# THE SMARTFIRE EXTINGUISHER

**MINI PROJECT REPORT**

***Submitted by***



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| **ISHITHA S** | **2116230701117** |
| **ISHWARI RAJMOHAN** | **2116230701118** |



**In partial fulfillment for the award of the degree**

## BACHELOR OF ENGINEERING

***in***

## COMPUTER SCIENCE AND ENGINEERING



## RAJALAKSHMI ENGINEERING COLLEGE

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# BONAFIDE CERTIFICATE

Certified that this project **“THE SMARTFIRE EXTINGUISHER**” is the bonafide work of “**ISHITHA S (2116230701117) and ISHWARI RAJMOHAN (2116230701118)”** who carried out the project work under my supervision.

**SIGNATURE**
**Dr.N.Duraimurugan, M.Tech., Ph.D.**

Associate Professor,

Computer Science & Engineering

Rajalakshmi Engineering College (Autonomous)

Thandalam, Chennai -602105.

Submitted for the **ANNA UNIVERSITY** practical examination Mini-Project work viva voice held on___________________

**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

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**ISHITHA S** **2116230701117**
**ISHWARI RAJMOHAN** **2116230701118**

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# LIST OF ABBREVIATION

| ABBREVIATION | ACRONYM |
|---|---|
| **IOT** | Internet of Things |
| **L298N** | Dual H-Bridge Motor Driver IC |
| **BO MOTOR** | Battery Operated Motor |
| **ESP8266** | Espressif Wi-Fi Module |
| **IDE** | Integrated Development Environment |

# ABSTRACT

Fire accidents pose a significant threat to life and property, especially in environments where rapid human intervention is challenging or dangerous. To address this critical issue, this project introduces **THE SMART SMARTFIRE EXTINGUISHER**, an IoT-based autonomous fire-fighting robot designed to detect and extinguish fires efficiently and safely. The robot uses IR flame sensors to detect fires in real time. An Arduino UNO processes the data and controls BO motors via an L298 driver, guiding the robot toward the fire.

Upon reaching the fire, a servo-controlled nozzle and water pump activate to extinguish it. The robot operates in two modes: autonomous (sensor-based) and manual (remote-controlled via IoT or RF).

This dual-mode functionality ensures flexibility and enhances safety in fire-prone zones. In autonomous mode, the robot makes real-time decisions to avoid obstacles and adjust its path as needed. In manual mode, it allows human operators to intervene and guide the system remotely through a dedicated control interface.

The **SMART FIRE EXTINGUISHER** offers a cost-effective and scalable solution for fire safety, particularly in hazardous or inaccessible locations. Future enhancements will include Android-based remote monitoring, AI integration for fire-type recognition, robotic arms for human rescue operations, and deployment as aerial drones for large-scale incidents like forest fires. This intelligent fire-fighting system presents a forward-thinking approach to mitigating fire hazards while minimizing human risk.

# CHAPTER 1

## INTRODUCTION

### 1.1 INTRODUCTION

Fire disasters are unpredictable and often lead to devastating consequences including loss of life, destruction of property, and long-term environmental damage. Traditional fire-fighting methods rely heavily on human intervention, which puts fire-fighters at high risk, especially in hazardous environments such as chemical plants, warehouses, and remote areas. With advancements in robotics and the Internet of Things (IoT), there is a growing opportunity to create autonomous systems that can detect, assess, and suppress fires without risking human lives.

This project introduces an innovative solution titled THE SMARTFIRE EXTINGUISHER, an IoT-based autonomous fire-fighting robot. The system is designed to operate intelligently in fire-prone environments, detect the presence of fire through IR flame sensors, and take appropriate actions to extinguish it. The robot not only ensures rapid response but also minimizes human exposure to danger. It integrates mobility, real-time detection, and water-spraying mechanisms controlled by a central microcontroller, offering a smarter and safer approach to fire management.

### 1.2 SCOPE OF THE WORK

This project involves designing a mobile robot that autonomously detects and extinguishes small fires using IR sensors, BO motors, an L298 driver, and a water-spraying system. It supports both autonomous and IoT-based manual modes for indoor and outdoor use. Future scope includes drone integration, AI fire analysis, and Android remote control.

### 1.3 PROBLEM STATEMENT

Fire accidents occur frequently in both residential and industrial areas, posing a serious risk to human safety and infrastructure. Current fire-fighting methods are largely dependent on human presence, which delays response time and increases the risk to fire-fighters. There is a lack of low-cost, autonomous systems that can monitor, detect, and act on fire emergencies in real time. Therefore, there is a need for a smart, responsive robot that can reduce human intervention and risk while improving the efficiency of fire suppression.

## 1.4 AIM AND OBJECTIVES OF THE PROJECT

This project aims to build an IoT-based autonomous fire-fighting robot that detects and extinguishes fires with minimal human input. It uses IR sensors, motorized navigation, and a servo-controlled water system, operating in both autonomous and manual modes. Future goals include AI fire analysis, mobile app control, and drone-based scalability.

# CHAPTER 2

## SYSTEM SPECIFICATIONS

### 2.1 IOT DEVICES

1. Arduino UNO – Microcontroller for processing and control
2. IR Flame Sensors (3 units) – Detect fire from right, front, and left directions
3. L298N Motor Driver Module – Controls direction and speed of BO motors
4. BO DC Motors (4 units) – Enable robot movement
5. Servo Motor – Rotates the water nozzle
6. Water Pump – Sprays water to extinguish fire

### 2.2 SYSTEM HARDWARE SPECIFICATIONS

| | |
|---|---|
| PROCESSOR | Intel Core i5 10th Gen |
| MEMORY SIZE | 8 GB (Minimum) |
| HDD | 40 GB (Minimum) |

### 2.3 SOFTWARE SPECIFICATIONS

| | |
|---|---|
| Operating System | Windows 11 |
| Arduino IDE | Read/Write Code to Arduino |
| Programming Language | Arduino C++ |

# CHAPTER 3
# SYSTEM DESIGN

## 3.1 ARCHITECTURE DIAGRAM

An architecture diagram is a graphical representation of a set of concepts, that are part of an architecture, including their principles, elements and components

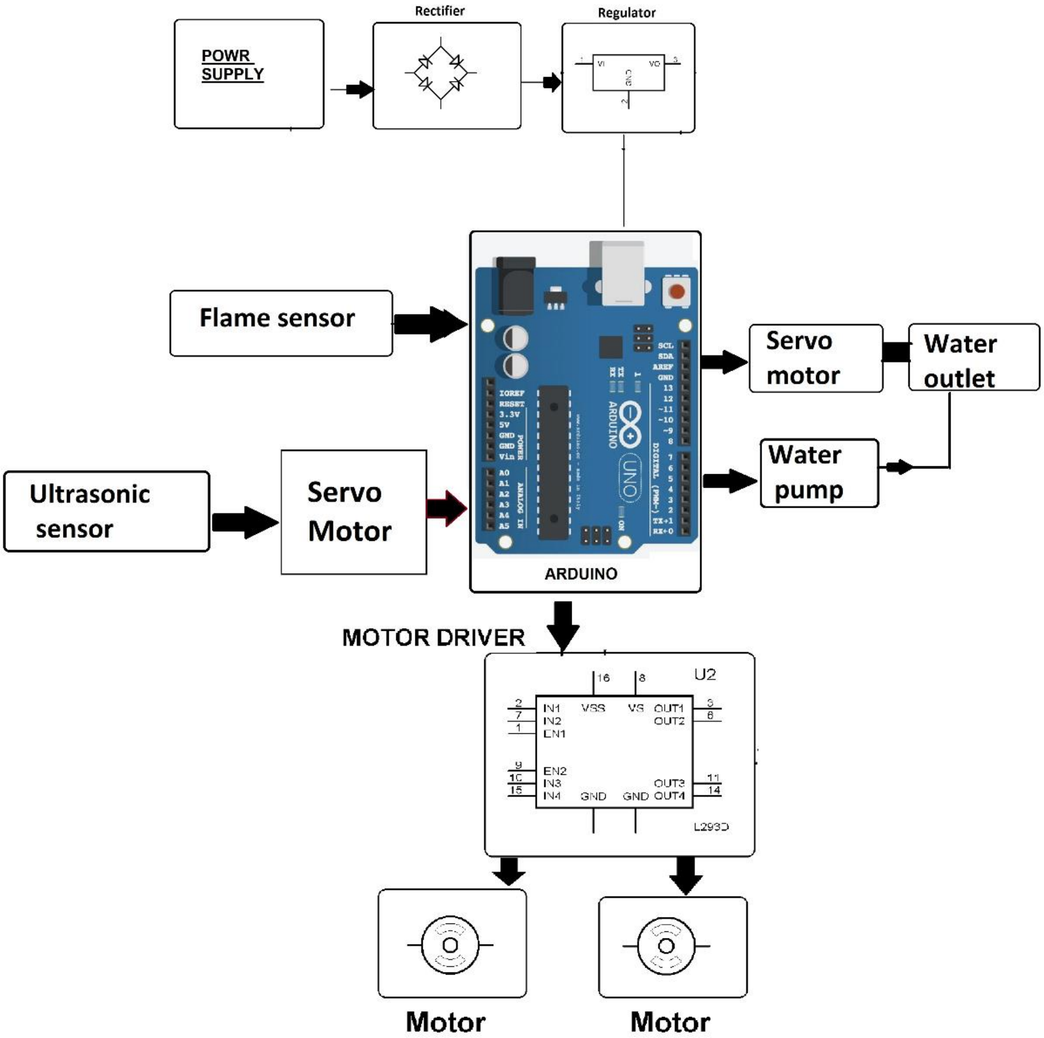


**Figure 3.1** Architecture Diagram

From the above Figure 3.1, the architecture of the system is well understood.

## 3.2 USE CASE DIAGRAM

A use case is a list of actions or event steps typically defining the interactions between a role (known in the Unified Modelling Language as an actor) and a system to achieve a goal. The actor can be a human or other external system.

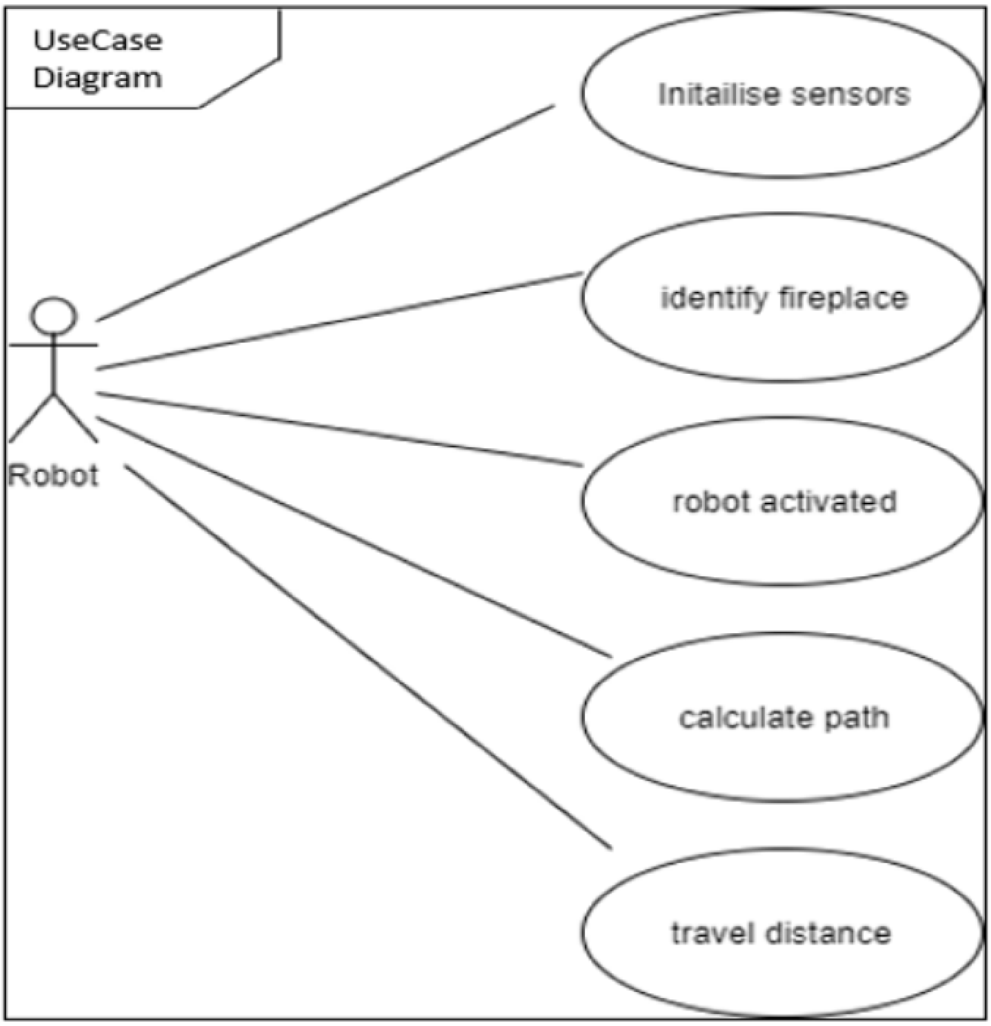


**Figure 3.2** Use case diagram

From the above figure 3.2, the interactions between a role in the system is shown

### 3.3 ACTIVITY DIAGRAM

An activity in Unified Modelling Language (UML) is a major task that must take place in order to fulfill an operation contract. Activities can be represented inactivity diagrams. An activity can represent: The invocation of an operation. A step in a business process.

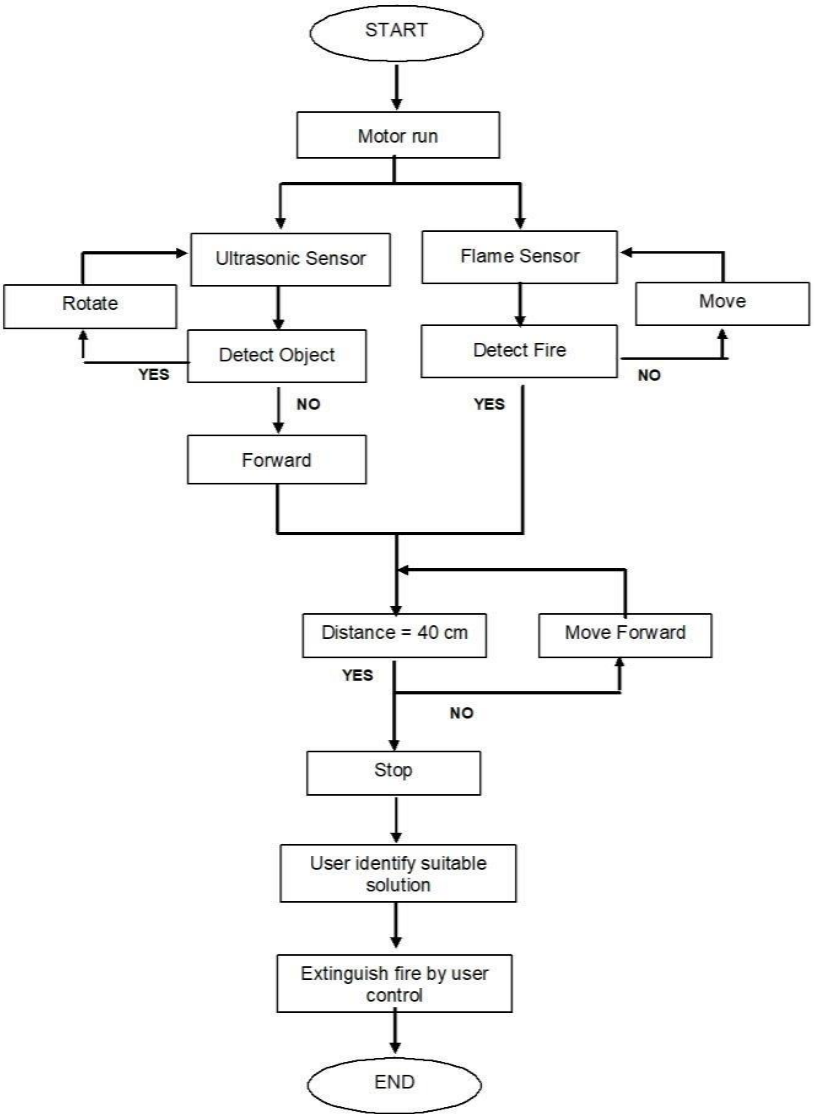


**Figure 3.3** Activity Diagram

From the above figure 3.3, the activities of the system are shown

## 3.4 CLASS DIAGRAM

A class diagram is an illustration of the relationships and source code dependencies among classes in the Unified Modelling Language (UML). In this context, a class defines the methods and variables in an object, which is a specific entity in a program or the unit of code representing that entity.

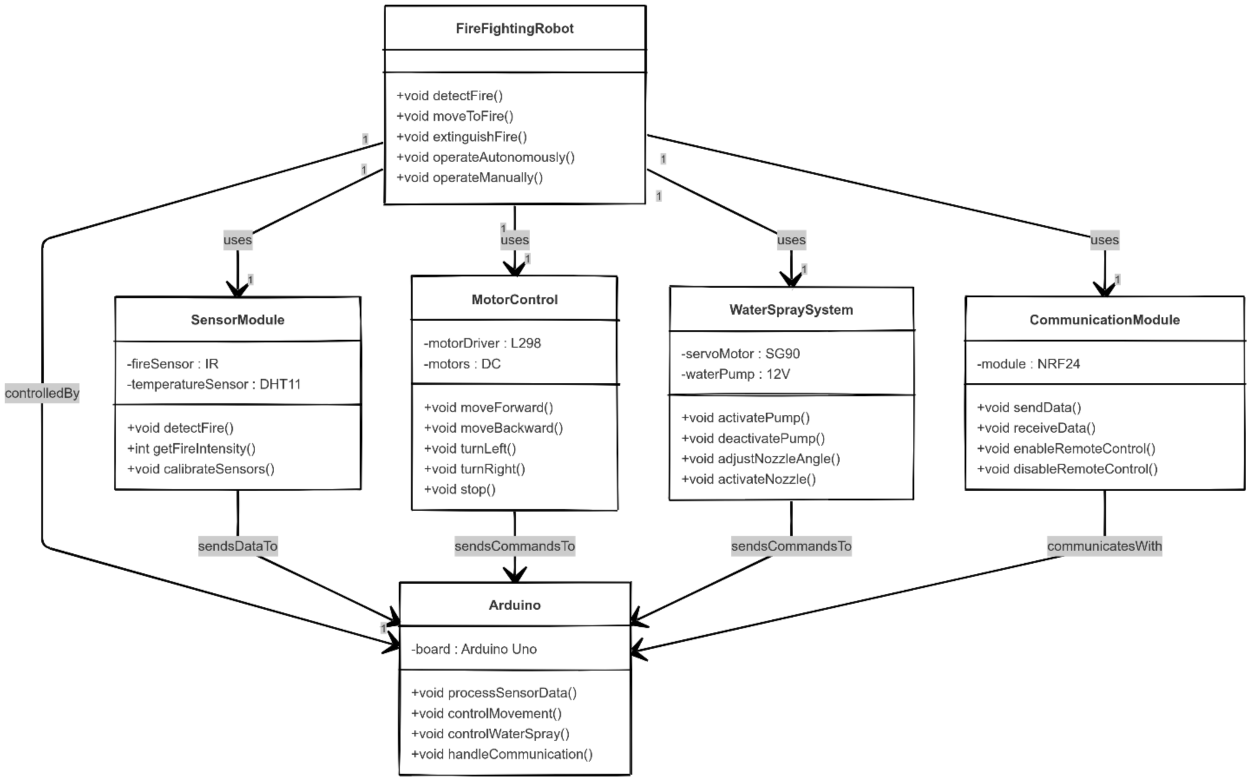


**Figure 3.4** Class Diagram

The above Figure 3.4 is the class diagram for the system.

# CHAPTER 4

# MODULE DESCRIPTION

## 4.1 HARDWARE MODULE:

The hardware module includes the physical components responsible for sensing, mobility, and fire suppression. It consists of an Arduino UNO microcontroller, IR flame sensors for fire detection, BO motors for movement, an L298 motor driver for motor control, a water pump for extinguishing fire, and a servo motor to control the water nozzle. A power supply unit (battery pack) provides the required voltage to all components. The module is designed for real-time response and precise mechanical actuation in hazardous environments.

## 4.2 DATA COLLECTION AND PROCESSING MODULE:

This module is responsible for collecting environmental data through IR flame sensors and processing it via the Arduino UNO. When a fire is detected, sensor data is processed to determine the direction and intensity of the flame. The Arduino interprets this data and makes decisions about the robot’s movement and activation of the extinguishing system. It serves as the brain of the system, managing all incoming signals and initiating appropriate responses based on the programmed logic.

## 4.3 CONTROL AND PROCESSING MODULE:

At the core of the system is the Arduino UNO, which processes input from the flame sensors and controls the motors, pump, and servo motor based on predefined logic. It acts as the central controller of the entire robot.

## 4.4 FIRE EXTINGUISHING MODULE:

Once a fire is detected, this module is activated. It includes a servo motor to rotate the nozzle and a water pump to spray water towards the fire. The nozzle sweeps across an arc to ensure maximum coverage.

# CHAPTER 5

## TABLE

### 5.1 HARDWARE COMPONENTS TABLE

| S.NO | ATTRIBUTE | TYPE |
|---|---|---|
| 1 | COMPONENT_ID | NUMBER(5) |
| 2 | COMPONENT_NAME | VARCHAR(45) |
| 3 | SENSOR_TYPE | VARCHAR(45) |
| 4 | MOTOR_TYPE | VARCHAR(45) |
| 5 | POWER_RATING | NUMBER(5,2) |
| 6 | CONTROL_TYPE | VARCHAR(20) |
| 7 | CONNECTION_TYPE | VARCHAR(20) |

### 5.2 SENSOR DATA TABLE

| S.NO | ATTRIBUTE | TYPE |
|---|---|---|
| 1 | SENSOR_ID | NUMBER(5) |
| 2 | SENSOR_TYPE | VARCHAR(45) |

| | | |
|---|---|---|
| 3 | SENSOR_READING | NUMBER(5,2) |
| 4 | TIME | TIMESTAMP |
| 5 | LOCATION | VARCHAR(45) |

## 5.3 MOTION DATA TABLE

| S.NO | ATTRIBUTE | TYPE |
|---|---|---|
| 1 | MOTION_ID | NUMBER(5) |
| 2 | COMPONENT_ID | NUMBER(5) |
| 3 | MOTOR_STATUS | VARCHAR(20) |
| 4 | POSITION_X | NUMBER(5,2) |
| 5 | POSITION_Y | NUMBER(5,2) |
| 6 | DIRECTION | VARCHAR(20) |
| 7 | TIME | TIMESTAMP |

## 5.4 FIRE DETECTION DATA TABLE

| S.NO | ATTRIBUTE | TYPE |
|---|---|---|
| 1 | FIRE_ID | NUMBER(5) |
| 2 | SENSOR_ID | NUMBER(5) |
| 3 | FLAME_INTENSITY | NUMBER(5,2) |
| 4 | LOCATION | VARCHAR(45) |
| 5 | TIME_DETECTED | TIMESTAMP |

# CHAPTER 6

# SAMPLE CODING

```
#define enA 10//Enable1 L298 Pin enA
#define in1 9 //Motor1 L298 Pin in1
#define in2 8 //Motor1 L298 Pin in2
#define in3 7 //Motor2 L298 Pin in3
#define in4 6 //Motor2 L298 Pin in4
#define enB 5 //Enable2 L298 Pin enB
#define ir_R A0
#define ir_F A1
#define ir_L A2
#define servo A4
#define pump A5
int Speed = 160; // Write The Duty Cycle 0 to 255 Enable for Motor Speed
int s1, s2, s3;
void setup(){ // put your setup code here, to run once
Serial.begin(9600); // start serial communication at 9600bps
pinMode(ir_R, INPUT);// declare fire sensor pin as input
pinMode(ir_F, INPUT);// declare fire sensor pin as input
pinMode(ir_L, INPUT);// declare fire sensor pin as input
pinMode(enA, OUTPUT); // declare as output for L298 Pin enA
pinMode(in1, OUTPUT); // declare as output for L298 Pin in1
pinMode(in2, OUTPUT); // declare as output for L298 Pin in2
pinMode(in3, OUTPUT); // declare as output for L298 Pin in3
pinMode(in4, OUTPUT); // declare as output for L298 Pin in4
pinMode(enB, OUTPUT); // declare as output for L298 Pin enB
pinMode(servo, OUTPUT);
pinMode(pump, OUTPUT);
for (int angle = 90; angle <= 140; angle += 5) {
servoPulse(servo, angle); }
for (int angle = 140; angle >= 40; angle -= 5) {
```

```
servoPulse(servo, angle); }
for (int angle = 40; angle <= 95; angle += 5) {
servoPulse(servo, angle); }
analogWrite(enA, Speed); // Write The Duty Cycle 0 to 255 Enable Pin A for Motor1
SpeedanalogWrite(enB, Speed); // Write The Duty Cycle 0 to 255 Enable Pin B for Motor2
Speeddelay(500);
}
void loop(){
s1 = analogRead(ir_R);
s2 = analogRead(ir_F);
s3 = analogRead(ir_L);
//=============================================================
// Auto Control
//=============================================================
Serial.print(s1);
Serial.print("\t");
Serial.print(s2);
Serial.print("\t");
Serial.println(s3);
delay(50);
if(s1<250){
Stop();
digitalWrite(pump, 1);
for(int angle = 90; angle >= 40; angle -= 3){
servoPulse(servo, angle);
}
for(int angle = 40; angle <= 90; angle += 3){
servoPulse(servo, angle);
}
}
else if(s2<350){
Stop();
digitalWrite(pump, 1);
for(int angle = 90; angle <= 140; angle += 3){
```

```
servoPulse(servo, angle);
}
for(int angle = 140; angle >= 40; angle -= 3){
servoPulse(servo, angle);
}
for(int angle = 40; angle <= 90; angle += 3){
servoPulse(servo, angle);
}
}
else if(s3<250){
Stop();
digitalWrite(pump, 1);
for(int angle = 90; angle <= 140; angle += 3){
servoPulse(servo, angle);
}
for(int angle = 140; angle >= 90; angle -= 3){
servoPulse(servo, angle);
}
}
else if(s1>=251 && s1<=700){
digitalWrite(pump, 0);
backword();
delay(100);
turnRight();
delay(200);
}
else if(s2>=251 && s2<=800){
digitalWrite(pump, 0);
forword();
}
else if(s3>=251 && s3<=700){
digitalWrite(pump, 0);
backword();
delay(100);
```

```
turnLeft();
delay(200);
}else{
digitalWrite(pump, 0);
Stop();
}
delay(10);
}
void servoPulse (int pin, int angle){
int pwm = (angle*11) + 500; // Convert angle to microseconds
digitalWrite(pin, HIGH);
delayMicroseconds(pwm);
digitalWrite(pin, LOW);
delay(50); // Refresh cycle of servo
}
void forword(){ //forword
digitalWrite(in1, HIGH); //Right Motor forword Pin
digitalWrite(in2, LOW); //Right Motor backword Pin
digitalWrite(in3, LOW); //Left Motor backword Pin
digitalWrite(in4, HIGH); //Left Motor forword Pin
}
void backword(){ //backword
digitalWrite(in1, LOW); //Right Motor forword Pin
digitalWrite(in2, HIGH); //Right Motor backword Pin
digitalWrite(in3, HIGH); //Left Motor backword Pin
digitalWrite(in4, LOW); //Left Motor forword Pin
}
void turnRight(){ //turnRight
digitalWrite(in1, LOW); //Right Motor forword Pin
digitalWrite(in2, HIGH); //Right Motor backword Pin
digitalWrite(in3, LOW); //Left Motor backword Pin
digitalWrite(in4, HIGH); //Left Motor forword Pin
}
void turnLeft(){ //turnLeft
```

```
digitalWrite(in1, HIGH); //Right Motor forword Pin
digitalWrite(in2, LOW); //Right Motor backword Pin
digitalWrite(in3, HIGH); //Left Motor backword Pin
digitalWrite(in4, LOW); //Left Motor forword Pin
}
void Stop(){ //stop
digitalWrite(in1, LOW); //Right Motor forword Pin
digitalWrite(in2, LOW); //Right Motor backword Pin
digitalWrite(in3, LOW); //Left Motor backword Pin
digitalWrite(in4, LOW); //Left Motor forword Pin
}
```

# CHAPTER 7

# PHOTOS

## 1. Circuit Diagram

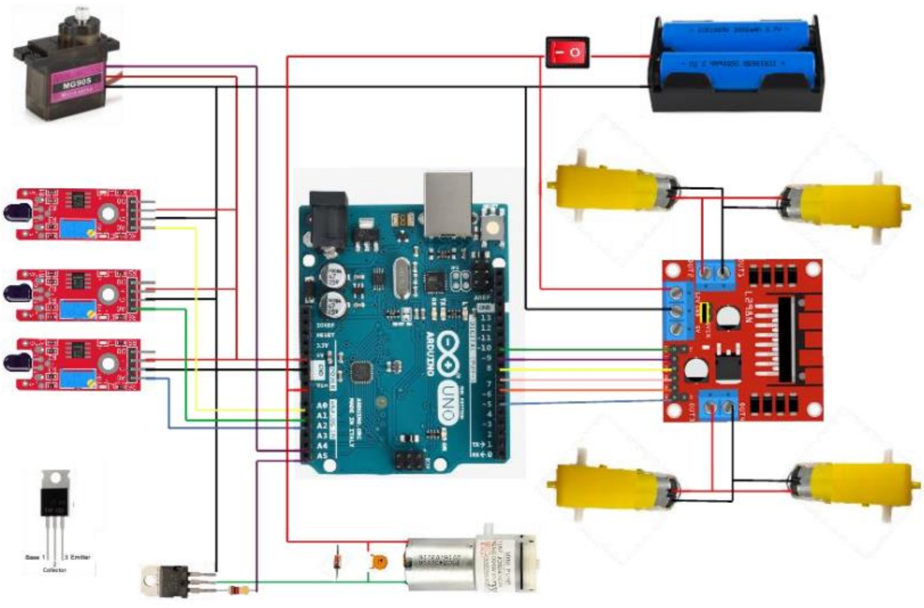

**Figure 7.1** Circuit Diagram

## 2. Prototype

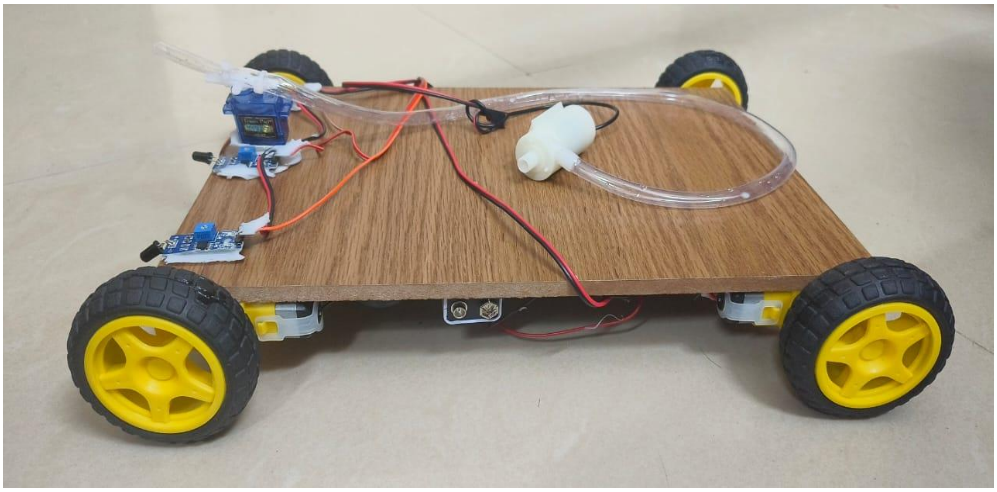

**Figure 7.2** Pictures of the prototype

# CHAPTER 8

## CONCLUSION AND FUTURE ENHANCEMENT

The SMARTFIRE EXTINGUISHER IoT-based autonomous fire-fighting robot represents a significant advancement in fire safety and emergency response. By integrating real-time fire detection through IR flame sensors, autonomous navigation, and an automated water-spraying mechanism, the system offers an innovative and cost-effective solution for fire control. The robot's ability to operate in both autonomous and manual modes provides flexibility, ensuring that it can efficiently tackle fires with minimal human intervention. This system not only reduces the risks associated with human involvement in fire-fighting but also ensures a rapid, reliable, and automated response to fire incidents.

The system's successful implementation paves the way for more intelligent fire safety solutions that can be deployed in various hazardous environments, contributing to enhanced safety and quicker response times. It represents a key step toward the integration of robotics and IoT in critical infrastructure and emergency services, promising more effective disaster management.

Future enhancements for the SMARTFIRE EXTINGUISHER system aim to improve efficiency and extend its applications in firefighting and rescue operations. A major upgrade would be the integration of Artificial Intelligence (AI) to help the robot analyze fire conditions, distinguish between fire types, and choose the most effective extinguishing method. AI would also enhance navigation and real-time decision-making.

Remote monitoring through mobile apps or cloud platforms could allow users to track the robot's status, location, and fire activity from anywhere. For large-scale incidents like forest fires, the addition of drones could offer aerial support and faster fire suppression over wider areas. To enhance rescue capabilities, the robot can be equipped with a robotic arm to assist trapped individuals. Improving battery life or adding solar power would support longer operations in remote areas. Future upgrades may also include multi-robot coordination and predictive maintenance for better performance, reliability, and safety during emergencies.

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