FIRE FIGHTING ROBOT

PROBLEM STATEMENT :

Create a robot that can find and put out fires by itself. The robot should be able to detect smoke and heat, move around safely, and spray water or foam to stop the fire. Make sure it can be controlled from a distance to keep people safe and be effective in different situations. The goal is to improve how we respond to fires and protect lives and property.

ABSTRACT :

The fire-fighting robot is a specialized robot designed to assist in extinguishing fires. Equipped with advanced sensors, it can detect smoke and heat to locate the fire source swiftly. The robot employs a water or foam spraying system to suppress flames effectively. Its remote control capability allows operators to navigate the robot through hazardous areas without endangering human lives. This technology aims to enhance firefighting efficiency and protect firefighters by providing a safer and more effective means of combating fires in various environments.

Project Team :

Gurubelli Padmanabham

HARDWARE DESIGN :

1.Arduino UNO

2.Fire Sensor or Flame Sensor

3.Servo Motor (SG90)

4.L293D Motor Driver module

SOFTWARE USED :

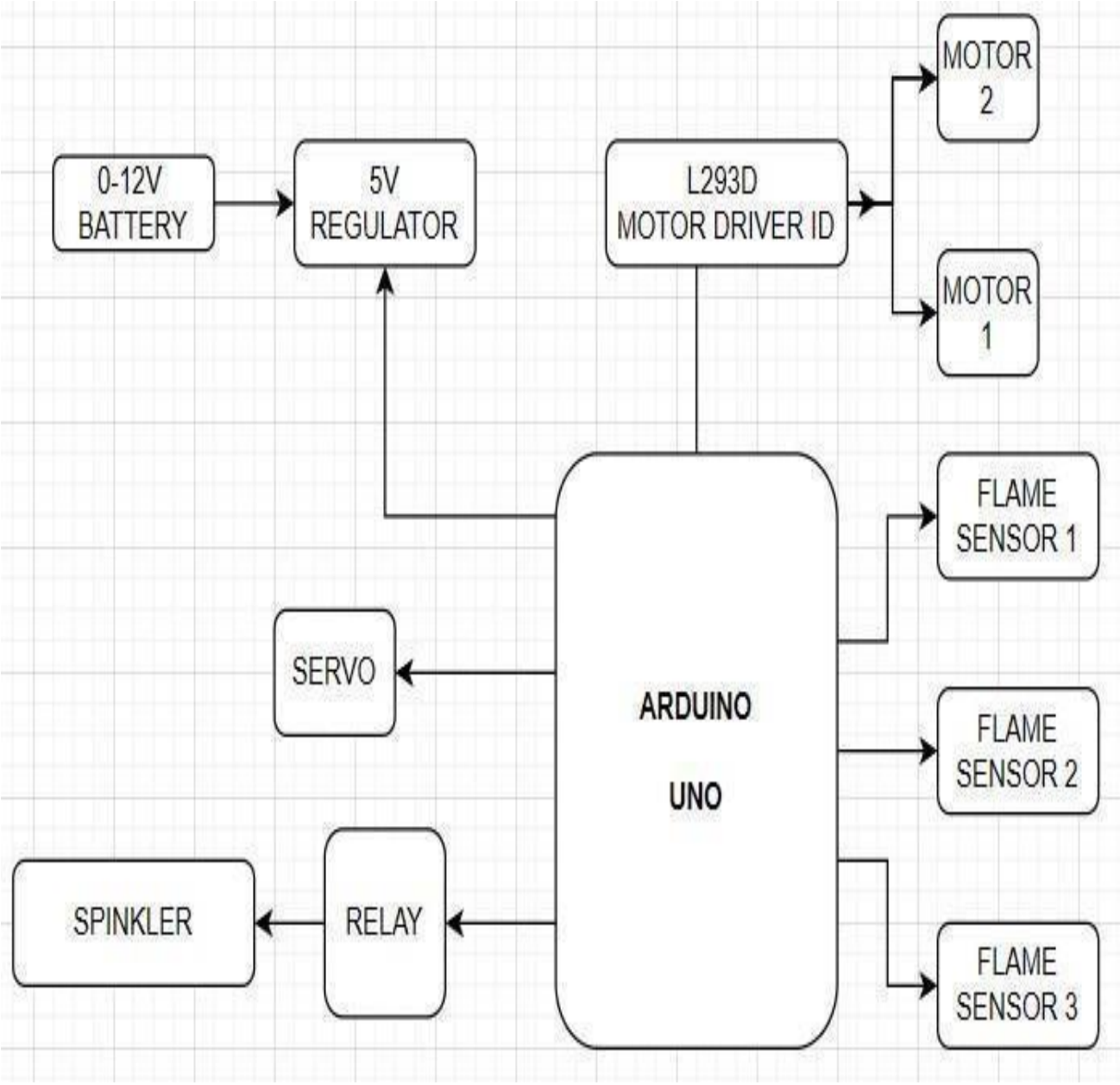
Arduino IDE.

DISCRIPTION :

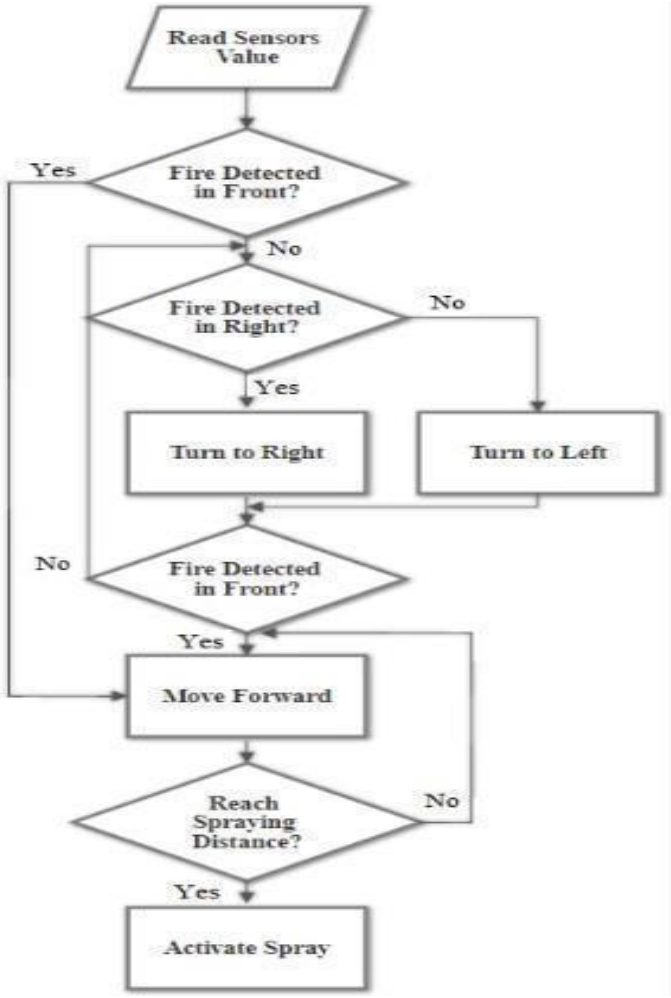
Introducing the Fire Guard Sentinel, a ground breaking firefighting robot engineered for rapid and precise fire response. This compact marvel integrates cutting-edge sensors and smart navigation to navigate challenging environments effortlessly. With advanced thermal imaging, the Sentinel detects and extinguishes flames with pinpoint accuracy, ensuring swift containment. Crafted from durable materials, this resilient robot thrives in high-temperature conditions, guaranteeing longevity in the face of adversity. Its user-friendly interface facilitates seamless remote control, placing firefighting expertise at the forefront. The Sentinel's efficient water and foam dispensing system, coupled with a high-pressure nozzle, delivers effective firefighting capabilities. Embodying innovation and reliability,

the Fire Guard Sentinel stands as a beacon of safety, heralding a new era in firefighting technology. Welcome to the forefront of fire protection.

BLOCK DIAGRAM :



PROCESS FLOW :



Components Used :

1.Arduino UNO

2.Fire Sensor or Flame Sensor

3.Servo Motor (SG90)

4.L293D Motor Driver module

5.Mini DC Submersible Pump and Pipe (40cm)

6.Small Breadboard

7.BO Motors (4) and Wheels(4)

8.Connecting Wires (Jumper Wires)

9.Cointainer

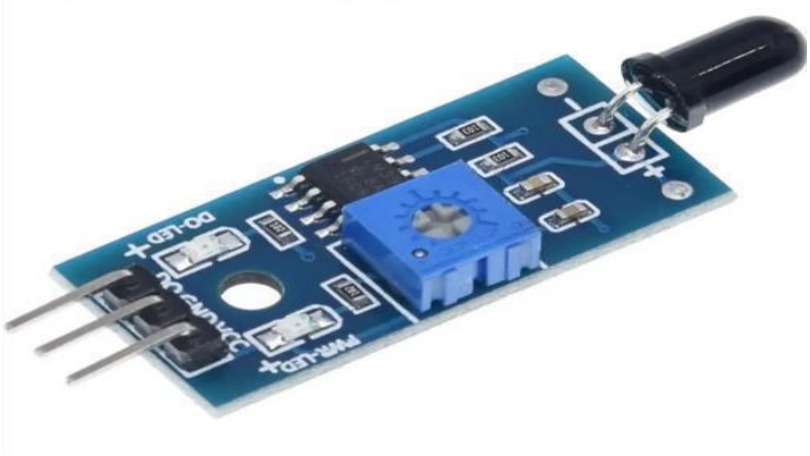
Arduino :

Arduino is an open-source electronics platform renowned for its simplicity and versatility, catering to a broad spectrum of enthusiasts, from beginners to seasoned engineers. The heart of the Arduino ecosystem lies in its microcontroller boards, such as the popular Arduino Uno, equipped with microcontrollers like the Atmel AVR family or newer ARM-based processors. These boards boast digital and analog pins, allowing users to effortlessly connect and control an array of sensors, actuators, and electronic components. The Arduino Integrated Development Environment (IDE) provides a user-friendly interface for coding in a simplified version of C++

Arduino programs, known as sketches, consist of setup and loop functions, while an extensive library collection facilitates interaction with various components. The platform's openness, both in hardware and software, has fostered a thriving community of makers, fostering collaboration, innovation, and a wealth of online resources. Arduino's accessibility, coupled with the availability of shields for added functionalities, has positioned it as a go-to choice for prototyping, education, and do-it-yourself projects.

Fire sensor or Flame sensor :

A flame sensor is a critical component in fire detection and safety systems, designed to detect the presence of an open flame or fire. Typically, these sensors work based on the principle of detecting infrared (IR) radiation emitted by flames. The sensor consists of an IR-sensitive element that responds to the specific wavelengths produced by flames. When a flame is present, the sensor generates an electrical signal, indicating the detection of a potential fire hazard.



One common application of flame sensors is in gas appliances, where they play a crucial role in ensuring safety by detecting flames associated with the combustion of natural gas or propane. In such systems, the flame sensor is integrated into the control circuit, and if the sensor does not detect the flame, it signals the system to shut off the gas supply as a safety measure.

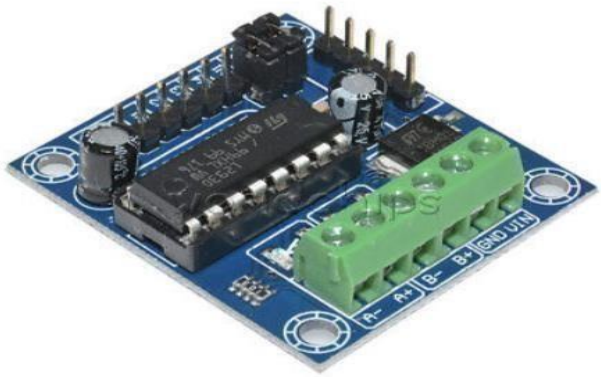
Servo Motor :

A servo motor is a type of rotary actuator that provides precise control of angular or linear position, velocity, and acceleration. It operates on the principle of receiving input signals to move to a specific position and maintain that position, making it an essential component in various robotics, automation, and control systems.

Servo motors are characterized by their closed-loop control system, where feedback from an internal position sensor is used to adjust the motor's movement. This closed-loop mechanism enables accurate and repeatable positioning, making servo motors ideal for applications demanding precision, such as in CNC machines and robotic arms. With their versatility and reliability, servo motors are widely used in a range of industries to achieve controlled and responsive motion.

L293D Motor Driver Module :

The L293D motor driver module is a widely used integrated circuit designed to control and drive DC motors. This module is particularly popular in robotics and electronics projects for its ability to drive two motors bidirectionally or a single stepper motor. The L293D chip incorporates two H-bridge circuits, allowing the module to control the direction of rotation and speed of each connected motor.



However, it's important to note that the L293D is a bipolar IC, and there are more modern alternatives, such as the L298N or L298, which offer improved performance and features. Despite this, the L293D motor driver module remains a popular choice due to its simplicity, ease of use, and widespread availability, making it a valuable component in the toolkit of many electronics enthusiasts and engineers.

Mini Breadboard :

A small breadboard is a compact and invaluable component in electronics prototyping, providing a convenient platform for designing and testing circuits without soldering. Its surface is populated with a grid of holes that facilitate the easy insertion and interconnection of electronic components. Typically used by hobbyists, students, and engineers, small breadboards are ideal for quick and temporary circuit configurations.

They enable rapid experimentation with various components like resistors, LEDs, and sensors, allowing users to iterate and refine designs efficiently. Their reusable and portable nature makes them a fundamental tool for hands-on learning, experimentation, and the development of smallscale electronic projects.

Mini DC Submersible Pump :

A mini DC submersible pump is a compact and versatile device designed for pumping water or other liquids in various applications. These pumps are typically small in size and submerged directly into the liquid they are meant to move, making them suitable for tasks such as water circulation in aquariums, hydroponic systems, or small-scale water features

Powered by direct current (DC), these pumps are often used in conjunction with batteries or lowvoltage power sources, providing flexibility in their application.The mini DC submersible pump generally consists of a motor, impeller, and housing. The motor is designed to operate underwater, and the impeller, driven by the motor, creates a flow of liquid.

BO Motors :

Brushed DC motors, commonly known as DC gear motors or BO motors, are fundamental components in robotics and automation. These motors feature a simple design with a rotating armature and brushes that conduct current, generating motion. BO motors often come with an integrated gearbox, providing higher torque and lower speed, making them suitable for applications requiring strength and precision.

They find widespread use in robotic platforms, wheeled vehicles, and various electronic projects. The versatility, affordability, and ease of control make BO motors popular choices for hobbyists and engineers seeking reliable and efficient solutions for motorized movement. However, they may require additional circuitry, such as an H-bridge, for proper control and direction reversal.

Jumper Wires :

Jumper wires are essential components in electronics and prototyping, serving as flexible connectors for establishing electrical connections between various components on a breadboard or circuit. Typically made of insulated wire with connectors at both ends, jumper wires enable the seamless assembly and modification of circuits during the design and testing phases. They come in various lengths and colors, providing versatility in organizing and identifying connections.

Jumper wires are widely used in educational settings, electronics labs, and DIY projects, offering a convenient and efficient means to link microcontrollers, sensors, and other electronic elements. Their plug-and-play nature facilitates quick and temporary connections, making them indispensable tools for students, hobbyists, and engineers engaged in experimenting and prototyping.

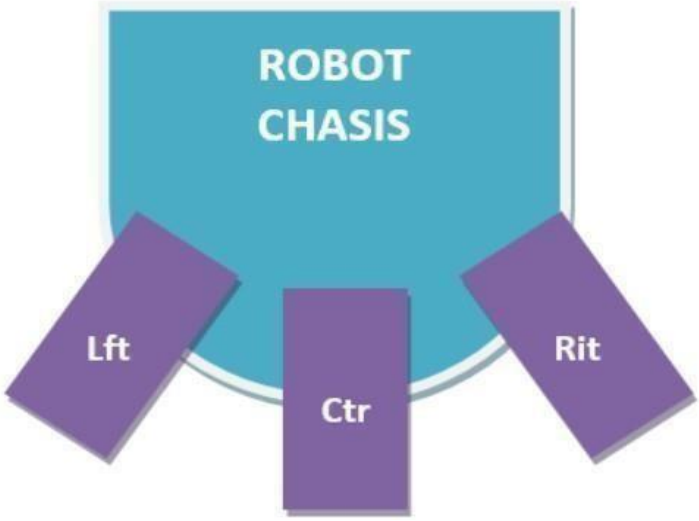
Arduino Based Fire Fighting Robot :

According to National Crime Records Bureau (NCRB), it is estimated that more than 1.2 lakh deaths have been caused because of fire accidents in India from 2015-2021. Even though there are a lot of precautions taken for Fire accidents, these natural/man-made disasters do occur now and then. In the event of a fire breakout, to rescue people and to put out the fire we are forced to use human resources which are not safe. With the advancement of technology especially in Robotics it is very much possible to replace humans with robots for fighting the fire. This would improve the efficiency of firefighters and would also prevent them from risking human lives. Today we are going to build a Fire Fighting Robot using Arduino, which will automatically sense the fire and start the water pump.

In this project, we will learn how to build a simple robot using Arduino that could move towards the fire and pump out water around it to put down the fire. It is a very simple robot that would teach us the underlying concept of robotics; you would be able to build more sophisticated robots once you understand the following basics.

Working Concept of Fire Fighting Robot:

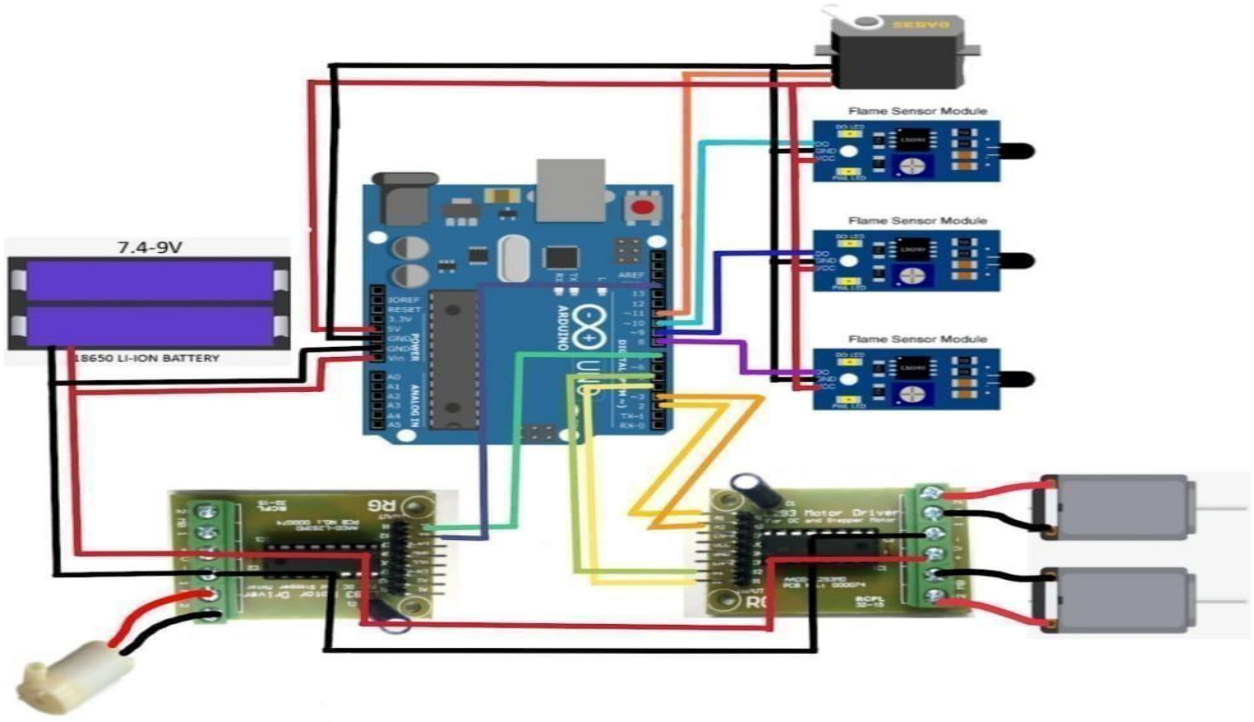
The main brain of this project is the Arduino, but in-order to sense fire we use the Fire sensor module (flame sensor)As you can see these sensors have an IR Receiver (Photodiode) which is used to detect the fire. How is this possible? When fire burns it emits a small amount of Infra-red light, this light will be received by the IR receiver on the sensor module. Then we use an Op-Amp to check for change in voltage across the IR Receiver, so that if a fire is detected the output pin (DO) will give 0V(LOW) and if the is no fire the output pin will be 5V(HIGH).



We detect the direction of the fire we can use the motors to move near the fire by driving our motors through the **L293D module**. When near a fire we have to put it out using water. Using a small container we can carry water, a 5V pump is also placed in the container and the whole container is placed on top of a **servo motor** so that we can control the direction in which the water has to be sprayed. Let's proceed with the connections now

Circuit Diagram :

The complete circuit diagram for this **Fire Fighting Robot** is



You can either connect all the shown connections for uploading the program to check the working or you can assemble the bot completely and then proceed with the connections. Both ways the connections are very simple and you should be able to get it right.

Based on the robotic chassis that you are using you might not be able to use the same type of container that I am using. In that case use your own creativity to set up the pumping system. However the code will remain same. I used a small aluminium can (cool drinks can) to set the pump inside it and poured water inside it. I then assembled the whole can on top of a servo motor to control the direction of water. My robot looks something like this after assembly.

I have fixed the servo fin to the bottom of the container using got glue and have fixed the servo motor with chassis using nuts and bolts. We can simply place the container on top of the motor and trigger the pump inside it to pump water outside through the tube. The whole container can then be rotated using the servo to control the direction of the water.

Programming Arduino :

Once you are ready with your hardware, you can upload the Arduino code for some action. The **complete program** is given at the end of this page. However I have further explained few important bits and pieces here.

As we know the fire sensor will output a HIGH when there is fire and will output a LOW when there is fire. So we have to keep checking these sensor if any fire has occurred. **If no fire is there we ask the motors to remain stop** by making all the pins high

If Fire not detected all sensors are zero

```
if (digitalRead(Left_S) ==1 && digitalRead(Right_S)==1 && digitalRead(Forward_S) ==1)
  {
  digitalWrite(LM1, HIGH);    digitalWrite(LM2,
HIGH);    digitalWrite(RM1,
HIGH);    digitalWrite(RM2, HIGH);
  }
```

Similarly, **if there is any fire we can ask the robot to move** in that direction by rotating the respective motor. Once it reaches the fire the left and right sensor will not detect the fire as it would be standing straight ahead of the fire. Now we use the variable named "*fire*" that would execute the function to put off the fire.

If Fire is straight ahead

```
else if (digitalRead(Forward_S) ==0)
  {
```

```
   digitalWrite(LM1, HIGH);    digitalWrite(LM2, LOW);    digitalWrite(RM1,
HIGH);    digitalWrite(RM2, LOW);
   fire = true;
   }
```

Once the variable fire becomes true, the **fire fighting robot arduino code** will execute the *put_off_fire* function until the fire is put off.

If fire becomes true

```
while (fire == true)
   {
    put_off_fire();
   }
```

Inside the *put_off_fire()* we just have to **stop the robot** by making all the pins high. **Then turn on the pump to push water outside** the container, while this is done we can also use the servo motor to rotate the container so that the water is split all over uniformly.

Activating Pumb and Servo

```
void put_off_fire()
{    delay (500);    digitalWrite(LM1, HIGH);
digitalWrite(LM2, HIGH);    digitalWrite(RM1,
HIGH);    digitalWrite(RM2, HIGH);
digitalWrite(pump, HIGH); delay(500);    for
(pos = 50; pos <= 130; pos += 1) {
myservo.write(pos);
   delay(10);
 }
 for (pos = 130; pos >= 50; pos -= 1) {    myservo.write(pos);    delay(10);
 }
 digitalWrite(pump,LOW);   myservo.write(90);
   fire=false;
}
```

Working of Fire Fighting Robot :

It is recommended to check the output of the robot in steps rather than running it all together for the first time. You can build the robot upto the servo motor and check if it is able to follow the fire successfully. Then you can check if the pump and the servo motor are working properly. Once everything is working as expected you can run the program below and enjoy the complete **working of the fire fighter robot**.

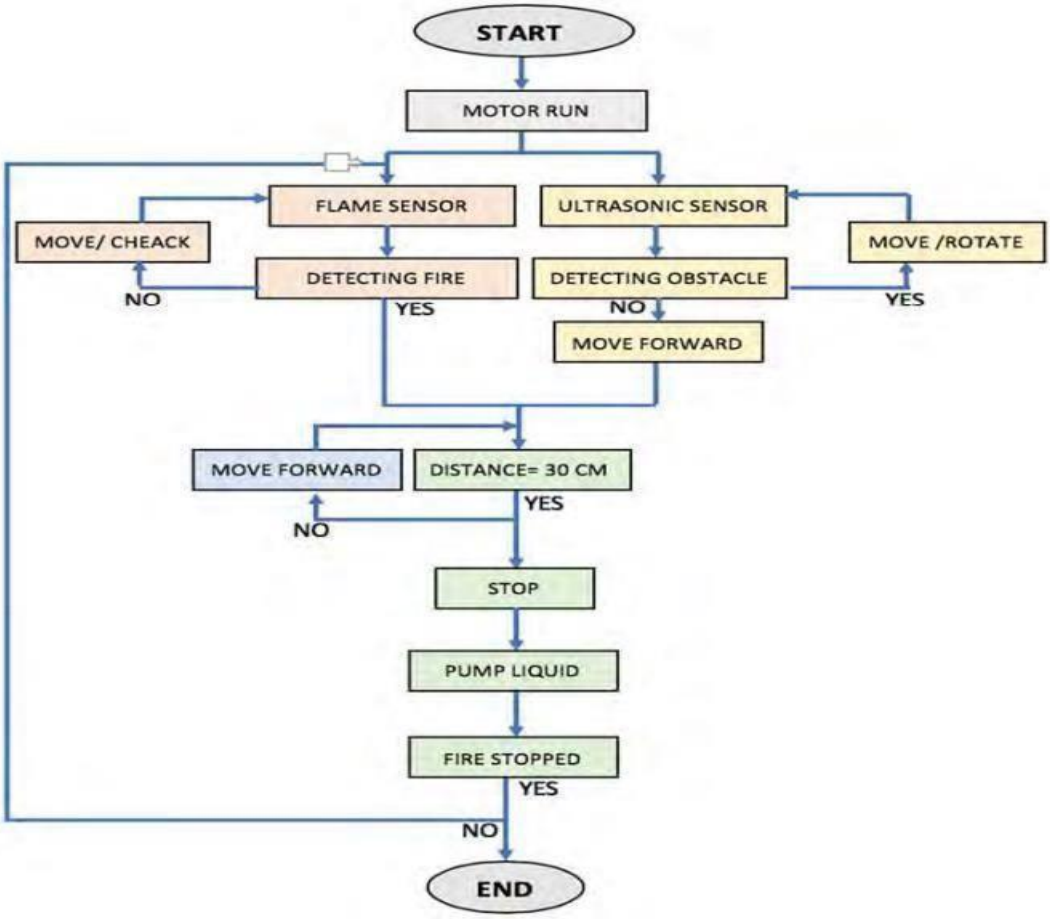
The maximum distance to which the fire can be detected depends on the size of the fire, for a small matchstick the distance is relatively less. You can also use the potentiometers on top of the modules to control the sensitivity of the robot. I have used a power bank to power the robot you can use a battery or even power it with a 12V battery.

Arduino IDE :

Arduino IDE is a user-friendly software that helps people create and program electronic projects with Arduino boards by providing a simple platform for writing, compiling, and uploading code. It's a versatile tool for beginners and experienced enthusiasts alike, making it easy to bring creative ideas to life through coding and hardware integration.

Methodology :

A fire fighter robot is one that has a small fire extinguisher added to it. By attaching a small fire extinguisher to the robot, the fire detection and controls are automatic. The robot works with sensor for searching the fire and when fire is detected then automatically spray the water over it.



Code :

```
/*------ Arduino Fire Fighting Robot Code by hobby project---- */

#include <Servo.h>  //include servo.h library
Servo myservo;

int pos = 0;
boolean fire = false;

#define Left 9      // left sensor
#define Right 10    // right sensor
#define Forward 8   //front sensor

#define LM1 2       // left motor
```

```
#define LM2 3      // left motor
#define RM1 4      // right motor
#define RM2 5      // right motor
#define pump 6

void setup()
{
  pinMode(Left, INPUT);
  pinMode(Right, INPUT);
  pinMode(Forward, INPUT);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
  pinMode(RM2, OUTPUT);
  pinMode(pump, OUTPUT);

  myservo.attach(11);
  myservo.write(90);
}

void put_off_fire()
{
    delay (500);

    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, HIGH);

   digitalWrite(pump, HIGH);
   delay(500);
```

```
   for (pos = 50; pos <= 130; pos += 1) {
   myservo.write(pos);
   delay(10);
  }
  for (pos = 130; pos >= 50; pos -= 1) {
   myservo.write(pos);
   delay(10);
  }

  digitalWrite(pump,LOW);
  myservo.write(90);

  fire=false;
}

void loop()
{
   myservo.write(90); //Sweep_Servo();

   if (digitalRead(Left) ==1 && digitalRead(Right)==1 && digitalRead(Forward) ==1)
   {

   digitalWrite(LM1, HIGH);
   digitalWrite(LM2, HIGH);
   digitalWrite(RM1, HIGH);
   digitalWrite(RM2, HIGH);
   }

   else if (digitalRead(Forward) ==0)
   {
   digitalWrite(LM1, HIGH);
   digitalWrite(LM2, LOW);
```

```
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, LOW);
    fire = true;
    }

    else if (digitalRead(Left) ==0)
    {
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, HIGH);
    }

    else if (digitalRead(Right) ==0)
    {
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, LOW);
    }

delay(300);//change this value to increase the distance

     while (fire == true)
    {
     put_off_fire();
    }
}
```

CONCLUSION :

In conclusion, the fire-fighting robot emerges as a crucial innovation in enhancing fire response capabilities. With its adept sensors and remote-controlled maneuverability, the robot significantly improves the efficiency of firefighting operations. By swiftly detecting and suppressing fires, it contributes to minimizing damage and safeguarding human lives. The integration of this technology represents a positive step towards a safer and more effective approach to tackling fires in diverse situations. The fire-fighting robot stands as a valuable asset in the ongoing efforts to protect communities and mitigate the impact of fire emergencies.