JABALPUR ENGINEERING COLLEGE, JABALPUR

A

Minor Project Report

on

FIREFIGHTING ASSISTANT ROBOT USING ARDUINO

Submitted in partial fulfilment of the requirements

for the award of the degree of

BACHELOR OF TECHNOLOGY
IN
MECHATRONICS ENGINEERING

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CERTIFICATE

This is to certify that the Minor Project report entitled "FIREFIGHTING ASSISTANT ROBOT USING ARDUINO" submitted by Suryansh Bajpayi (0201MT211057), Upendra Singh Rathore (0201MT211058), Vaibhav Thakur (0201MT211059), Varsha Gurbani (0201MT211061), Varsha Shukla (0201MT211062) has been approved for submission towards partial fulfilment of the requirements for the award of the Bachelor of Technology degree in Mechatronics Engineering in the sixth semester at Jabalpur Engineering College (JEC).

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DECLARATION

We hereby declare that the project entitled "FIREFIGHTING ASSISTANT ROBOT USING ARDUINO" which is being submitted as Minor Project of Sixth Semester in Department of Mechatronics Engineering to JABALPUR ENGINEERING COLLEGE, JABALPUR (M. P.) is an authentic record of our genuine work done under the guidance of Dr. KUMAR MAHARSHI and Prof. ABHILASH K. PATEL, Faculties, Dept. of Mechatronics Engineering, Jabalpur Engineering College, Jabalpur.

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INTRODUCTION

In a world where rapid urbanization and technological advancement intersect, the need for innovative solutions to address safety concerns is paramount. One of the most critical challenges faced by urban communities is the ever-present threat of fire emergencies, which can result in devastating loss of life and property if not promptly addressed. In light of this pressing need, the project at hand seeks to develop an automated fire-fighting assistant system, poised to revolutionize fire response mechanisms.

Traditional fire-fighting methods, although effective, often rely heavily on human intervention, which can be hindered by factors such as response time, accessibility, and risk to personnel. Moreover, in scenarios where fires occur in hazardous or inaccessible environments, human intervention may prove impractical or perilous. Consequently, there arises a compelling necessity for the integration of advanced technologies to augment and expedite firefighting efforts while mitigating risks to human responders.

The envisioned automated fire-fighting assistant system addresses this need by harnessing the power of sensors and intelligent control mechanisms to detect, analyse, and combat fire. By leveraging flame sensors and vision sensors, the system can swiftly identify fire outbreaks with high precision, enabling proactive intervention before the situation escalates. Additionally, the incorporation of proximity sensors facilitates obstacle detection, ensuring seamless navigation through complex environments to reach the site of the fire.

Against this backdrop, the project endeavours to fill a crucial gap in fire response capabilities by introducing an automated system capable of augmenting and, in some cases, supplanting traditional fire-fighting methods. Through the integration of advanced sensors and intelligent control mechanisms, the system promises to enhance the efficiency, reliability, and safety of fire response operations, thereby

safeguarding lives and property in the face of emergent threats. This project report chronicles the journey towards realizing this vision, outlining the rationale, objectives, methodologies, and outcomes of the endeavour, while also exploring its broader implications for safety and urban resilience.

LITERATURE REVIEW

Nagesh et al. [1] presented a novel approach to designing robots for firefighting, aiming to enhance firefighting capabilities in hazardous environments. The paper included a review of existing literature on firefighting robots, detailed the design and implementation of the authors' robot, and demonstrated its effectiveness through experimental results. Reinhart et al. [2] was all discussed about design and the implementation of the fire-fighting robot. The key design elements of the robot to be discussed include: the assembly and construction of the robot hardware, the processing algorithm based on the sensor's response, and the navigation algorithm that will enable the robot to find an efficient path in and out of the house model. Rodriguez et al. [3] was all discussing the development of each component of the robot that is designed to find a small fire represented by a light emitting diode in a model home and extinguish it. This paper will talk about each component of the robot from the start signal to the robot platform to the line following and room finding and finishing with the fire detection. Prasanna et al. [4] was 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. Sahil et al. [5] described the design, development, and implementation of a firefighting robot. They discussed the robot's hardware and software components, its ability to detect and extinguish fires, and its effectiveness in simulated firefighting scenarios.

OBJECTIVES

The objectives of this project is focused on making an automated firefighting assistant system using flame sensor and vision sensor. We are using proximity sensor to detect obstacles and managing the movement of system through motor drive.

- **Fire Detection**: Implement a reliable fire detection system using a fire sensor that can accurately sense the presence of invisible fire within a certain range.
- **Obstacle Avoidance**: Develop an obstacle avoidance system using a ultrasonic sensor to detect obstacles in the robot's path and navigate around them to reach the fire source.
- **Navigation**: Program the robot to navigate through a predefined path to reach the fire source, using motor control to drive the wheels of the robot.
- **Fire Extinguishing**: Integrate a fire diminishing equipment into the robot's design and implement a mechanism to activate it upon detecting the fire.

METHODOLOGY

The theme of this paper is to automatically sense the environmental fire and extinguish it without human intervention. The methodology is divided into three parts. The first part is on the design structure, followed by hardware description and the finally on the programming design. All these three parts were assembled together and experiments were then performed to build a system that can extinguish the fire that was carried out.

HARDWARE IMPLEMENTATION

The hardware part is one of the crucial parts in the development of firefighting robot. It includes Arduino UNO, IR flame sensors, servo motors, submersible water pump, motor driver, mini breadboard, BO motors, and rubber wheels. Fig 01 shows the block diagram of firefighting robot which consists of three IR flame sensors as the input of the system. Arduino UNO is used as a micro-controller that connects other components. L293D Motor driver is used to drive motors and is capable of running two DC motors (Left DC motor and Right DC motor) at the same time.

BLOCK DIAGRAM

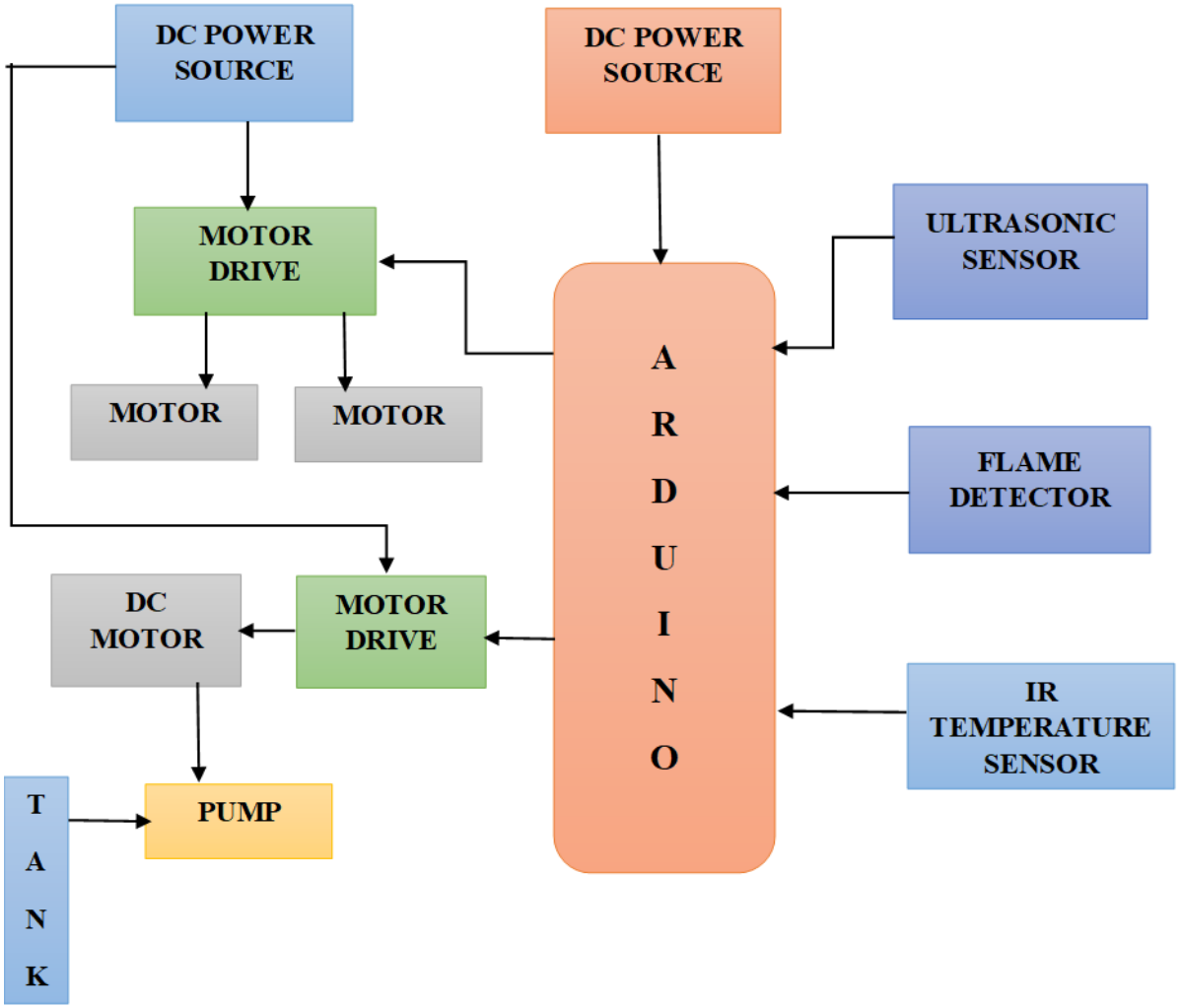


Fig.01: Block diagram of the Firefighting Robot

COMPONENTS

FLAME SENSOR:

Fire Sensor (Flame Sensor): Detects the presence of fire by sensing the infrared light emitted by the flames. When the sensor detects a fire, it sends a signal to the Arduino Uno.

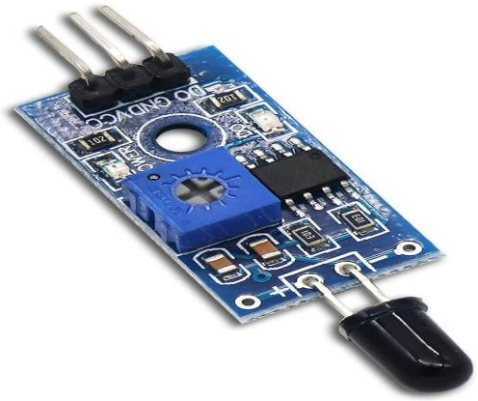


Fig.02: flame sensor

IR THERMOMETER:

An infrared thermometer sensor is used to measure the temperature of objects without making contact. It works by detecting the infrared radiation emitted by an object and converting it into a temperature reading. The sensor is commonly used in various applications such as industrial temperature control, medical devices, and automotive systems.

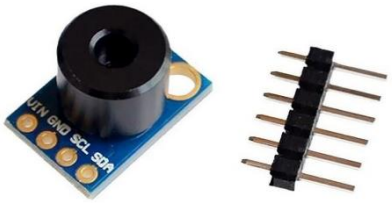


Fig.03: IR thermometer

MOTOR DRIVER:

Motor drivers serve as the crucial interface between your motors and control circuits. While the control circuit operates on low-current signals, the motor requires a higher amount of current to function optimally. That's where motor drivers come in. They transform low-current control signals into higher-current signals, capable of driving the motor effectively.

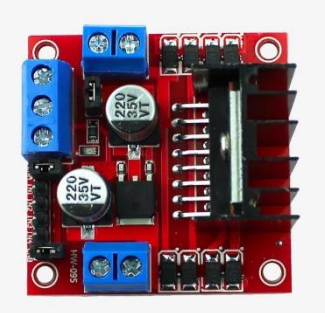


Fig.04: Motor driver

ARDUINO UNO:

The Arduino Uno is a microcontroller board based on the ATmega328P. It has digital and analog input/output pins that can be used to interface with various components such as sensors, motors and pump.

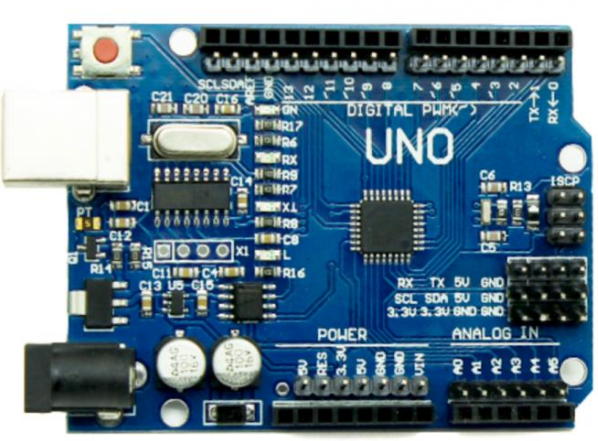


Fig.05: Arduino UNO

MQ2 SENSOR:

The MQ2 gas sensor detects flammable gases in the air, such as methane and propane. Usage: Detects flammable gases that may indicate a fire and sends a signal to the Arduino Uno.

Fig.06: MQ2 Gas Sensor

DC MOTORS:

Drive the wheels of the robot, enabling it to move forward, backward, and turn. The Arduino Uno controls the motor via motor driver.

Fig.07: DC Motor

POWER SOURCE:

The battery provides power to the Arduino Uno and other components. Usage: Powers the robot's electronics and motors.

Fig.08: Battery

SERVO MOTORS:

Servo Motors are electronic devices that are mainly used for providing specific velocity and acceleration.

Fig.09: Servo motor

BREADBOARD:

The breadboard is used for prototyping and connecting the components temporarily. Usage: Facilitates easy connection and testing of the circuit.

Fig.10: Bread Board

JUMPER WIRES:

Jumper wires are used to connect the components on the breadboard and to the Arduino Uno. Usage: Provide electrical connections between components.

Fig.11: Jumper Wires

RELAY:

A relay is a switch that is powered by electricity as shown in Fig. 7. A magnetic field is generated by coil of the relay is which the current flows through, which attracts a lever and changes the switch contacts. There are two switch places on their lay, both of which are double throw switches. There is no electrical connection between the two circuits within the relay. Only magnetic and mechanical connections exist. Relays are incredibly basic instruments.

Fig.12: Relay

ULTRASONIC SENSOR:

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

Fig.13: Ultrasonic Sensor

FLOWCHART

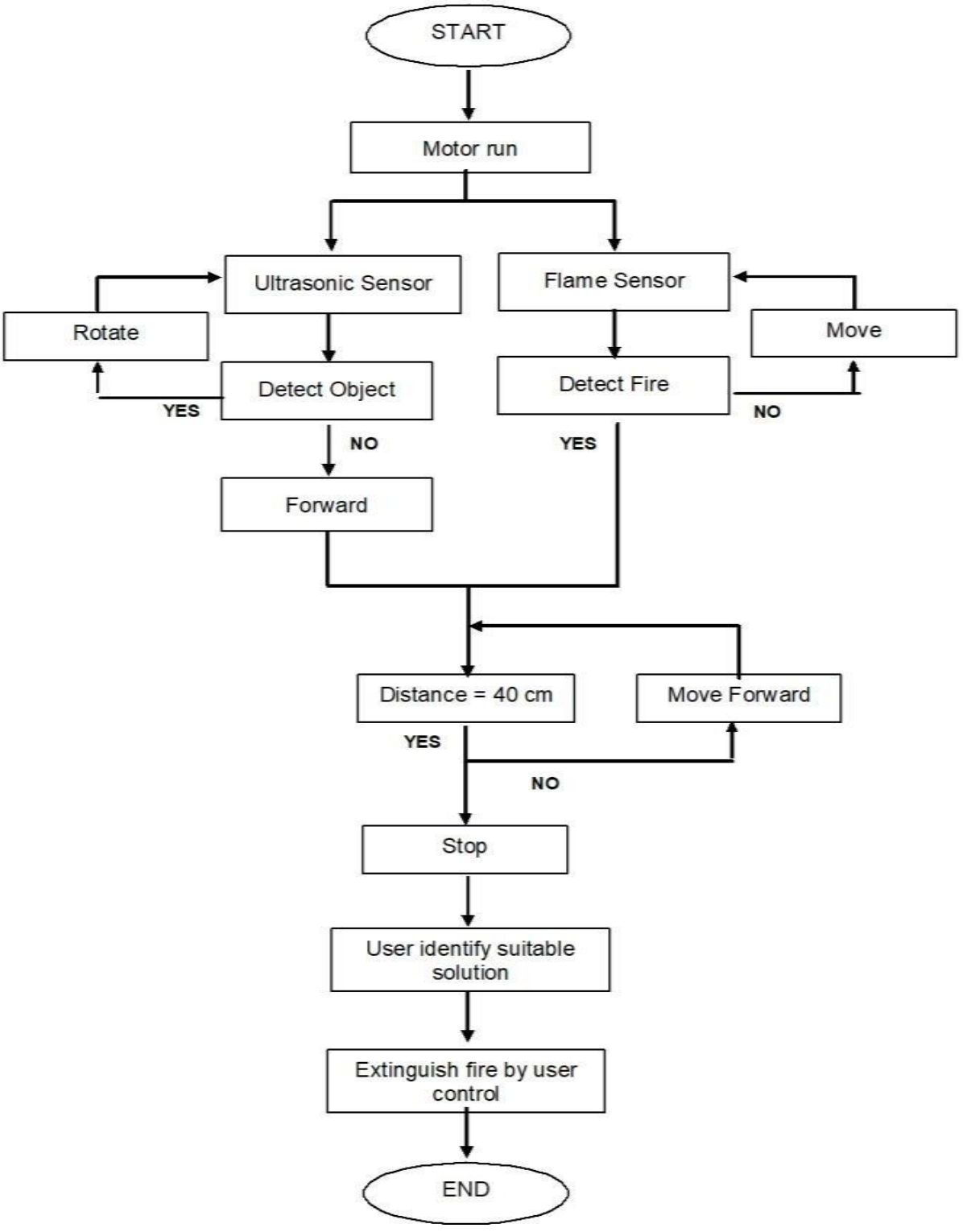
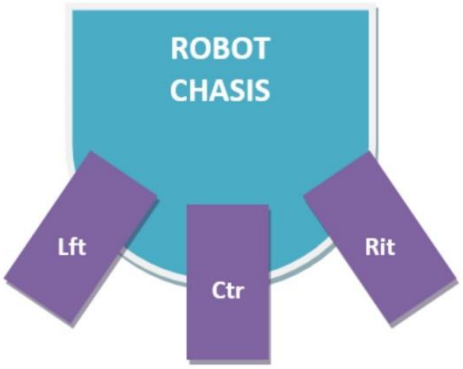


Fig.14: Flow chart of the working principle of Firefighting Robot

ASSEMBLY

- **Prepare the Chassis**: Start by preparing the chassis of your robot. This is the frame that will hold all the components. Ensure it is sturdy and has enough space to accommodate the components.



- **Mount the Sensors:** Mount the flame sensor, MQ2 gas sensor, and any other sensors you are using. Position them in a way that allows them to detect fires and obstacles effectively.
- **Mount the Motors:** Attach the DC motors to the chassis. Depending on the design of your robot, you may need to use brackets or mounts to secure the motors in place.
- **Attach the Wheels:** Attach the wheels to the shafts of the DC motors. Ensure the wheels are securely attached and can rotate freely.
- **Mount the Arduino Uno**: Mount the Arduino Uno board on the chassis using screws or adhesive. Place it in a central location where it is easily accessible.
- **Connect the Motor Drive**r: Connect the L293 motor driver to the Arduino Uno. Use jumper wires to connect the input pins of the motor driver to the output pins of the Arduino Uno
- **Connect the Motors:** Connect the DC motors to the motor driver.

- Use jumper wires to connect the motor terminals to the output terminals of the motor driver.
- **Connect the Sensors:** Connect the sensors to the Arduino Uno. Use jumper wires to connect the sensor output pins to the input pins of the Arduino Uno.
- **Install the fire diminishing equipment:** Install them on the chassis. Position it in a way that allows it to diminish fire effectively.
- **Connect the equipment**: Connect the fire diminishing equipment to the Arduino Uno. Use jumper wires to connect the power and control pins to the Arduino Uno's output pins.
- **Power Supply:** Connect the power supply to the Arduino Uno and other components. Use the LM2596 buck converter to step down the voltage from the battery to the required level for the Arduino Uno.
- **Test the Robot:** Before sealing the chassis, test the robot to ensure all components are working correctly. Check the movement of the wheels, the activation of the water pump, and the sensor reading.
- **Finalize the Assembly:** Once everything is working correctly, finalize the assembly by securing all components in place. Use zip ties, adhesive, or brackets to secure wires and prevent them from getting tangled. Programming:
- Upload the Arduino sketch to the Arduino Uno to control the robot's movements, sensor readings, and water pump activation.
- **Testing and Calibration:** Test the robot in a controlled environment to ensure it can detect and extinguish fires effectively. Calibrate the sensors and adjust the code as necessary for optimal performance.

WORKING PRINCIPLE

MQ2 Gas Sensor:

The MQ2 gas sensor detects various gases in the air, including LPG, propane, methane, alcohol, and smoke. It operates on the principle of conductivity changes in the presence of these gases, which alters the sensor's resistance.

Flame Sensor:

The flame sensor detects infrared (IR) light emitted by flames. It consists of an IR receiver and transmitter. When there is a fire, the flames emit IR radiation, which is detected by the receiver, triggering an alert.

Ultrasonic Sensor:

Ultrasonic sensors use sound waves with frequencies higher than the human audible range to detect objects. They emit ultrasonic waves and measure the time taken for the waves to reflect back, calculating the distance to the object.

PROGRAMMING

For programming, the Arduino software provides an integrated development environment (Arduino IDE) and core libraries. The Arduino IDE program is a software program written in Java language and based on the Processing. The Arduino IDE is basically a framework built on top of C and C++. The open-source Arduino IDE makes it easy to write code and upload it to the Arduino Uno for execution. It is available for all major desktop platforms i.e., Windows, Mac OS X, and Linux.

```
//Fire Fighting Robot using ADUINO

#include <Wire.h>
#include <Servo.h>
#include <Adafruit_MLX90614.h>

Adafruit_MLX90614 mlx;
Servo myservo;

#define Left 8
#define Right 9
#define Forward 10
#define LM1 2
#define LM2 3
#define RM1 4
#define RM2 5
#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);
```

```
  mlx.begin();
  myservo.attach(11);
  myservo.write(90);
}

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

void put_off_fire() {
  digitalWrite(LM1, LOW);
  digitalWrite(LM2, LOW);
  digitalWrite(RM1, LOW);
  digitalWrite(RM2, LOW);
  digitalWrite(pump, HIGH);
  sweepServo();  // Sweep the servo while extinguishing the fire
  digitalWrite(pump, LOW);
}

void loop() {
  double temp = mlx.readObjectTempC();

  if (temp > 37.0) {
    put_off_fire();
  } else {
    myservo.write(90);  // Center the servo

    int leftSensor = digitalRead(Left);
    int rightSensor = digitalRead(Right);
    int forwardSensor = digitalRead(Forward);

    if (leftSensor && rightSensor && forwardSensor) {

      digitalWrite(LM1, HIGH);
      digitalWrite(LM2, HIGH);
```

```
      digitalWrite(RM1, HIGH);
      digitalWrite(RM2, HIGH);
    } else {
      // Stop and adjust movement based on sensor inputs
      digitalWrite(LM1, HIGH);
      digitalWrite(LM2, LOW);
      digitalWrite(RM1, HIGH);
      digitalWrite(RM2, LOW);

      if (leftSensor == LOW) {
        // Turn left
        digitalWrite(LM1, HIGH);
        digitalWrite(LM2, LOW);
        digitalWrite(RM1, HIGH);
        digitalWrite(RM2, HIGH);
      }

      if (rightSensor == LOW) {
        // Turn right
        digitalWrite(LM1, HIGH);
        digitalWrite(LM2, HIGH);
        digitalWrite(RM1, HIGH);
        digitalWrite(RM2, LOW);
      }
    }
  }
}
```

CONCLUSION

After series of study and research, it is evident that the development of a firefighting robot using Arduino Uno and associated components represents a significant advancement in the field of robotics. The integration of various sensors and components has enabled the robot to detect fires, navigate through obstacles, and extinguish fires, showcasing the potential of robotics in enhancing firefighting operations. While challenges such as cost, technological dependencies, and regulatory requirements exist, the overall benefits of using robotics in firefighting scenarios outweigh these challenges. This project serves as a stepping stone towards the development of more advanced and efficient firefighting robots, with the potential to revolutionize firefighting practices and improve overall safety.

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