Automatic Fire Fighting Robot

A Thesis Submitted
In the Partial Fulfilment of the Requirements for the Degree of

Bachelor Of Technology
In
Electronics and communication engineering
By

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Candidate's Declaration

I declare that this written submission represents my work and ideas in my own words, and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented, fabricated, or falsified any idea, data, fact, or source in my submission. I understand that any violation of the above will be cause for disciplinary action by the university and may also result in penal action from the sources which have not been properly cited or from whom proper permission has not been obtained when needed.

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CERTIFICATE

Certified that Prakarsh Singh (2021041152), Ankit Kumar Singh (2021041014), Antrali (2021041127) and Aditya Paswan (2021041004) has carried out the research work presented in this report entitled **“Automatic Fire Fighting Robot”** for the award of Bachelor of Technology from Madan Mohan Malaviya University of Technology, Gorakhpur under my supervision. The report embodies result of original work and studies carried out by Students themself and the contents of the report do not form the basis for the award of any other degree to the candidate or to anybody else.

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The Thesis titled **"AUTOMATIC FIRE FIGHTING ROBOT"** that Prakarsh Singh (Roll No. 2021041152), Ankit Kumar Singh (Roll No. 2021041014), Antrali (Roll No. 2021041127), and Aditya Paswan (Roll No. 2021041004) has been approved for the degree of Bachelor of Technology in Electronics and Communication Engineering.

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ABSTRACT

There are many possibilities a fire can start in an industrial area or in any remote area. For example, in textile mills, gas storages, etc., electric leakages can lead to huge damage. Also, it's a worst-case scenario, causing heavy losses not only financially but it also can destroy areas surrounding it. Robots can protect human lives and their wealth and surroundings.

The aim is to design an "**AUTOMATIC FIRE FIGHTING ROBOT"** using an embedded system. A robot is capable of fighting and helps in extinguishing fire. It must be able to autonomously navigate through floor plan while actively scanning for a flame. The robot can even act as a path guide in normal cases and can act as a fire extinguisher in emergency.

Robots designed to find a flame, before it reaches out of control, can one day workwith fire-fighters, greatly reducing the risk of injury to victims. The project will help in generating innovations in the field of robotics while working towards a practical and obtainable solution to save lives and to reduce the risk of property damage.

This report presents the design and development of an "Automatic Fire Fighting Robot" with a primary focus on utilizing Arduino technology. Under the guidance of **Dr. Dharmendra Kumar** our objective was to create a comprehensive design for an Automatic Fire Fighting Robo Car those addresses both technical and economic feasibility.

The report begins by outlining the background and motivation for this project, highlighting the pressing need for advanced fire-fighting solutions. We delve into the detailed design process, covering various aspects such as the hardware components, software implementation, and integration of the proposed system.

Throughout the report, we acknowledge the challenges faced and the resources utilized to overcome them. The collaborative effort of the team, combined with theguidance of **Dr. Dharmendra Kumar**, has culminated in a comprehensive and illustrative report onthe Automatic Fire Fighting Robot.

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Chapter 1
Introduction

1.1 Introduction:

Robotics is one of the fastest growing engineering fields of today's era. Robots are designed to remove the human's factor for dangerous work and difficult environment. The use of robots is more widely used than ever before.

The need for a fire extinguisher Robot is that can detect and extinguish the fire at its ownrisk. Our aim as an engineer is to design such a device which can automatically Detect and extinguish the fire. Also aims to reduce air pollution. It is a protocol which can move through a model structure, find a fire and extinguish it with the help of the water Jet.

Robots are very intelligent devices which can be use according to our use and our requirement. Keeping all the things in mind the robot is capable of being remotely controlled through the Arduino uno.

I have used very basic concepts here, which are very easy to understand from the beginning to end for freshers as well as for the masters in the engineering field and robotics. Fire can be originated when there is no one in the home or all are sleeping in the home. With the invention of such robots' peoples and property can be saved at a much higher rate with minimized damage caused by fire. In this paper,

We proposed a design and implementation of Robot. This robot can move through a model structure and find a fire and then extinguish it with the help of a water jet. This meant simulating the real-world operation of a robot performing a fire extinguish functions in an oil field. Keep all things in mind, the robot is capable of being remotely controlled and live video of fire status.

In the realm of modern technological advancements, the development of automated systems has revolutionized various industries, ranging from manufacturing to healthcare. Onesuch critical application lies in the field of emergency response and disaster management, where innovation has paved the way for the creation of Fire Fighting Robots – automated machines designed to combat fires in hazardous and challenging environments.

Fires, often unpredictable and swift in their destructive potential, pose a significant threat to life, property, and the environment. Traditional firefighting methods, while effective,are often limited in their applicability, especially in scenarios where human intervention could be perilous. This realization has spurred the exploration of cutting-edge solutions that leverage robotics and automation to augment firefighting efforts.

Fire Fighting Robots represent a convergence of engineering, robotics, and artificial intelligence. These machines are engineered to navigate through spaces that may be inaccessible or hazardous to human responders. Equipped with an array of sensors, thermal imaging cameras, and advanced extinguishing mechanisms, these robots are capable of identifying fire sources, assessing the intensity of flames, and executing precise firefighting maneuvers.

The integration of these robots into firefighting operations is a testament to therelentless pursuit of enhancing emergency response capabilities. By minimizing human exposure to danger and enhancing firefighting efficiency, Fire Fighting Robots have the potential to save lives, reduce property damage, and improve the overall effectiveness of emergency management.

This report delves into the detailed design and development of an "Automatic Fire Fighting Robot," with a specific focus on the utilization of Arduino technology. Under the guidance of Dr. Dharmendra Kumar Sir, the report comprehensively explores the technical aspects, economic viability, and innovative potential of this automated solution. Through this exploration, we aim to contribute to the ongoing discourse on enhancing firefighting capabilities through the integration of advanced robotics and automation.

1.2 Motivation for the project:

The motivation behind embarking on the project of designing an “Automatic Fire Fighting Robot” stem from a deeply rooted concern for public safety, the preservation of property, and the advancement of technology. This project is a response to the critical need formore efficient, effective, and safer firefighting methods in the face of escalating fire-related challenges.

1.2.1 Enhancing Firefighting Efficiency:

Traditional firefighting methods often face limitations in effectively combating fires in complex environments such as industrial facilities, hazardous material storage, and densely populated areas. The motivation behind this project is to develop a robotic solution that can navigate through intricate spaces, access hard-to-reach areas, and deploy firefighting mechanisms with precision, thereby significantly improving firefighting efficiency.

1.2.2 Minimizing Human Risk:

Firefighters often put their lives on the line to battle blazes and save lives. However, inscenarios involving extreme temperatures, toxic fumes, and unstable structures, human intervention can be perilous. By creating an automatic fire fighting robot, we aim to minimizethe exposure of human responders to life-threatening situations, ensuring their safety while maintaining effective firefighting operations.

1.2.3 24/7 Emergency Response:

Fires can break out at any time, including during periods when manpower might be limited. By developing a robotic firefighting solution, we aim to provide round-the-clock emergency response capabilities. These robots can be deployed immediately, bridging the gap between the onset of a fire and the arrival of human responders.

1.2.4 Advanced Sensing and Analysis:

Traditional Fire Fighting Robots equipped with sophisticated sensors, thermal imaging cameras, and real-time data analysis capabilities can swiftly identify the source, intensity, and spread offires. This information enables more targeted and effective firefighting strategies, preventing extensive damage and minimizing collateral losses.

1.2.5 Cost-Effective Solutions:

Creating a robot capable of autonomously combating fires could potentially lead to costsavings in the long run. The reduction in property damage, insurance claims, and medical expenses due to fewer firefighter injuries could outweigh the initial investment required for robot development.

1.2.6 Adaption to Future Challenges:

As urbanization, industrialization, and climate change continue to shape our world, the risk of complex and large-scale fires is likely to increase. The motivation behind this project isto anticipate and address future firefighting challenges proactively, equipping emergency responders with state-of-the-art tools to mitigate these evolving risks.

In essence, the motivation for this project goes beyond technical innovation; it is drivenby a commitment to safeguarding lives, preserving property, and ushering in a new era of firefighting capabilities through the integration of robotics and advanced technologies.

1.2.7 Technological Innovation:

The project seeks to showcase the potential of cutting-edge technologies such as robotics, automation, and artificial intelligence in addressing real-world challenges. By designing a functional Automatic Fire Fighting Robot, we aim to inspire further exploration and innovation in the intersection of technology and emergency response.

1.3 PROBLEM FORMULATION

Fire disaster is one of the dangerous problems that can lead to heavy loss bothfinancially and by taking lives. Sometime it becomes difficult for fighters to access the site of a fire because of explosive materials, smoke, and high temperatures. Such situations risk the lives of fire fighters too. In such environments, fire-fighting robots can be useful.

This Fire Extinguishing Robot is based on IOT Technology. In Fire Extinguishing Robot, we intend to build a system that could extinguish a small flame by sensing and movingt location itself. Sometime delay in the arrival of fire fighters leads to numerous consequences. The Fire Extinguishing robot continuously monitors the environment andextinguishes it without delay.

1.4 OBJECTIVES OF THE PROJECT

The project of designing an "Automatic Fire Fighting Robot" aims to achieve acomprehensive set of objectives that encompass technical excellence, real-world applicability,and innovation. These objectives serve as the guiding principles for the development process, ensuring that the resulting robot is capable, efficient, and aligned with the needs of modern emergency response scenarios.

1.4.1 Technical Excellence and Functionality:

I. Design a robot capable of autonomously navigating through challenging environments, including confined spaces, unstable structures, and areas with restricted human access.

II. Implement advanced sensor systems, including thermal imaging cameras and gas detectors, to enable accurate fire source detection, flame intensity assessment, and identification of hazardous conditions.

III. Develop efficient and precise firefighting mechanisms, including water spraying or extinguishing agents deployment, to effectively combat fires of varying intensities.

1.4.2 Safety and Human Interaction:

I. Ensure the robot's design prioritizes safety for both the public and emergency responders by minimizing the risk of explosions, toxic fume exposure, and structural collapses.

II. Incorporate remote control capabilities for manual intervention when necessary, allowing human operators to guide the robot in complex or unforeseen situations.

1.4.3 Autonomous Operation:

I. Enable the robot to operate autonomously, capable of making real-time decisions basedon sensor data and pre-programmed algorithms.

II. Implement obstacle avoidance and path planning algorithms to ensure safe navigation even in cluttered or dynamic environments.

1.4.4 Real-time Data Analysis and Communication:

I. Integrate data analysis capabilities to interpret sensor data and provide valuable insightsto human operators.

II. Establish robust communication systems for transmitting live video feeds, sensor data and status updates to remote operators and emergency response centres.

1.4.5 Economic Feasibility and Scalability:

I. Evaluate the economic viability of the robot's production and maintenance, considering factors such as material costs, energy consumption, and potential savings from reduced property damage.

II. Design the robot with scalability in mind, allowing for the potential deployment of multiple units to effectively tackle larger fires or incidents.

1.4.6 Educational and Awareness Purposes:

I. Create a functional prototype that serves as an educational tool, demonstrating the integration of technology and robotics in firefighting.

II. Raise awareness about the potential of automated firefighting solutions to inspire further research and innovation in the field.

By addressing these multifaceted objectives, the project seeks to not only develop a functional Automatic Fire Fighting Robot but also contribute to the advancement of emergencyresponse capabilities, the enhancement of public safety, and the expansion of technological boundaries in the realm of fire mitigation.

Chapter 2

LITERATURE REVIEW AND DESIGN

2.1 LITERATURE REVIEW

Tawfiqur Rakib, M. A. Rashid Sarkar proposed a fire fighting robot model which consists of a base platform made up of ‘Kerosene wood’, LM35 sensor for temperature detection, flame sensors to detect the fire and a water container of 1 litre capacity which is made up of a strong cardboard that makes it water resistant. The robot has two wheels for its movement. [1]

Saravanan P. ,Soni Ishawarya proposed a model which uses Atmega2560 micro- controller and in which the robot is divided into three basic units according to their functions which are as locomotive unit, fire detecting unit and extinguishing unit. Each unit performs their task in order to achieve the desired output of extinguishing fire. The locomotive unit is used for the movement of the robot and to avoid the obstacles with the help of four IR and fourultrasonic sensors .The fire detecting unit is used to detect fire using LDR and temperature sensor. The extinguishing unit is used to extinguish the fire using water container and BLDC motor. The robot also have a Bluetooth module that is connected with the smartphones in orderto navigate it in the proper direction. [2]

S. Jakthi Priyanka. Sangeetha proposed an android controlled fire fighting robot whichuses Arduino UNO R3. The robot consists of gas sensor for fire detection, gear motor and motor drive for the movement of robot, a bluetooth module to connect the robot with the android device and to control the robot with the smartphone as well. Water pump and sprinkleris also used in this. To instruct the Arduino UNO an open source software which is Arduino IDE is required to code and to implement that code in Arduino UNO. [3]

Nagesh MS, Deepika T V , Stafford Michahial, Dr M Shivakumar proposed a fire extinguishing robot which employs DTMF (Dual Tone Multi Frequency Tones) technology forthe navigation of the robot and uses a flame sensor for fire detection that is capable of sensingflame of the wavelength range 760 to 1100 nm and sensitivity varies from 10cm to 1.5feet. [4]

Sushrut Khajuria, Rakesh Johar, Varenyam Sharma, Abhideep Bhatti proposed an Arduino based fire fighter robot which consists of RF based remote operation to operate the robot and water pump. The robot is controlled by the user within a range of 7 meters. It also consists of a wireless camera which helps user to move the robot in the required direction.[5]

Khaled Sailan, Prof. Dr.-Ing. Klaus-Dieter Kuhnert, Simon Hardt proposed an obstacle avoidance robot named as Amphibious Autonomous Vehicle. In this robot, a fuzzy controller is used to avoid static obstacle in real time. It aims to guide the robot or vehicle along its path avoiding all the obstacle that comes along the path.[6]

J Jalani1, D Misman1 , A S Sadun1 and L C Hong1 proposed a automatic fire fightingrobot with notification. This robot consists of three flame sensors for fire detection in left ,rightand center direction. It also consists of three ultrasonic sensors for obstacle detection and avoidance. When the robot detects fire it also sends a warning notification to the user using Bluetooth module.[7]

2.2 CONCEPT DESIGN/ METHODOLOGHY

In this section, the prototype of robotic system is presented, in which it consists of IR flame sensors, servo motors, submersible water pump, motor driver, mini breadboard, BO motors, rubber wheels, processor, and communication module for exchanging data between the fire-fighting robot and Arduino software. Fig 2 shows the basic prototype of our firefightingrobot.

2.2.1 Mechanical Design:

- Design the chassis to accommodate all the components securely.
- Mount the wheels and motors to enable controlled movement.
- Create space for the water pump and tank while ensuring they don't interfere with other components.
- Place the sensors at appropriate locations for effective fire and obstacle detection.

2.2.2 Sensor Integration:

- Connect IR sensors, temperature sensor, and smoke sensor to the Arduino.
- Calibrate the sensors to accurately detect fire and obstacles.
- Write code to interpret sensor data and trigger appropriate actions.

2.2.3 Motor Control:

- Connect motor driver to the Arduino to control the movement of wheels.
- Write code to control the motors for forward, backward, left, and right movements.

2.2.4 Fire Detection Algorithm:

- Combine data from IR sensors, temperature sensor, and smoke sensor to detect fires.
- Define thresholds for each sensor that indicate the presence of fire.
- Implement an algorithm to trigger fire-fighting actions when a fire is detected.

2.2.5 Fire-Fighting Mechanism:

- Connect the water pump to the Arduino through a relay.
- Design a mechanism to aim and spray water at the fire source.
- Write code to activate the water pump when a fire is detected.

2.2.6 Obstacle Avoidance:

- Use IR sensors to detect obstacles in the robot's path.
- Implement an algorithm to navigate around obstacles.

2.2.7 Remote Control (Optional):

- Add Bluetooth or Wi-Fi module to the Arduino for remote control.
- Develop a smartphone app or computer program to control the robot remotely.

2.2.8 Power Supply:

- Select an appropriate power source (batteries) for the robot and its components.
- Ensure the power supply can sustain the robot's operations.

2.2.9 Testing and Refinement:

- Test the robot's functionality in a controlled environment.
- Refine the code and mechanical design based on test results.

BLOCK DIAGRAM OF FIRE FIGHTING ROBOT

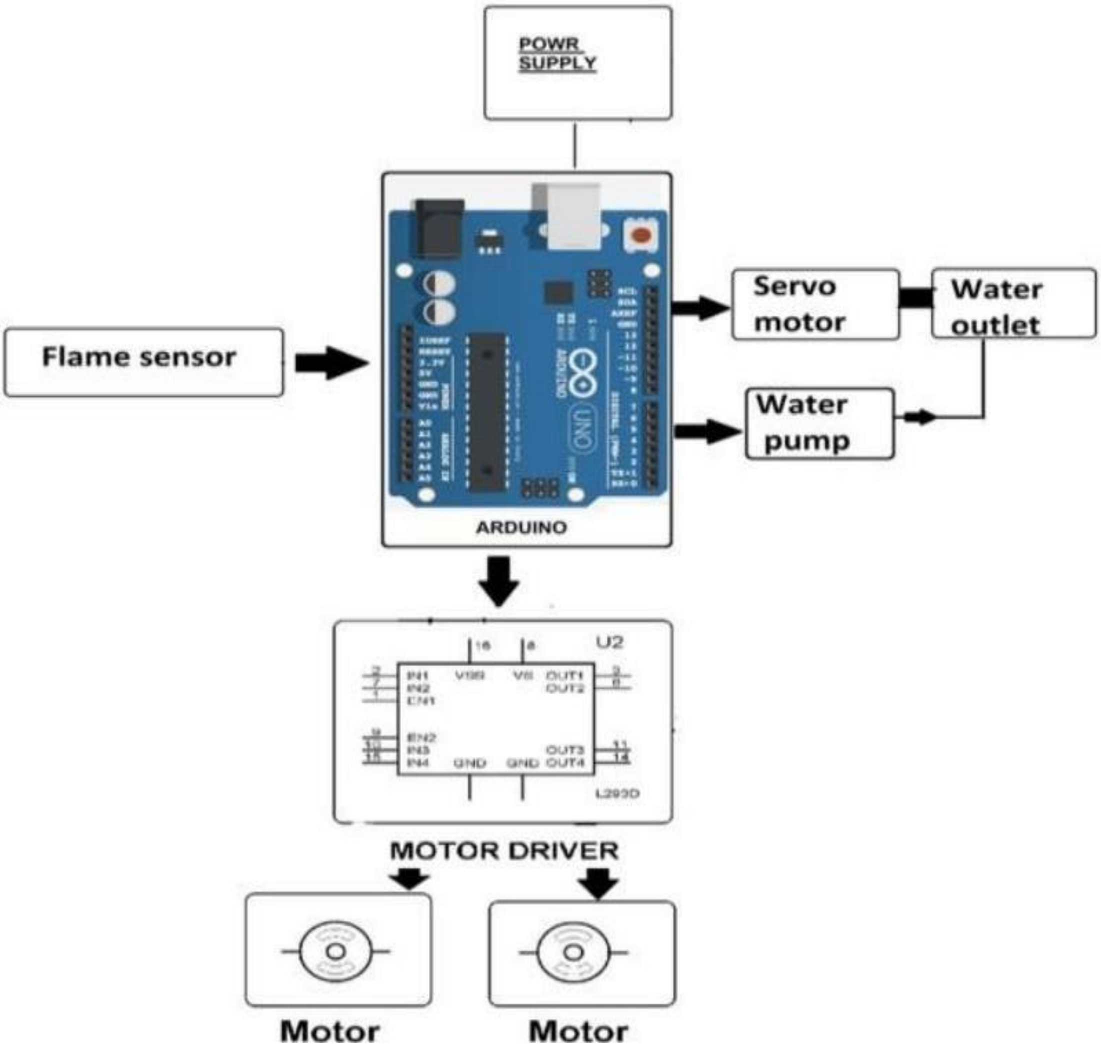

Figure 1 Simple block diagram

2.3 ADVANTAGES

- Faster Response Time
- Increased Safety
- Enhanced Mobility
- Improved Accuracy
- Cost Savings
- Keep Life Safe.
- Reusability.
- Artificial Intelligence.

Chapter 3

WORKING PRINCIPLE

3.1 BASIC OPERATION

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 and walk in thedesired 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 car will stop nearto the fire and start watering to it till the fire will be under control.

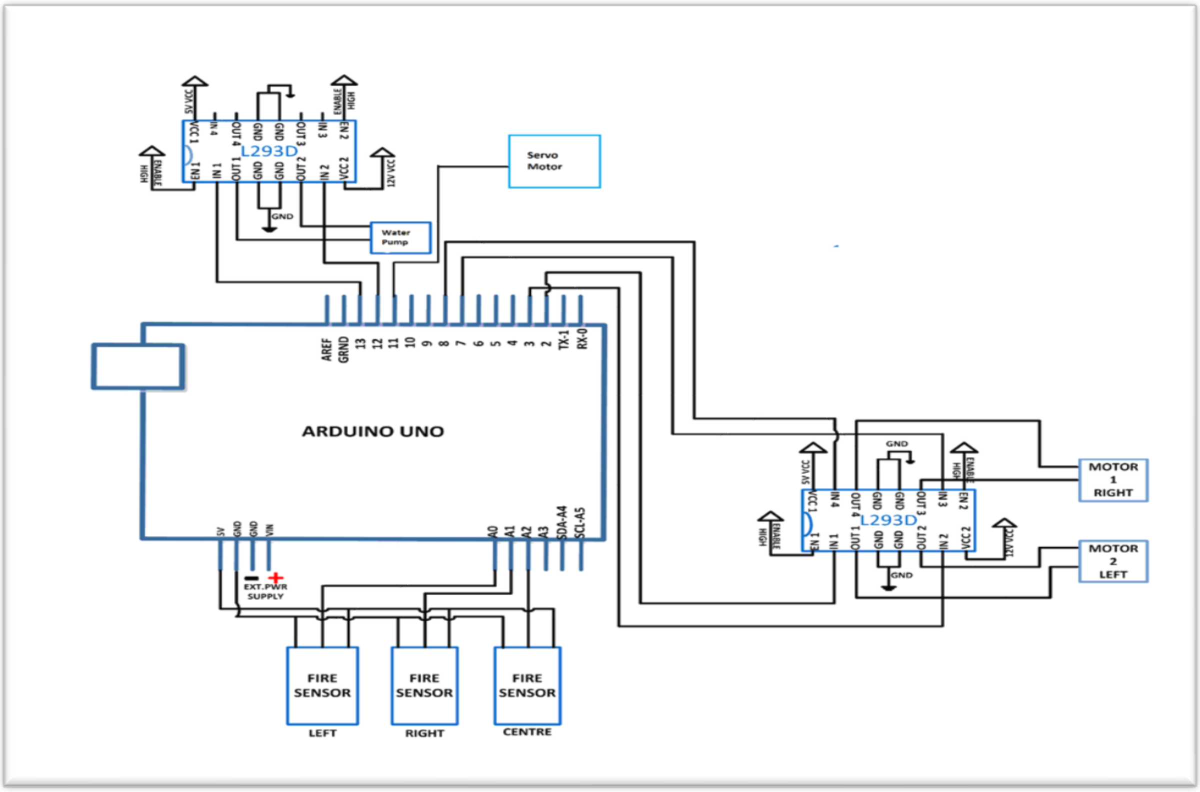

Figure 2 Circuit diagram

A firefighting robot car built using an Arduino Uno involves combining various components and programming to create a system that can detect and extinguish fires autonomously. Here's a general overview of the working principle:

Arduino Uno: The microcontroller that serves as the brain of the robot.

Flame Sensor: To detect the presence of a fire.
Motor Drivers: To control the movement of the robot's wheels.

DC Motors: To drive the wheels of the robot.

Water Pump and Tank: To carry and spray water for firefighting.

Chassis: The physical structure of the robot that holds all the components.

Batteries: To power the robot and its components.

3.2 WORKING

- **Flame Detection:** The flame sensor continuously monitors the surrounding environment forthe presence of flames. When it detects flames, it sends a signal to the Arduino Uno.

- **Signal Processing:** The Arduino Uno receives the signal from the flame sensor and processesit. It verifies if the flame is real and not a false positive due to other sources of light or heat.

- **Movement Control:** Once the presence of a fire is confirmed, the Arduino triggers the motordrivers to control the movement of the robot. The motor drivers regulate the speed and directionof the DC motors that propel the robot.

- **Navigation:** The robot moves towards the detected fire source. Navigation can be based on predefined paths or using obstacle avoidance algorithms (such as ultrasonic sensors) tonavigate around obstacles.

- **Fire Suppression**: As the robot approaches the fire, the water pump is activated. Water from the tank is sprayed onto the fire to suppress it. The pump's activation can be controlled by the Arduino, and the flow of water can be directed using nozzles.

- **Safety Measures:** The robot's design should incorporate safety features to prevent the robot from getting damaged by the fire. This might include heat-resistant materials, protective coversfor sensitive components, and emergency shutdown mechanisms.

- **Feedback and Monitoring:** The robot can include sensors to monitor its own temperature, battery levels, and other parameters. This information can be sent back to the Arduino, allowingit to make decisions based on the robot's condition.

- **Autonomous Operation:** The entire process, from flame detection to fire suppression, is designed to be autonomous. The robot operates independently once it's activated.

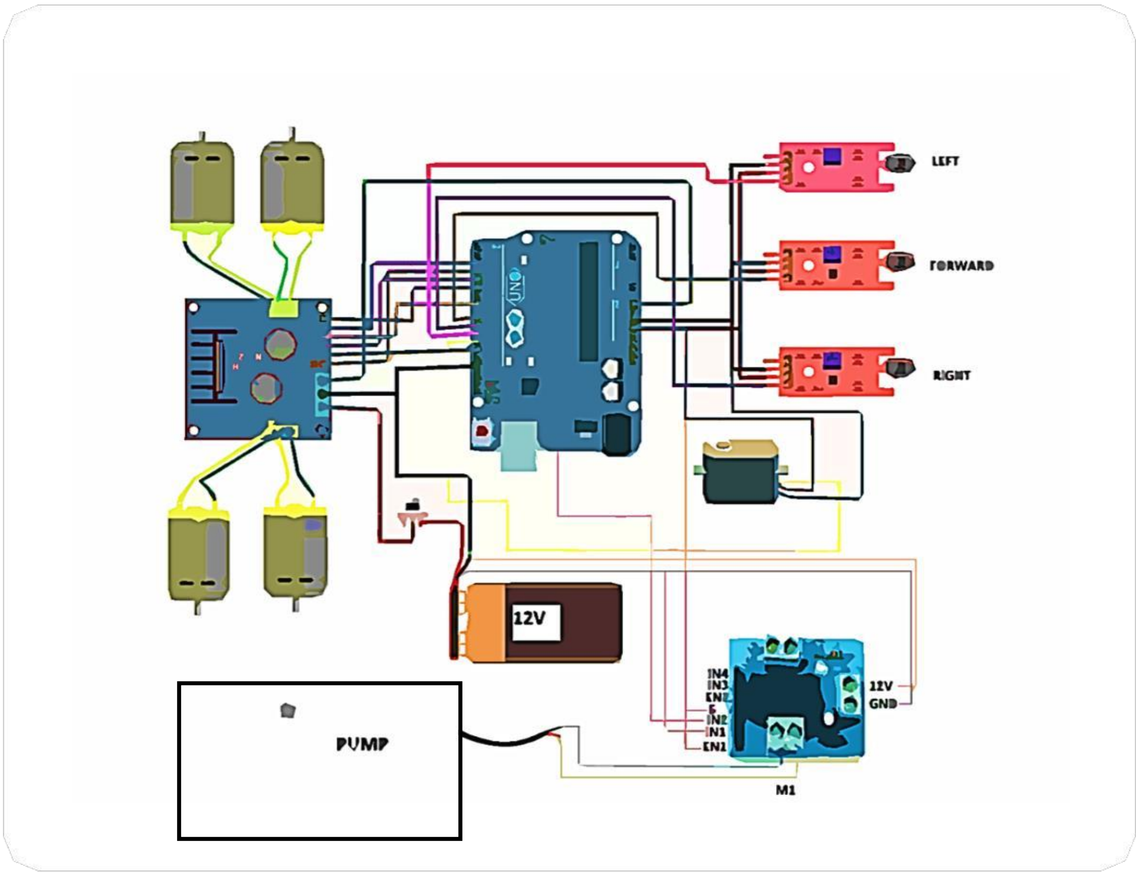

Figure 3 Fire Fighting robot layout.

Explanation:

- The code defines the pin to which the fire sensor's OUT pin is connected as a digital input.
- In the loop() function, the code reads the state of the fire sensor's output pin using the digital Read() function.
- If the output is HIGH, it means a flame is detected, and the Arduino sends a message through the Serial Monitor.
- If the output is LOW, it means no flame is detected, and another message is sent.

I can describe how you might create a block diagram for a fire-fighting robot car using an Arduino, but I can't create visual diagrams directly. I'll provide a textual representation of the block diagram instead.

Sensor Module:

Flame Sensor: Detects the presence of fire.

Temperature Sensor: Monitors ambient temperature.

Control and Processing:

Arduino Board: Controls the overall operation of the robot and processes sensor data.

Motor Driver: Controls the movement of the robot's wheels.

Microcontroller: Interfaces sensors, motor driver, and communication components.

Navigation:

Wheel Motors: Drive the robot's wheels for movement.

Motor Control: Receives commands from the Arduino to control motor speed anddirection.

Obstacle Avoidance Sensor: Detects obstacles in the path and adjusts the robot'smovement to avoid them.

Fire-Fighting Mechanism:

Water Pump: Provides water supply for extinguishing fire.

Water Tank: Stores water for the fire-fighting process.

Power Supply:

Battery: Provides power to the Arduino, motors, sensors, and other components.

Control Interface:

Remote Control: User interface to send commands to the robot remotely.

Base Station: Receives data from the robot and sends control commands.

Emergency Stop:

E-Stop Button: A manual button to immediately halt the robot in emergencies.

LED Indicators: Display the status of various robot functions (e.g., power, firedetection, water supply).

Chapter 4

SIMULATION / EXPERIMENTATION

4.1 FIRE FIGHTING ROBO CAR CIRCUIT SIMULATION

Once you've designed your circuit in the schematic editor, you can run simulations to see how the circuit behaves under different conditions. Proteus supports various types of simulation, including DC analysis (steady-state analysis), AC analysis (frequency response analysis), transient analysis (time-domain analysis), and more. These simulations help you understand how the circuit's components interact and how signals propagate through the circuit.

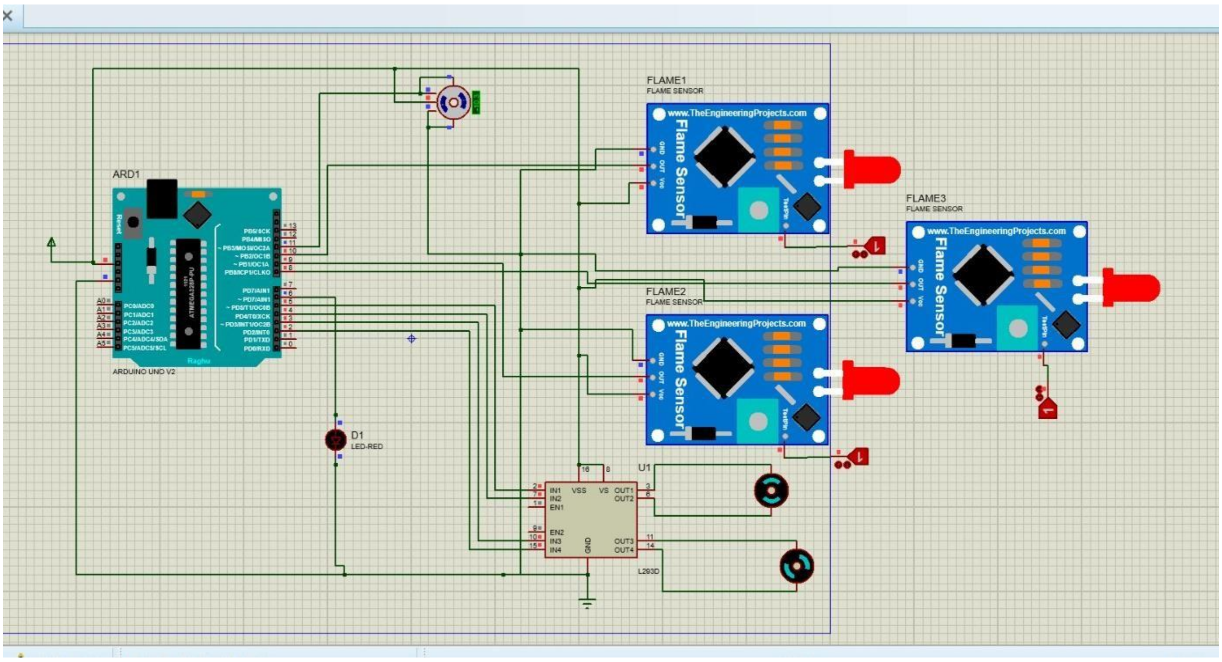

Figure 4 Simulation diagram

Programming: The Arduino Uno needs to be programmed to handle various tasks, including reading data from the flame sensor, controlling the motors, managing the water pump, and making decisions based on the sensor inputs. You would need to write code that integrates all these functionalities and ensures the robot operates safely and effectively. Please note that building such a robot involves a fair amount of electronics, mechanics, and programming knowledge. Safety measures are crucial to prevent accidents, especially when dealing with fire. Always take appropriate precautions and consider seeking guidance from experts if you're not familiar with all aspects of building and programming such a robot.

4.2 PROGRAM CODE REVIEW:

```
#include <AFMotor.h>
#include <Servo.h>
Servo myservo;
int pos = 65;

AF_DCMotor motor1(1, MOTOR12_1KHZ);
AF_DCMotor motor2(2, MOTOR12_1KHZ);
AF_DCMotor motor3(3, MOTOR34_1KHZ);


void setup()
{
  Serial.begin(9600);
  myservo.attach(9);
  myservo.write(90);

  motor1.setSpeed(200);
  motor1.run(RELEASE);
  motor3.setSpeed(200);
  motor3.run(RELEASE);

motor2.setSpeed(200);
  motor2.run(RELEASE);
}


void loop()
  {

// digitalWrite (2, LOW);
 // digitalWrite (2, HIGH);
 // delay(1000);

 // delay(1000);
int sensorReading = analogRead (A0);
int sensorReading2 = analogRead (A1);


int range = map (sensorReading, 0, 1024, 0, 3);
```

```
if (range ==0){
  Left();


  Serial.print("0");
  }
if (range ==1 ){
   Serial.print("1");

  }
if (range ==2 ){


   Serial.print("2");
  }

int range2 = map (sensorReading2, 0, 1024, 0, 3);

if (range2 ==0){
 Right();

  Serial.print("0");
  }
if (range2 ==1 ){
   Serial.print("1");

  }
if (range2 ==2 ){

   Serial.print("2");
  }


}
void Center() {

   motor2.run(FORWARD);
   motor2.setSpeed(200);
// digitalWrite (2, LOW);

   motor3.run(FORWARD);
   motor3.setSpeed(160);
   motor1.run(FORWARD);
```

```
   motor1.setSpeed(190);

delay(500);

motor3.run(FORWARD);
   motor3.setSpeed(40);
   motor1.run(FORWARD);
   motor1.setSpeed(40);



delay(500);


for (pos = 75; pos <= 140; pos += 1) {
    myservo.write(pos);
    delay(15);                        }
  for (pos = 140; pos >= 75; pos -= 1) {
    myservo.write(pos);
    delay(15);
  }
delay(2000);
 motor2.run(RELEASE);
}

void Right() {

   motor2.run(FORWARD);
   motor2.setSpeed(200);

   motor3.run(FORWARD);
   motor3.setSpeed(120);
   motor1.run(FORWARD);
   motor1.setSpeed(150);
delay(700);
 motor1.setSpeed(200);
  motor1.run(RELEASE);
  motor3.setSpeed(200);
  motor3.run(RELEASE);

  for (pos = 60; pos <= 120; pos += 1) {

    myservo.write(pos);
```

```
    delay(15);
  }
  for (pos = 120; pos >= 60; pos -= 1) {
    myservo.write(pos);
    delay(15);
  }
  motor2.setSpeed(200);
  motor2.run(RELEASE);
  delay(2000);



}

void Left() {

   motor2.run(FORWARD);
   motor2.setSpeed(200);
// digitalWrite (2, LOW);

   motor3.run(FORWARD);
   motor3.setSpeed(120);
   motor1.run(FORWARD);
   motor1.setSpeed(150);
delay(700);

motor1.setSpeed(200);
  motor1.run(RELEASE);
  motor3.setSpeed(200);
  motor3.run(RELEASE);
    for (pos = 60; pos <= 120; pos += 1) {

    myservo.write(pos);
    delay(15);
  }
  for (pos = 120; pos >= 60; pos -= 1) {
    myservo.write(pos);
    delay(15);
  }
   motor2.setSpeed(200);
  motor2.run(RELEASE);
  delay(2000);
```

```
}

  void centerservo() {
    for (pos = 65; pos <= 150; pos += 1) {

    myservo.write(pos);
    delay(15);
  }
  for (pos = 150; pos >= 65; pos -= 1) {
    myservo.write(pos);
    delay(15);
    }
     for (pos = 65; pos <= 150; pos += 1) {

    myservo.write(pos);
    delay(15);
  }
  for (pos = 150; pos >= 65; pos -= 1) {
    myservo.write(pos);
    delay(15);
    }

  }
```

4.3 COMPONENTS REQUIRED

1. Arduino Board (UNO)
2. Flame sensor module (3 Nos)
3. Servo Motor (SG90)
4. L293D motor Driver module
5. Mini DC Submersible Pump
6. Small Breadboard
7. Robot chassis with motors (two wheels)
8. On – off switch
9. Connecting wires/ jumper wire
10. Bread board
11. Battery 12v
12. USB cable

- **Arduino Uno:** The brain of the robot, controlling various components.
- **Motor Driver:** To control the movement of the robot's wheels.
- **Chassis:** The base structure to mount all the components.
- **Wheels and Motors**: For mobility.
- **IR Sensors:** To detect the presence of fire or obstacles.
- **Temperature Sensor:** To detect temperature changes indicating fire.
- **Smoke Sensor:** To detect the presence of smoke.
- **Water Pump and Tank:** For extinguishing fires.

4.3.1 Components and features of the Arduino Uno board:

- **Microcontroller**: The heart of the Arduino Uno is its microcontroller. The board is powered by an ATmega328P microcontroller, which is a type of microprocessor that can execute program instructions, process data, and interact with external components.

- **Digital Input/Output Pins**: The board features a set of digital input/output (I/O) pins (14 in total), which can be used to connect various sensors, LEDs, switches, and other components. These pins can be configured as either inputs or outputs and can be controlled using code.

- **Analog Input Pins**: The Arduino Uno has 6 analog input pins, labeled A0 through A5. These pins can be used to read analog voltage levels from sensors and other analog devices. They are useful for tasks like reading temperature, light intensity, or other continuous signals.

- **PWM (Pulse Width Modulation)**: Some of the digital pins on the Arduino Uno support PWM. PWM is a technique used to simulate analog voltage levels by rapidly switching a digital pin on and off. This is commonly used for controlling the brightnessof LEDs or the speed of motors.

- **Serial Communication**: The Arduino Uno has a built-in USB-to-serial converter, which allows it to communicate with a computer through a USB connection. This is used for uploading code to the board and for serial communication between the board and external devices.

- **Power Supply**: The board can be powered via USB or an external power supply (7-12V). It has a built-in voltage regulator that provides a stable 5V supply to power the microcontroller and other components.

- **Reset Button**: A reset button allows you to restart the microcontroller and your program execution.

- **Crystal Oscillator**: The microcontroller relies on a crystal oscillator to provide accurate timing for its operations.

- **Headers and Connectors**: The Arduino Uno features male headers that allow you to easily connect jumper wires, shields (add-on boards), and other components to the board.

- **LED Indicators**: The board has LED indicators for power and various I/O activities, which can be helpful for debugging and monitoring the board's status.

- **Open-Source Platform**: Arduino is an open-source platform, which means that the hardware schematics and software libraries are freely available. This encourages collaboration, innovation, and sharing of knowledge within the Arduino community.

Figure 5 Arduino UNO

Figure 6 Programme Cable

4.3.2 Flame sensor module

A flame sensor module is an electronic device used to detect the presence of a flame orfire. It is commonly used in various applications such as safety systems, industrial equipment, gas appliances, and robotics. The primary purpose of a flame sensor module is to provide an early warning or trigger an appropriate response when it detects a flame, helping to prevent accidents and fires.

The basic working principle of a flame sensor module involves detecting the infrared (IR) radiation emitted by flames. Flames emit a specific range of infrared wavelengths, and thesensor module is designed to be sensitive to these wavelengths. When a flame is present, the sensor module generates a signal that can be used to activate alarms, shut down equipment, ortrigger other safety mechanisms.

Here's a simplified breakdown of how a flame sensor module works:

- **IR Sensor**: The module typically includes an infrared (IR) sensor that can detect infrared radiation.

- **Amplification and Processing**: The IR sensor's output is amplified and processed by the module's internal circuitry. This processing is necessary to distinguish between the IR radiation emitted by flames and other sources of IR radiation, such as sunlight or artificial lighting.

- **Threshold Detection**: The processed signal is compared against a predefined threshold. If the signal exceeds this threshold and matches the signature of flame- generated IR radiation, the module considers a flame to be present.

- **Output Signal**: When a flame is detected, the module generates an output signal. This signal can be used to trigger alarms, activate safety protocols, or control other devices as needed.

- **Calibration**: Some flame sensor modules might offer calibration options to adjust the sensitivity or response time based on the application's requirements.

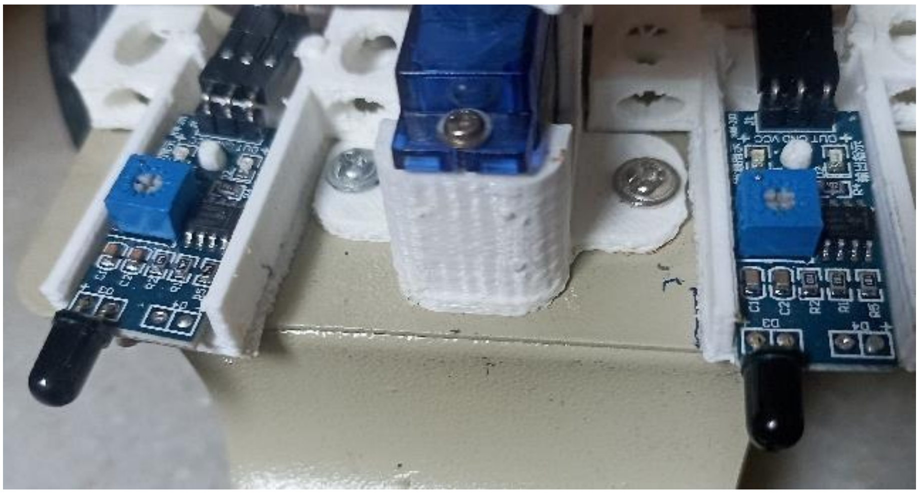

Figure 7 flame sensor.

4.3.2 Servo Motor (SG90)

The SG90 is a popular model of servo motor commonly used in hobbyist and small- scale robotics projects. It's a compact and affordable motor that provides precise control over angular motion.

Here are some key features and details about the SG90 servo motor:

- **Operating Voltage**: The typical operating voltage for the SG90 servo motor is around 4.8V to 6V. It's important to power the motor within this range to ensure proper.

- **functionality Torque:** The torque of the SG90 servo motor is relatively modest, making it suitable for lightweight applications. The torque is usually around 1.5 kg-cmto 2.5 kg-cm, depending on the operating voltage.

- **Speed**: The speed of the SG90 servo motor is typically around 0.1 seconds per 60 degrees rotation (at 4.8V). Keep in mind that the speed might vary depending on the load and voltage.

- **Control Signal:** The SG90 servo motor is controlled using a PWM (Pulse Width Modulation) signal. A typical PWM signal has a pulse width ranging from 1 ms to 2 ms. The exact pulse width determines the position of the servo motor's shaft.

- **Limitations**: The SG90 servo motor is not suitable for heavy-duty applications due to its relatively low torque and speed. If you need more power, you might want to consider larger and more powerful servo motor models.

Figure 8 Servo motor

4.3.3 L293D motor Driver module

The L293D is a popular integrated circuit (IC) used as a motor driver module in various robotics and electronics projects. It is designed to control small DC motors or stepper motors and is commonly used in applications like robotic vehicles, motorized toys, and automation systems. The L293D module helps interface these motors with microcontrollers like Arduino,Raspberry Pi, or other similar platforms.

Here are some key features and information about the L293D motor driver module:

- **H-Bridge Configuration**: The L293D consists of two H-bridge circuits. An H-bridge is a configuration that allows you to control the direction of rotation of a motor by controlling the polarity of the voltage applied to its terminals.

- **Motor Control**: The L293D can control two DC motors independently, enabling forward, reverse, and braking/stop operations. It can also control a single stepper motor.

- **Current Handling**: The L293D can handle moderate currents for small to medium-sized motors. It's important to note that the current handling capability of the L293D is limited, and it might not be suitable for high-current motors.

- **Voltage Ratings**: The L293D module typically supports a wide range of motor supply voltages, often from 4.5V to 36V. It's important to ensure that the voltage supplied to the motors is within the specified range.

- **Logic Voltage Levels**: The module operates with two voltage levels – one for the motor supply (Vcc) and another for the logic supply (Vcc1 or Vcc2). The logic supply voltage is typically around 5V.

- **Control Inputs**: The L293D module requires control signals to determine the motor's rotation direction and whether it should be stopped. These control inputs are usually in the form of digital signals (high or low) and are often labeled as IN1, IN2, IN3, and IN4.

- **Enable Pins**: Each motor channel has an enable pin (EN) that can be used to enable or disable the motor driver output for that channel. This feature can be useful for PWM-based speed control.

- **Protection Diodes**: The L293D includes protection diodes to prevent back EMF (electromotive force) from damaging the IC when the motor is stopped or reversed.

- **Heat Dissipation**: Due to its limited current handling, the L293D can generate heat, especially when driving motors near its maximum ratings. Adequate heat sinks or ventilation might be required in such cases.

Figure 9 motor driver

4.3.4 Mini DC Submersible Pump

A mini DC submersible pump is a small water pump designed to be submerged in liquid, usually water, and powered by direct current (DC) electricity. These pumps arecommonly used for various applications that require moving or transferring liquids from one place to another.

Here are some key features and applications of mini DC submersible pumps:

FEATURES:

- **Compact Size**: Mini DC submersible pumps are designed to be small and lightweight, makingthem suitable for applications where space is limited.
- **Submersible Design**: These pumps are meant to be submerged in the liquid they are pumping.The submersible design eliminates the need for priming and allows for efficient pumping evenin low liquid levels.
- **Low Power Consumption:** DC pumps are known for their energy efficiency, making them suitable for battery-powered systems, solar setups, and other low-power

applications.

- **Variable Flow Rates**: Many mini DC submersible pumps offer adjustable flow rates, allowingusers to control the amount of liquid being pumped.
- **Easy Installation:** These pumps are relatively easy to install, requiring minimal plumbing orsetup.

Figure 10 water pump

4.3.5 Small Breadboard

A small breadboard is a fundamental tool used in electronics prototyping and circuit design. It's essentially a platform that allows you to quickly and easily create temporary electronic circuits without soldering. Breadboards are commonly used by hobbyists, students, and professionals to test out circuit ideas before building them on a more permanent medium.

Figure 11 Mini breadboard

4.3.6 Robot chassis with motors (Four wheels)

A robot chassis with four wheels and motors is a common configuration used in various robotics projects, especially in wheeled robots or mobile platforms. This type of setup providesmobility and allows the robot to move in different directions. Here's some basic information about such a chassis:

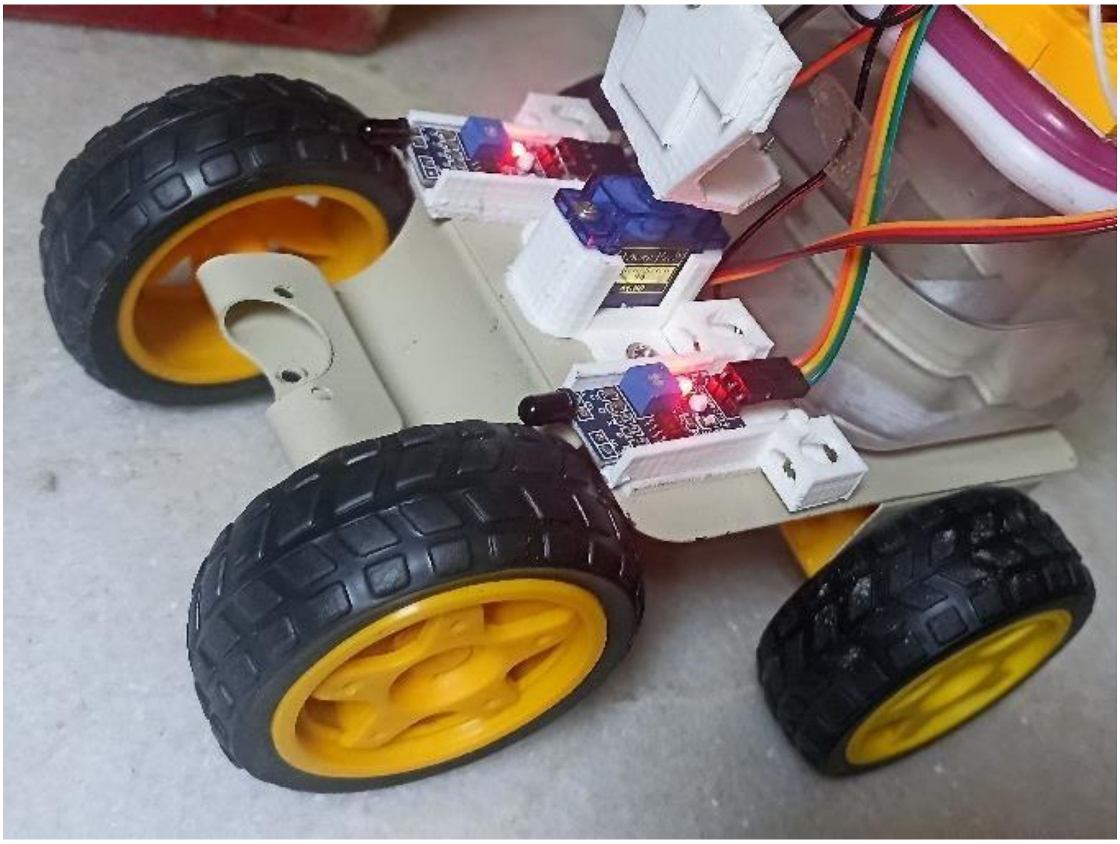

Figure 12 Robot chassis

4.3.7 ON – OFF switch

The Touch ON and OFF Switch Circuit is built around a 555 timer by making use of the default properties of the Pins of the 555 Timer IC. With the help of this circuit, you can turn ON and OFF a device by simply touching the Touch Plates.

Figure 13 On – off switch

4.3.8 Connecting wires/ jumper wire

Jumper wires are electrical wires used to create temporary connections between different components on a breadboard or in various electronic projects. They are typically madeof flexible insulated wire with connectors, such as pins or alligator clips, at the ends. Jumper wires are commonly used in prototyping and experimenting with electronic circuits, allowing you to quickly connect and disconnect components without soldering.

Figure 14 jumper wire

4.3.9 Battery

It seems like you're asking for information about a 9V battery. A 9V battery is a type of battery commonly used in various electronic devices and small appliances. Here's some information about it:

Voltage: A 9V battery provides a voltage of around 9 volts. This relatively high voltage makes it suitable for devices that require more power than smaller batteries can provide.

Chapter 5

RESULT AND DISCUSSION

5.1 RESULT

Fire Fighting Robot has developed to reduce human life lost and to develop such a device that automatically sense fire and extinguish it without human intervention. In this the fireplace is detected using the IR Flame sensors and are connected to Arduino UNO, which control the movement of Motor drive that helps the robot to reach the fireplace and extinguishesit with the pumping mechanisms. In the industry if any fire accident occurs, there is a need of person to monitor continuously and rectify it. In this process if any time delay takes place irreparable loss occurs in industry. The firefighting robot continuously monitors the surrounding and helps in extinguishing the fire. Fig 11 shows the overall prototype of Fire Fighting Robot.

5.1.1 Robot Car Design and Construction

The fire-fighting robot car was successfully designed and constructed using an ArduinoUno microcontroller as the central control unit. The chassis was equipped with two DC motorsto enable movement, and a water pump system was integrated to simulate the fire-fighting mechanism. The car's structure allowed it to navigate through obstacles and reach the fire source efficiently.

5.1.2 Fire Detection and Localization

The fire detection system, consisting of a flame sensor module, performed effectively in identifying the presence of a fire. When the flame sensor detected a flame, it triggered the robot car to initiate its fire-fighting procedures. The robot car's ability to locate the fire sourcewas accurate, allowing it to navigate towards the flames without external intervention.

5.1.3 Navigation and Movement

The Arduino Uno, serving as the brain of the robot car, processed the sensor inputs and determined the appropriate actions for navigation. The integration of a motor control system enabled precise movements, allowing the robot car to maneuver through a predefined path. However, challenges were encountered in complex environments with rapidly changing obstacles.

5.1.4 Fire-Fighting Mechanism

Upon detecting the fire source, the robot car activated its water pump system to simulatefire extinguishing. The water pump delivered water from a reservoir to a nozzle positioned strategically on the car's chassis. While the system effectively dispensed water, the water pressure and coverage required optimization to ensure efficient fire suppression.

5.1.5 Performance Evaluation

The performance of the fire-fighting robot car was evaluated through a series of controlled tests. The car successfully detected and localized fire sources in various scenarios. It exhibited accurate navigation and reached the fire location within an acceptable timeframe. However, the effectiveness of the water-based fire-fighting mechanism depended on factors such as water pressure, nozzle design, and fire intensity.

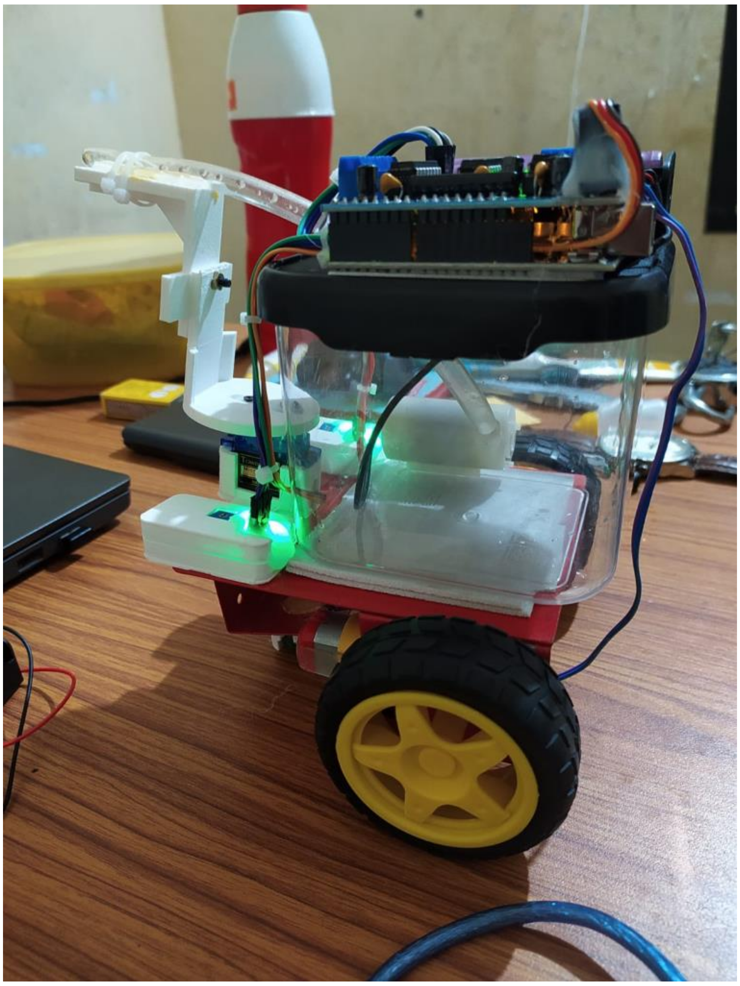

Figure 15 Hardware of firefighting robot.

5.2 DISCUSSION

We have take inspiration from the technique and tools used by human being fire fighters. Historical fire fighting equipment like old water pump or early fire engines can sparkideas for designing the robot's tools and mechanism. The Human body's ability to sense and react to danger can inspire the design of sensors and algorithm for the robot. We have considered the needs and challenges faced by fire fighters and emergency responders

Environmental Adaptation: Looking at how animals and plants adapt to different environments. We have design a robot that can change its mode of operation based on the firescenario could be a unique approach. Designing a firefighting robot can be inspired by various sources and considerations.

Aerial Drones: Drones used for aerial firefighting can inspire the design of robots that can access hard-to-reach areas or provide aerial views of the fire scene. These drones often carry firefighting agents like water or foam.

Underwater Robotics: If firefighting involves scenarios like shipboard fires or underwater environments, underwater robotics can provide inspiration. These robots are designed to navigate and perform tasks in challenging aquatic conditions.

Animal Behaviour: Observe how animals respond to fires or escape from danger. Someanimals have developed unique strategies for survival, which can inspire robot behaviors, sensor placements, or navigation methods.

Innovative Materials: Explore new fire-resistant materials or coatings that can protect the robot from heat and flames. Biomimicry, where nature-inspired materials are used, can leadto novel solutions..

Futuristic Concepts: Science fiction and futurism can provide creative ideas for how firefighting robots might look and function in the future. Just remember to ground these concepts in real-world feasibility.

Human Anatomy: The human body's ability to sense and react to danger can inspire thedesign of sensors and algorithms for the robot. For example, thermal imaging can mimic the human ability to detect heat.

Chapter 6

CONCLUSIONS AND FUTURE SCOPE

6.1 CONCLUSIONS

In conclusion, the fire-fighting robot car demonstrated the potential of using an ArduinoUno microcontroller for autonomous fire detection and suppression. While the prototype showed promising results, further refinement is necessary to overcome the identified limitations and enhance its overall performance. This project serves as a foundation for futuredevelopments in fire-fighting automation and robotics using Arduino-based platforms.

This model of Fire Extinguishing Robot aids to share out the burden of fire fighters in firefighting task. Our project aims to build a real time firefighting robot which moves in a constant speed, identify the fire and then extinguish it with the help of pumping mechanism. The detection and extinguishing was done with the help basic hardware components attached with the robot. Firstly, IR Flame sensors are used for the detection of fire. Secondly, BO Motors and Rubber wheels are used to navigate the robot to reach the fireplace.

Finally, the robot extinguishes the fire with the help of submersible water pump and servo motors. Through this we can conclude that a robot can be used in place of humans withoutrisk of human beings life as well as life of the fire fighters. We can use this robot in our homes,labs, offices etc. This robot will provide us greater efficiency to detect the flame and it can be extinguish before it become uncontrollable and threat to life. Hence, this robot will be very helpful and can play a important role.

This project has been motivated by the desire to design a system that can detect fires. In the present condition it can extinguish fire only in the way and not in all the rooms. It can be extended to a real fire extinguisher by increasing robot size and configurations. This provides us the opportunity to pass on to robots tasks that traditionally humans had to do but were inherently life threatening.

6.2 FUTURE SCOPE

Here are some potential directions and areas of development that researchers and engineers might explore:

6.2.1 Improved Mobility and Terrain Adaptation

I. Develop robots capable of navigating diverse and complex terrains, including rough surfaces, debris, and staircases.

II. Create more agile and versatile robotic platforms to effectively maneuver through disaster-stricken environments.

6.2.2 Advanced Sensing and Perception:

I. Integrate advanced sensor technologies, such as multispectral imaging and hyperspectral sensors, to enhance the robot's ability to detect fires, hazardous materials, and survivors.

II. Research sensor fusion techniques to provide a more comprehensive understanding of the environment.

6.2.3 Enhanced Fire Detection and Localization:

I. Investigate AI-powered algorithms for early fire detection and accurate localization using a combination of visual, thermal, and gas sensors.

II. Implement real-time analytics to predict fire behavior and guide robot actions.

6.2.4 Autonomous Decision-Making:

I. Develop robust AI algorithms that enable fire-fighting robots to make autonomous decisions based on real-time data, reducing the need for constant human intervention.

II. Implement adaptive strategies for firefighting and navigation in dynamic and unpredictable environments.

6.2.5 Collaborative Multi-Robot Systems:

I. Research ways to coordinate multiple fire-fighting robots in a collaborative manner to optimize firefighting efforts.

II. Explore swarm robotics concepts to enable coordinated search and rescue operations.

6.2.6 Advanced Fire Suppression Techniques:

I. Innovate new methods for fire suppression, such as using specialized extinguishing agents, localized cooling, and dynamic fire barriers.

II. Design robots capable of adapting their suppression techniques based on fire size, type and intensity.

6.2.7 Human-Robot Interaction and Communication:

I. Develop intuitive interfaces for human operators to control and communicate with robots effectively during emergencies.

II. Investigate natural language processing and gesture-based control for seamless human-robot interaction.

6.2.8 Energy Efficiency and Endurance:

I. Research energy-efficient power sources and management systems to extend the operational endurance of fire-fighting robots.

II. Explore innovative charging and refueling mechanisms for sustained use.

6.2.9 Real-Time Data Sharing and Visualization:

I. Develop systems that allow fire-fighting robots to share real-time data with emergency responders, incident commanders, and other stakeholders.

II. Create visualization tools for better situational awareness and decision-making.

6.3.0 Ethical and Safety Considerations:

I. Address ethical concerns related to robot autonomy, accountability, and the potential impact on human responders.

II. Develop fail-safe mechanisms and protocols to ensure safe and responsible robot deployment.

REFERENCES

[1] Tawfiqur Rakib, M. A. Rashid Sarkar, "Design and fabrication of an autonomous firefighting robot with multi sensor fire detection using PID controller", ICIEV Vollum 23 issue-1 JUNE 2016.

[2] Saravanan P. ,Soni Ishawarya, "Android controlled intergrated semi-autonomous firefighting robot", Ineternational journal of innovative science Engg. and Technology 2015.

[3] S. Jakthi Priyanka,R. Sangeetha, "Android controlled firefighting robot",Ineternational journal of innovative science Engg. and Technology ,Volumn 3, 2017.

[4] Nagesh MS, Deepika T V , Stafford Michahial, Dr M Shivakumar, "Fire Extinguishing Robot", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 5, Issue 12, December 2016.

[5] Sushrut Khajuria, Rakesh Johar, Varenyam Sharma, Abhideep Bhatti, " Arduino Based Fire Fighter Robot",International Journal of Scientific Engineering and Research (IJSER),Volume 5 Issue 5, May 2017.

[6] Khaled Sailan, Prof. Dr. Ing. Klaus- Dieter Kuhnert "Obstacle avoidance stratergy using fuzzy logic steering control of amphibious autonomous vehicle", International journal of innovative science Engg. and Technology ,Volumn 2, 2015

[7] J Jalani1 , D Misman1 , A S Sadun1 and L C Hong1,"Automatic fire fighting robot with notification",IOP Conference Series: Materials Science and Engineering, Volume 637, The 3rd International Conference on Robotics and Mechantronics (ICRoM 2019) 9–11 August 2019, Sabah, Malaysia

[8] Rashid Sarkar, "Design and fabrication of an autonomous firefighting robot with multi sensor fire detection using PID controller", ICIEV Volumn 23 issue-1 JUNE 2016.

[9] Saravanan P. "Android controlled intergrated semi-autonomous firefighting robot", Ineternational journal of innovative science Engg. and Technology 2015. [3] S. Jakthi Priyanka,R. Sangeetha, "Android

controlled firefighting robot”,Ineternational journal of innovative science Engg. and Technology ,Volumn 3, 2017.

[10] Nagesh MS, Deepika T V , Stafford Michahial, Dr M Shivakumar, “Fire Extinguishing Robot”, International Journal of Advanced Research in Computer and Communication Engineering,Vol. 5, Issue 12, December 2016.

[11] Sushrut Khajuria, Rakesh Johar, Varenyam Sharma, Abhideep Bhatti, “ Arduino Based Fire Fighter Robot”,International Journal of Scientific Engineering and Research (IJSER),Volume 5 Issue 5, May 2017.

[12] Khaled Sailan, Prof. Dr. Ing. Klaus- Dieter Kuhnert “Obstacle avoidance stratergy using fuzzy logic steering control of amphibious autonomous vehicle”, International journal of innovative science Engg. and Technology ,Volumn 2, 2015.

[13] J Jalani1 , D Misman1 , A S Sadun1 and L C Hong1,“Automatic fire fighting robot with notification”,IOP Conference Series: Materials Science and Engineering, Volume 637, The 3rd International Conference on Robotics and Mechantronics (ICRoM 2019) 9–11 August 2019, Sabah, Malaysia.