot spots, fire sources, and assessing fire intensity in smoke-filled environments.
- These sensors help measure proximity to obstacles, enabling robots to avoid collisions (Table 1).

Table 1. Output Result of the proposed system.

S.N.	Photo	Fire	Sensor	Output Result
1		-	off	-
2		on	Heat Detect	Sprinkle Water
3		on	No signal	off

CONCLUSION

With the potential to greatly improve emergency response and fire safety, the creation of a firefighter robot is an extremely ambitious and significant undertaking. A firefighter robot can identify and fight fires, navigate dangerous settings on its own, and lessen the risk to human firefighters by integrating sophisticated robotics, sensors, fire detection, and suppression technology. Careful planning in several areas is necessary for successful implementation. Making sure the robot is robust, equipped with the required sensors, and capable of extinguishing fires. Software development is the process of developing algorithms for decision-making, navigation, and fire detection while guaranteeing smooth communication with the robot's sensors and actuators. Testing and Validation: To guarantee dependability and safety, thoroughly test the robot under real-world circumstances. Such robots have the potential to completely transform firefighting as technology develops, particularly in situations where people cannot safely operate, such huge industrial fires or fires in unstable buildings. AI-driven decision-making increased multi-robot cooperation to more effectively combat bigger flames are possible future advancements. In conclusion, creating a firefighter robot poses several technological and engineering difficulties, but the outcome may save lives, save property, and promote safer firefighting techniques across the world.

REFERENCES

1. Pranamurti H, Murti A, Setianingsih C. Fire detection uses CCTV with image processing based raspberry pi. In J Phys: Conf Ser. 2019 May 1; 1201(1): 012015. IOP Publishing.
2. Kirubakaran S, Rithanyaa SP, Thanavarsheni SP, Vigneshkumar E. Arduino based firefighting Robot. In J Phys: Conf Ser. 2021 May 1; 1916(1): 012204. IOP Publishing.
3. Wu C, Ge F, Shang G, Zhao M, Wang G, Guo H, Wu L. Design and development of intelligent fire-fighting robot based on stm32. In: J Phys: Conf Ser. 2021; 1748(6): 062019. IOP Publishing.
4. Aliff M, Sani NS, Yusof MI, Zainal A. Development of firefighting robot (QROB). Int J Adv Comput Sci Appl. 2019; 10(1): 142–147.
5. Joo CK, Kim YC, Choi MH, Ryoo YJ. Self-localization for intelligent mobile robots using multiple infrared range scanning system. In 2007 IEEE International Conference on Control, Automation and Systems. 2007 Oct 17; 606–609.
6. Su KL. Automatic fire detection system using adaptive fusion algorithms for firefighting robots. In 2006 IEEE International Conference on Systems, Man and Cybernetics. 2006 Oct 8; 2: 966–971.
7. Anandakumar H, Umamaheswari K. A bio-inspired swarm intelligence technique for social aware cognitive radio handovers. Comput Electr Eng. 2018 Oct 1; 71: 925–37.
8. Arulmurugan R, Anandakumar H. Early detection of lung cancer using wavelet feature descriptor and feed forward back propagation neural networks classifier. In: Computational vision and bio inspired computing. Cham: Springer International Publishing; 2018; 103–110.
9. Nagesh MS, Deepika TV, Stafford Michahial DM. Fire Extinguishing Robot. International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE). 2016 Dec; 5(12): 2278–1021.
10. Diwanji M, Hisvankar S, Khandelwal C. Autonomous fire detecting and extinguishing robot. In 2019 IEEE 2nd International Conference on Intelligent Communication and Computational Techniques (ICCT). 2019 Sep 28; 327–329.

