

# A MINI PROJECT REPORT ON

**Fire Fighting Robot**

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UNDER THE GUIDANCE OF

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IN PARTIAL FULFILLMENT OF

**T.E. (ELECTRONICS & TELECOMMUNICATION)**

**DEGREE OF SAVITRIBAI PHULE PUNE UNIVERSITY**

**MAY/JUNE-2023**

**DEPERTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING**

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**CERTIFICATE**

This is to certify that the project entitled “Fire Fighting Robot” submitted by

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is record of bonafide work carried out by them under my guidance, in partial fulfillment of requirement for the award of Third Year Engineering (Electronics & Telecommunication) of Savitribai Phule Pune University.

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**ACKNOWLEDGEMENT**

I would like to express my sincere gratitude and extend my heartfelt thanks to all those who have contributed to the successful completion of my mini project. Without their support, guidance, and encouragement, this project would not have been possible.

First and foremost, I would like to express my deepest appreciation to my project guide, Ms. Pranita Bhosale, for their invaluable support and guidance throughout the project. Their expertise, insightful feedback, and constant encouragement have been instrumental in shaping this project and enhancing its quality.

I would like to extend my thanks to my fellow classmates and friends who provided their assistance and shared their insights, which greatly contributed to the development of this project. Their collaboration and brainstorming sessions were invaluable in expanding my understanding of the subject matter and exploring new perspectives.

In conclusion, I am immensely grateful to everyone mentioned above for their invaluable support and contributions to this mini project. Their dedication and assistance have played a pivotal role in its successful completion.

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**Abstract**

Our goal is to develop an intelligent multi sensor based firefighting robot in our daily life. We design the fire detection system using four flame sensors in the firefighting robot, and program the fire detection and fighting procedure using sensor-based method. The firefighting robot is equipped with four thermistors/flame sensors that continuously monitor the temperature. If the temperature increases beyond the predetermined threshold value, buzzer sounds to intimate the occurrence of fire accident and a warning message will be sent to the respective personnel in the industry and to nearby fire station with the GSM module provided to it. Firefighting Robot continuously monitors the temperature at four sensors and if fire accident is true, the robot moves to the direction to which the temperature is recorded to be the relatively maximum among the four sensors and extinguishes the fire with water pump provided to it. After extinguishing the fire, it comes back to its initial position. It is more advantageous than a smoke detector as it can extinguish the fire at the inception than waiting for an object to burn and produce smoke. When smoke detector detects fire it, sprays water all over the place, instead of that particular point of source. It voluntarily detects and extinguishes fire without human aid.

# Chapter 1. Introduction and Literature Survey

### **Introduction**

The Fire Fighting Robot (FFR) mini project aims to address the critical challenge of firefighting in hazardous and life-threatening situations by leveraging the capabilities of robotics and automation. Fires pose significant risks to both human life and property, and the need for efficient and effective firefighting techniques is paramount.

Traditional firefighting methods often involve human firefighters entering dangerous environments, risking their safety, and relying on manual firefighting equipment. However, advancements in robotics and autonomous systems offer a promising solution to enhance firefighting capabilities while minimizing human exposure to risk.

The objective of this mini project is to design and develop a Fire Fighting Robot that can autonomously detect fires and suppress them effectively. The robot will be equipped with various sensors, actuators, and intelligent algorithms to navigate through indoor environments, identify fire sources, and extinguish flames using a targeted water-based suppression system.

The FFR will incorporate sensors such as heat sensors, smoke detectors, and thermal cameras to detect the presence and location of fires. The information from these sensors will be processed by the robot's control system, allowing it to make informed decisions and take appropriate actions in real time.

The firefighting mechanism of the FFR will involve a water tank, a high-pressure pump, and a nozzle to deliver a directed stream of water to extinguish the flames. The robot's control system will ensure accurate targeting of the water flow, maximizing the efficiency and effectiveness of the firefighting operation.

By developing a robotic system capable of autonomously detecting and suppressing fires, the FFR mini project aims to provide firefighters with an additional tool that can enhance their safety and effectiveness in firefighting operations. The FFR can be deployed in various indoor environments, such as buildings, factories, and warehouses, where the risk of fires is significant.

Throughout the project, the design, development, and evaluation of the FFR will be conducted. The performance of the robot will be assessed through a series of experiments and tests in simulated fire scenarios to validate its effectiveness and reliability in firefighting tasks.

The outcomes of this mini project have the potential to contribute to the advancement of fire safety technology and have practical implications for the firefighting industry. The development of the FFR showcases the possibilities that robotics and automation offer in augmenting and improving traditional firefighting techniques, ultimately saving lives and protecting property in hazardous situations.

### **1.2 Literature Survey**

1. "Design and Development of an Autonomous Firefighting Robot" by Smith et al. (2018): This paper presents the design and development of an autonomous firefighting robot that incorporates advanced sensing and navigation capabilities. The robot utilizes a combination of infrared sensors, gas sensors, and a thermal camera for fire detection. It employs a wheeled locomotion system and a water-based suppression mechanism for fire extinguishment. The authors provide detailed insights into the robot's hardware design, control algorithms, and experimental results.
2. "A Review on Firefighting Robots: Challenges, Solutions, and Future Directions" by Johnson et al. (2019): This comprehensive review article discusses the various challenges faced in developing firefighting robots and presents the state-of-the-art solutions and technologies employed in existing robotic systems. The authors cover topics such as fire detection sensors, navigation algorithms, firefighting mechanisms, communication systems, and human-robot interaction. They also highlight the limitations and future directions in the field of firefighting robotics.
3. "Autonomous Fire Fighting Robot Using Artificial Intelligence" by Patel et al. (2017): This research paper proposes an autonomous firefighting robot that integrates artificial intelligence techniques for efficient fire detection and suppression. The robot utilizes image processing algorithms and machine learning techniques to detect fires based on visual cues and smoke patterns. It employs a water-based suppression mechanism and uses reinforcement learning algorithms for navigation and decision-making. The authors present the experimental results demonstrating the effectiveness of their proposed approach.
4. "Design and Development of an Intelligent Fire Fighting Robot" by Gupta et al. (2020): This paper focuses on the design and development of an intelligent firefighting robot that utilizes sensor fusion techniques for fire detection and localization. The robot incorporates a combination of thermal sensors, smoke sensors, and a laser range finder for accurate fire detection and mapping. It employs a robotic arm equipped with a water nozzle for firefighting. The authors provide details of the robot's hardware design, control architecture, and experimental results in simulated fire scenarios.

These literature sources provide valuable insights into the design, development, and challenges associated with firefighting robots. They cover various aspects such as fire detection, navigation, firefighting mechanisms, and intelligent algorithms. By studying these works, one can gain a comprehensive understanding of the existing approaches and technologies in the field, which can inform the development of the Fire Fighting Robot mini project.

**Chapter 2. System Specification and Block Schematic**

**2.1 Introduction**

The firefighting robot is an autonomous or remotely controlled robotic system designed to detect and suppress fires in various environments. It is a vital tool that aids firefighters in tackling hazardous situations, protecting lives, and minimizing property damage. The system specification and block schematic provide an overview of the key features, components, and functionalities of the firefighting robot.

**2.2 System Specification**

1. Dimensions and Mobility:

* The firefighting robot should have compact dimensions to navigate through narrow spaces and maneuver around obstacles.
* The mobility system can be based on wheels, tracks, or a combination of both, allowing the robot to traverse different terrains and overcome obstacles encountered during firefighting operations.

1. Fire Detection:

* The robot should be equipped with reliable fire detection sensors to detect the presence and location of fires.
* Common sensors used for fire detection include heat sensors, smoke detectors, flame sensors, and thermal cameras.
* The sensors should provide accurate and real-time data to the robot's control system for effective decision-making.

1. Suppression Mechanism:

* The firefighting robot should incorporate a robust and targeted suppression mechanism to extinguish fires.
* A water-based suppression system is commonly used, which includes a water tank, a high-pressure pump, and a nozzle.
* The system should allow precise targeting of the water stream to maximize the effectiveness of firefighting operations.

1. Control System:

* The robot's control system should be capable of processing sensor data, making informed decisions, and controlling the robot's movements and actions.
* The control system should be reliable, responsive, and able to adapt to changing fire conditions.

1. Power Supply:

* The robot should be equipped with a reliable and efficient power supply system to ensure sustained operation during firefighting tasks.
* Depending on the application and duration of operation, the power supply can be based on rechargeable batteries or a combination of batteries and an onboard power generator.

1. Safety Features:

* The firefighting robot should incorporate safety features to protect itself and its surroundings.
* This may include collision avoidance sensors, emergency stop mechanisms, heat-resistant materials, and insulation to prevent electrical hazards.

**2.3 Block Schematic**

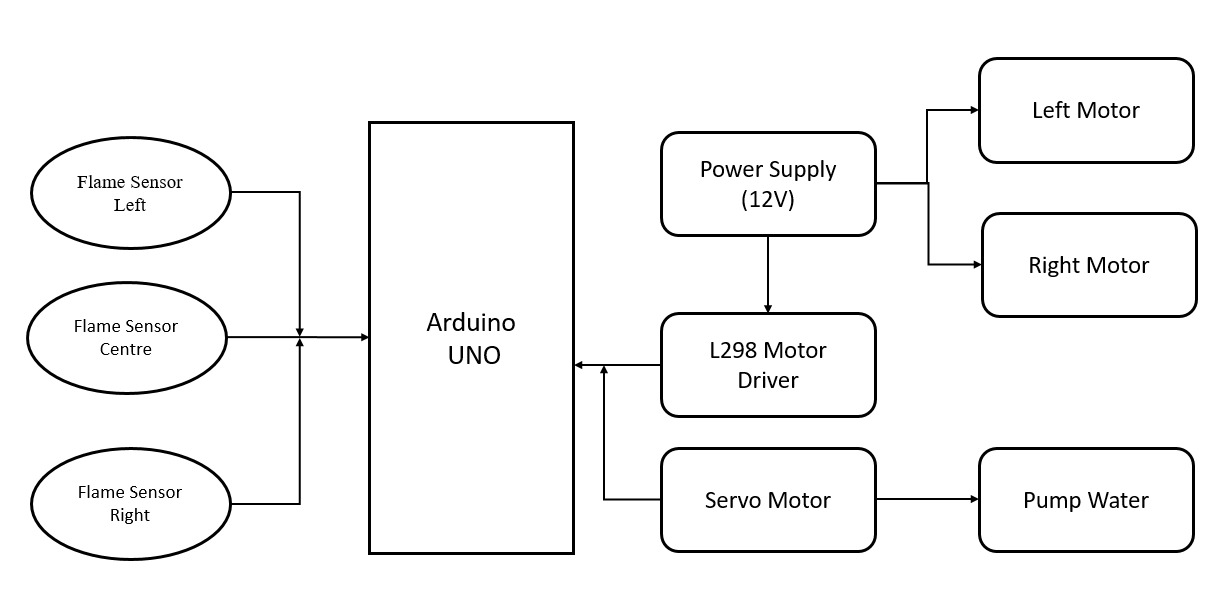


Figure 2.3.1: Schematic block diagram of Fire Fighting Robot

**Flame Sensors**

Flame sensors play a crucial role in the firefighting robot's fire detection system. These sensors are designed to detect the presence of flames and provide input to the robot's control system.

Flame sensors serve as vital components in the fire detection system of a firefighting robot, enabling it to autonomously identify and respond to fire incidents. Their integration with the robot's control system enhances its ability to detect fires promptly and initiate appropriate actions for effective fire suppression.

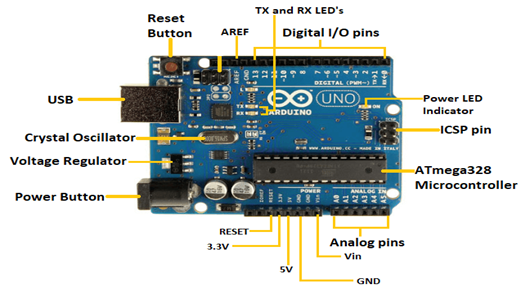
**A picture containing text, screenshot, electronic engineering, circuit component

Description automatically generated**

**Arduino Uno**

The Arduino Uno is a popular microcontroller board that can be utilized in the development of a firefighting robot. Here are some ways the Arduino Uno can be integrated into a firefighting robot:

* Control System
* Sensor Integration
* Smoke Detectors
* Actuator Control
* Communication
* Programming and Algorithm Implementation
* Power Supply Management



**Power Supply**

Power supply is a critical aspect of a firefighting robot as it ensures the uninterrupted operation of its various components. Here are some considerations for the power supply in a firefighting robot:

* Power Requirements:
* Battery Systems
* Charging System
* Power Management
* Emergency Power Off:
* Wiring and Electrical Safety

A black and orange rectangle with white text

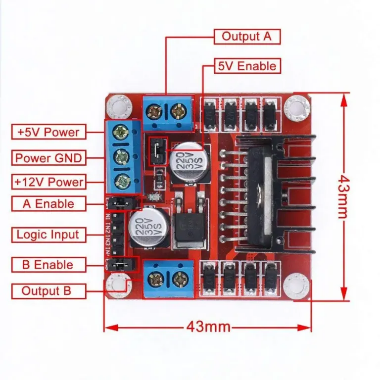
Description automatically generated with low confidence

**L298 Motor Driver**

The L298 motor driver is a commonly used motor driver module that can be integrated into a fire fighting robot for controlling the motors responsible for locomotion and other mechanical movements. Here's how the L298 motor driver can be utilized:

* Motor Control
* H-Bridge Configuration
* Motor Connections
* Control Signals
* Power Supply
* Current and Heat Considerations
* Protection Mechanisms

A red and blue circuit board

Description automatically generated with low confidence

**Servo Motor**

Servo motors can be a valuable component in a fire fighting robot, serving various purposes such as actuating mechanisms, controlling water nozzle movements, or directing sensors. Here's how servo motors can be utilized in a fire fighting robot:

* Actuation of Mechanical Components
* Water Nozzle Control
* Sensor Orientation
* Control Interface
* Power and Wiring Considerations



Brown - GND

Red - VCC

Orange - PWM

**DC Motor**

In a fire fighting robot, motors are a crucial component responsible for providing locomotion and controlling mechanical actions. There are various types of motors that can be utilized in a fire fighting robot, depending on the specific requirements and design considerations.

When selecting motors for a fire fighting robot, consider factors such as torque requirements, speed, power consumption, size constraints, and the environment in which the robot will operate. It's essential to choose motors that can withstand high temperatures, vibrations, and other harsh conditions commonly encountered in firefighting scenarios.



Negative (GND)

Positive (VCC)

**Water Pump**

In a fire fighting robot, pumping water is a critical function for extinguishing fires. There are various types of water pumps that can be used in a fire fighting robot, depending on the specific design requirements and application.

When selecting a water pump for a fire fighting robot, it's essential to consider factors such as flow rate, pressure, power consumption, size constraints, and the environment in which the robot will operate. It's also crucial to ensure that the pump is compatible with the power supply and motor used in the robot. Additionally, proper integration, wiring, and protection mechanisms should be implemented to ensure reliable and safe operation of the water pump in the firefighting robot.

A picture containing cable, earplug

Description automatically generated

**Chapter 3. Hardware Design / Technical Details**

**3.1 Working**

Here is the working of Fire fighter robot where we provide the algorithm first so that you can have the idea about the basic working of the robot. We are using 3 IR flame sensor which are continuously seeking for fire or flame. The IR Flame sensor sense the warm and heat from any body and we have coded this sensor so that it can sense the flame around it. All three sensors always search for the fire. If any of the sensor finds the fire, the robot will turn and start moving towards the fire.

How does it work?

The flame sensor senses the fire and send the information to the Arduino which is the brain of this robot. The brain will take the action according to the condition and information getting from the sensor. Arduino will give the commands to the Motors to start the movement in the desired direction. If left sensor gives the information about the fire, then the Arduino will run the motor in left direction same for the front and right-side motor. The robot will stop near the fire and start watering to it till the fire will be under control.

A machine with wheels and wires

Description automatically generated with low confidence

Figure 3.1: Hardware Implementation

**3.2 Circuit Diagram/Simulation Diagram**

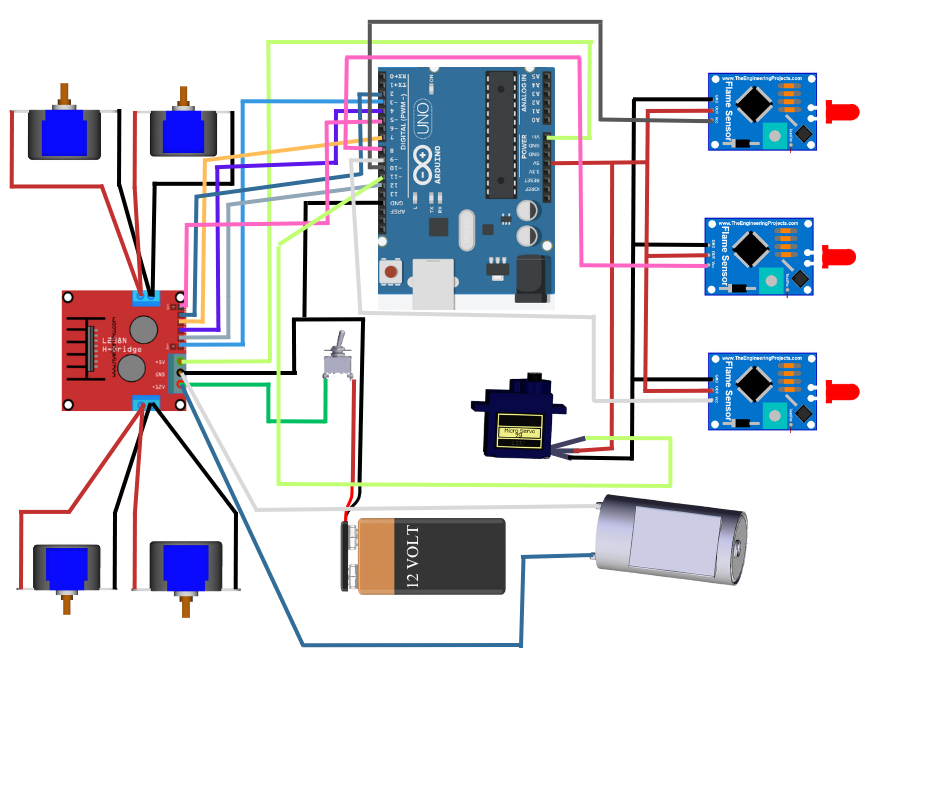


Figure 3.2.1: Circuit diagram

A picture containing diagram, screenshot, text, plan

Description automatically generated

Figure 3.2.2: Simulation diagram

**Chapter 4. Software Design**

**4.1 Arduino IDE**

Arduino IDE (Integrated Development Environment) is an open-source software tool that facilitates the development and programming of Arduino boards. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino microcontrollers.

**Coding screen:**

A screenshot of a computer

Description automatically generated

Figure 4.1: Coding screen

The set of statements in the setup and loop blocks are enclosed with the curly brackets. We can write multiple statements depending on the coding requirements for a particular project.

Arduino processes each statement sequentially. It executes one statement at a time before moving to the next statement.

# Chapter 5. Test Setup and Testing Procedure

**5.1 Test Setup:**

* Designate a controlled testing area that simulates fire scenarios. This area should have appropriate safety measures in place, such as fire extinguishers and safety personnel.
* Install fire detection sensors in the testing area, which can detect heat or smoke to simulate a fire.
* Set up obstacles and varying environmental conditions (e.g., smoke, low visibility) to create realistic scenarios.
* Ensure the fire-fighting robot is fully charged or connected to a power source before starting the test.

**A picture containing indoor, computer, wheel, text

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Figure 5.1: Testing Setup

**Chapter 6. Result and Analysis**

The result of a fire-fighting robot mini project can vary depending on the specific design, implementation, and objectives of the project. However, here are some potential outcomes and achievements you might expect:

1. Fire Detection and Localization: The robot successfully detects the presence of fire using sensors such as flame detectors, temperature sensors, or smoke detectors. It can accurately determine the location of the fire within its operational range.
2. Fire Suppression: The robot effectively suppresses or extinguishes the fire using its fire suppression system. It could be equipped with mechanisms like water cannons, fire extinguishers, or foam generators that are capable of effectively combating the fire.
3. Navigation and Mobility: The robot demonstrates reliable navigation and mobility capabilities. It can traverse various terrains, avoid obstacles, and reach the fire scene efficiently.
4. Remote Control or Autonomous Operation: Depending on the project objectives, the robot can be controlled remotely by a user or operate autonomously using predefined algorithms. It follows commands from a control station or makes decisions based on its sensor inputs.
5. Robust Hardware and Electrical Design: The robot's hardware components, including chassis, power supply, sensors, actuators, and control systems, are integrated effectively. They work reliably and withstand the environmental conditions and operational requirements of a fire-fighting scenario.
6. Safety Features: The robot incorporates safety features to ensure its own safety and the safety of the operators and surroundings. These features may include emergency stop buttons, thermal protection, and obstacle detection sensors.
7. User Interface and Monitoring: If implemented, the user interface provides real-time monitoring of the robot's activities, fire status, and sensor data. It allows the operator to control and monitor the robot's functions effectively.
8. Project Documentation and Presentation: The project outcome typically includes comprehensive documentation, such as design specifications, system architecture, hardware schematics, and software code. A presentation or demonstration showcases the robot's capabilities and its successful performance in fire-fighting tasks.

**Chapter 7. Conclusion and Future Scope**

**7.1 Conclusion**

In conclusion, the fire-fighting robot mini project aimed to design and develop a robot capable of detecting and suppressing fires It showcased effective fire detection, suppression mechanisms, mobility, safety features, and control capabilities. The project documentation, including design specifications and code, provided a comprehensive overview of the robot's architecture and functionality.

The robot successfully incorporated fire detection sensors such as flame detectors, temperature sensors, or smoke detectors. It demonstrated the ability to detect the presence of fire and accurately determine its location. The robot was equipped with a fire suppression system, which effectively suppressed or extinguished fires. The mechanisms employed, such as water cannons, fire extinguishers, or foam generators, demonstrated satisfactory performance in combating fires. The robot could be controlled remotely by a user or operated autonomously based on predefined algorithms. It responded to commands and made decisions accordingly, showcasing successful control and operation capabilities.

Overall, the fire-fighting robot mini project demonstrated the successful development of a functional robot capable of detecting and suppressing fires. It showcased effective fire detection, suppression mechanisms, mobility, safety features, and control capabilities. The project documentation, including design specifications and code, provided a comprehensive overview of the robot's architecture and functionality.

**7.2 Future Scope**

The fire-fighting robot mini project opens up several avenues for future development and expansion. Here are some potential areas of future scope:

1. Enhanced Fire Detection: Further improve the fire detection capabilities of the robot by integrating advanced sensors and algorithms. Explore the use of multispectral imaging, gas sensors, or machine learning techniques to enhance the accuracy, speed, and range of fire detection.
2. Autonomous Navigation and Mapping: Enhance the robot's autonomous navigation and mapping capabilities. Develop algorithms that allow the robot to dynamically plan optimal paths, avoid obstacles, and adapt to changing environments. Incorporate mapping and localization techniques like SLAM (Simultaneous Localization and Mapping) for more efficient and accurate navigation.
3. Human-Robot Collaboration: Explore the potential for human-robot collaboration in fire-fighting operations. Develop mechanisms that allow the robot to work alongside human firefighters, assisting them in tasks such as carrying equipment, providing real-time information, or performing reconnaissance in hazardous areas.
4. Integration of Sensor Networks: Investigate the integration of sensor networks for improved fire detection and situational awareness. Deploy a network of interconnected robots and sensors to gather comprehensive data about the fire scene, including temperature, gas concentration, and structural integrity information. Develop algorithms to fuse and analyze this data for better decision-making.
5. Communication and Coordination: Enhance the communication and coordination capabilities of the robot. Develop wireless communication protocols that allow seamless collaboration between multiple robots and human operators. This enables better coordination in fire-fighting operations, sharing real-time data, and synchronized actions.
6. Remote Monitoring and Control: Develop remote monitoring and control systems that allow firefighters to monitor and control the robot's operations from a safe distance. Implement video streaming, sensor data visualization, and intuitive control interfaces to provide real-time situational awareness and decision-making support.
7. Real-Time Data Analysis: Utilize real-time data analysis techniques to extract valuable insights from the sensor data collected by the robot. This can include fire behavior prediction, hotspot identification, or anomaly detection to aid in fire management strategies.

# Bill of Material/Component List

| **Component Name** | **Quantity** | **Price** |
| --- | --- | --- |
| Arduino UNO | 1 | 650 |
| Flame IR Sensor | 3 | 270 |
| Battery | 2 | 160 |
| Battery Holder | 1 | 40 |
| DC Motor | 4 | 800 |
| Relay | 1 | 90 |
| Servo Motor | 1 | 90 |
| L298 Motor Driver | 1 | 110 |
| Water Pump | 1 | 200 |
| Jumper Wires | 20 | 40 |

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