Contents

Certificate

DECLARATION

I declare that this project report titled **Fire Fighting Robot** submitted in partial fulfillment of the degree of B. Tech in Electronics and Telecommunication Engineering is a record of original work carried out by me under the supervision of **Prof.S.S.Thorat** and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made wherever the findings of others have been cited.

Signature of Guide

ACKNOWLEDGEMENT

It is an incident of great pleasure for us submitting this Mini Project Report.We take this opportunity to express our deep sense of gratitude and great thanks to our Guide and Head of department **Prof.S.S.Thorat** Who has been a constant source of guidance and inspiration through this report work we shall ever be grateful to them for the encouragement and suggestion gives by them from time to time.

It is grateful to thank all the teaching member of electronic and telecommunication engineering department who always inspire us and their suggestions helped us to complete our micro project. We would also like to thanks our principal **DR.P.M.Khodke** who always inspire us and their suggestions helped us to complete our micro project.

We also thankful to our friends and library staff members whose encouragement Last but not the least, we thankful to our parents whose wishes are always with us.

ABSTRACT

The project aims to develop a fire-fighting robot equipped with three infrared (IR) fire sensors and one IR sensor for object detection. The robot is designed to detect and respond to fires autonomously. This robot is designed to minimize the risk to human life during fire emergencies and provide an efficient and rapid response to fire incidents.

When no fire is detected, the robot moves in a straight direction. It continuously scans the surroundings using the object detection sensor. If an object is detected in its path, the robot changes its direction and starts moving forward to avoid collisions.

However, when a fire is detected by any of the three fire sensors, the robot immediately stops its movement. It activates its water spraying mechanism to extinguish the fire effectively. Once the fire is successfully extinguished, the robot resumes its movement and enters the cycle again, constantly scanning for fires and objects.

This fire-fighting robot offers an automated solution to detect and combat fires, reducing the risk to human operators and enhancing the efficiency of fire-fighting operations. It combines fire detection capabilities with object detection for safe navigation, ensuring prompt action in the event of a fire.

The Fire Fighting Robot project has the potential to revolutionize the way fire emergencies are handled by reducing response time, improving safety, and minimizing property damage. It can be employed in various settings such as residential buildings, industrial facilities, and public spaces to enhance fire prevention and firefighting capabilities.

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1 CHAPTER

1.1 INTRODUCTION

Fires are among the most important form of problems. Robot industry has a lot of work in this area. So today robot is more commonly used to reduce the human efforts. The need of Fire extinguisher Robot that can detect and extinguish a fire on its own. Robotics is one of the fastest growing engineering fields of today. Robots are designed to remove the human factor from labour intensive or dangerous work and also to act in inaccessible environment. With the invention of such a device, lives and property can be saved with minimal damage caused by the fire. As an engineer's we have to design a prototype that could autonomously detect the fire and extinguish it. The Fire Fighter Robot is designed to search for a fire in the house or industry for extinguish the fire.

The main and only work is to deploy the robot in a fire prone area and the robot will automatically work once it detects a fire breakout. This prototype helps in Rescue operations during fire accidents where the entry of service man is very difficult in the fire prone area. There are several existing types of vehicles for firefighting at home and extinguish forest fires. Our proposed robot is designed to be able to work on its own or be controlled remotely. By using such robots, fire identification and rescue activities can be done with higher security without placing fire fighters at high risk and dangerous conditions. In other words, robots can reduce the need for fire fighters to get into dangerous situations.

When we the field of firefighting has long been a dangerous one, and there have been numerous and devastating losses because of a lack in technological advancement. Additionally, the current methods applied in firefighting are inadequate and inefficient relying heavily on humans who are prone to error, no matter how extensively they have been trained. A recent trend that has become popular is to use robots instead of humans to handle fire hazards. This is mainly because they can be used in situations that are too dangerous for any individual to involve themselves in. In our project, we develop a robot that is able to locate and extinguish fire in a given environment. The robot navigates the area and avoids any obstacles it faces in its excursion. Arduino board acts as a brain of the whole control circuitry .Robot consist of the two sensors that are interfaced in the control circuitry. Sensors are used to detect fire prone area all directions and moves the robo to fire location. When the robot reaches fire zone then a pump extinguisher is attached on the robot comes into action to extinguish the fire.

2 CHAPTER

2.1 LITERATURE REVIEW

1. **Development of Fire Fighting Robot (QRob)**

   Fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. Fire fighters are primarily tasked to handle fire incidents, but they are often exposed to higher risks when extinguishing fire, especially in hazardous environments such as in nuclear power plant, petroleum refineries and gas tanks. They are also faced with other difficulties, particularly if fire occurs in narrow and restricted places, as it is necessary to explore the ruins of buildings and obstacles to extinguish the fire and save the victim. Therefore, this paper presents the development of a firefighting robot dubbed QRob that can extinguish fire without the need for fire fighters to be exposed to unnecessary danger.

   QRob is designed to be compact in size than other conventional fire-fighting robot in order to ease small location entry for deeper reach of extinguishing fire in narrow space. QRob is also equipped with an IR sensor to avoid it from hitting any obstacle and surrounding objects, while a flame sensor is attached for fire detection. This resulted in QRob demonstrating capabilities of identifying fire locations automatically and ability to extinguish fire remotely at particular distance. QRob is programmed to find the fire location and stop at maximum distance of 40 cm from the fire. A human operator can monitor the robot by using camera which connects to a smartphone or remote devices.

3 CHAPTER

3.1 METHODOLOGY

Initially we need to make sure all the components are connected and give power supply through an external device. The robot remains idle initially, later it starts rotating in 360 degrees to detect the presence of object with the help of flame sensor. If the object is not within the range it moves ahead and then again checks the presence of object within the range. The signal is sensed to the one of the 5 channel flame sensor and then robot moves if it signals to center sensor so that we can move to the object accurately. After detecting the flame it moves to certain distance and again checks the range of distance until it moves near the flame object. After it reaches it then in turn activates fire extinguisher or water pump to sprinkle the water on fire object.

3.1.1 Existing System

The common conventional firefighting methods involve fire brigades, portable fire extinguisher (hand held) and sprinklers. These conventional methods consume lot of time to reach the place of the mishap like the fire brigade must be deployed from the fire station and should get through the traffic and reach the fire struck area, the portable extinguisher is also no gift because it is generally place at one off the corners of the building which may be difficult to reach and it needs constant maintenance. On the other hand the sprinkler and smoke detector set up is very non reliable method because the sprinkler pipes has any defect may not provide enough pressure and it is suited to cover large areas.

Problems in Existing System:

The problem with existing system is that exposure to the hazardous and chaotic fire environment, rather than to the fire itself, is the most significant cause of injury and death in fires. The reachability of precise information in real-time on the conditions directly at the center of the fire ground is a crucial factor in the guidance of rescue actions together with feasible counter-plans. Unfortunately the firefighting environments are normally hard to reach and restricted in accessibility by obstacles, tumbledown architectures and visibility by smoke, dangerous gases or dust.

Therefore, the fire scene is an information-poor environment due to lack of information on location of fire, firefighters and victims, and the search and rescue opportunities are previously unimaginable due to lack of situational conditions and real-time information for targeted decision making.to this the accidents occurs. Additionally, the current methods applied in firefighting are inadequate and inefficient relying heavily on humans who are prone to error, no matter how extensively they have been trained.

3.1.2 Proposed System

The proposed model is able to detect presence of fire using flame sensor and calculates object distance using ultrasonic sensor and moves the robot to fire accident location. It contains gear motors and motor driver to control the movement of robot. When it detects fire it communicates with microcontroller (Arduino MEGA) and the robo will move towards the fire affected area. The fire extinguisher is mounted on the robotic vehicle which is then controlled over the wireless communication so that it extinguishes the fire automatically.

ADVANTAGES OF PROPOSED SYSTEM

1. The robot will be used at places where it is dangerous for humans to enter.
2. Capability of sensing accurately with increased flexibility.
3. Reduce human effort.
4. Reliable and economical.
5. It reduces the time delay in reaching fire affected area.]
6. It reduce the errors and the limitations that are faced by human fire fighters.
7. Sensors have long life time and less cost.

3.2 Circuit Components lists

Table 1: List Of Components

Sr.No	**Component**	**Specification**	**Quantity**
1	Arduino Uno	-	1
2	Arduino Uno Sheild v1	L293D	1
3	Flame Sensor Module	KY-026	1
4	IR Sensor Module	-	3
5	DC Gear Motor	12v Dual Shaft	4
6	Water Pump	5v DC	1
7	Servo Motor	SG90	1
8	Mini Breadboard	SLITD021	1
9	Jumping Wires	SG90	1
10	Rechargable LiPo Battery	12v DC	1

3.2.1 Arduino Uno

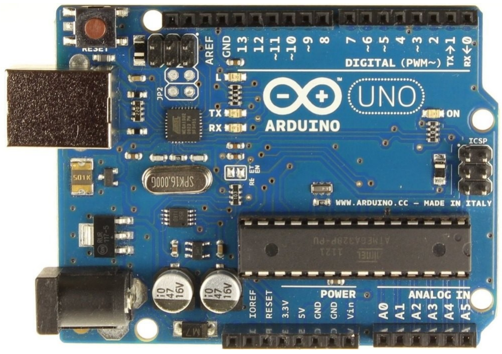

Figure 1: Arduino Uno

Arduino Uno is a popular microcontroller board based on the Atmega328P chip. It is a compact and user-friendly development board designed for beginners and experienced electronics enthusiasts. Arduino Uno provides an open-source platform for creating and prototyping a wide range of electronic projects.

With its easy-to-use interface and a large community of users, Arduino Uno allows you to write and upload code to control and interact with various electronic components such as sensors, motors, and displays. It has digital and analog input/output pins that can be easily programmed to perform different tasks.

Arduino Uno can be powered via USB or an external power source, making it versatile and portable. It supports a simplified programming language based on C/C++, making it accessible for beginners to start coding and experimenting with electronics.

The board can be connected to a computer through a USB cable, enabling seamless code uploading and real-time data monitoring. Arduino Uno also offers a wide range of shields and modules that expand its capabilities, allowing you to create complex projects with ease.

Overall, Arduino Uno is a versatile and user-friendly microcontroller board that serves as an excellent platform for learning, prototyping, and creating interactive electronic projects.

Arduinos contain a number of different parts and interfaces together on a single circuit board. The design has changed through the years, and some variations include other parts as well. But on a basic board, you're likely to find the following pieces.

- A number of pins, which are used to connect with various components you might want to use with the Arduino. These pins come in two varieties.
- Digital pins, which can read and write a single state, on or off. Most Arduinos have 14 digital I/O pins.Analog pins, which can read a range of values, and are useful for more fine-grained control. Most Arduinos have six of these analog pins.
- These pins are arranged in a specific pattern, so that if you buy an add-on board designed to fit into them, typically called a "shield," it should fit into most Arduino-compatible devices easily.
- A power connector, which provides power to both the device itself, and provides a low voltage which can power connected components like LEDs and various sensors, provided their power needs are reasonably low. The power connector can connect to either an AC adapter or a small battery.
- A power connector, which provides power to both the device itself, and provides a low voltage which can power connected components like LEDs and various sensors, provided their power needs are reasonably low. The power connector can connect to either an AC adapter or a small battery.
- A microcontroller, the primary chip, which allows you to program the Arduino in order for it to be able to execute commands and make decisions based on various input. The exact chip varies depending on what type of Arduino you buy, but they are generally Atmel controllers, usually a ATmega8, ATmega168, ATmega328, ATmega1280, or ATmega2560. The differences between these chips are subtle, but the biggest difference a beginner will notice is the different amounts of onboard memory.
- A serial connector, which on most newer boards is implemented through a standard USB port. This connector allows you to communicate to the board from your computer, as well as load new programs.
- Variety of other small components, like an oscillator and/or a voltage regulator, which provide important capabilities to the board, although you typically don't interact with these directly; just know that they are there.

3.2.2 Infrared Sensor - IR Sensor

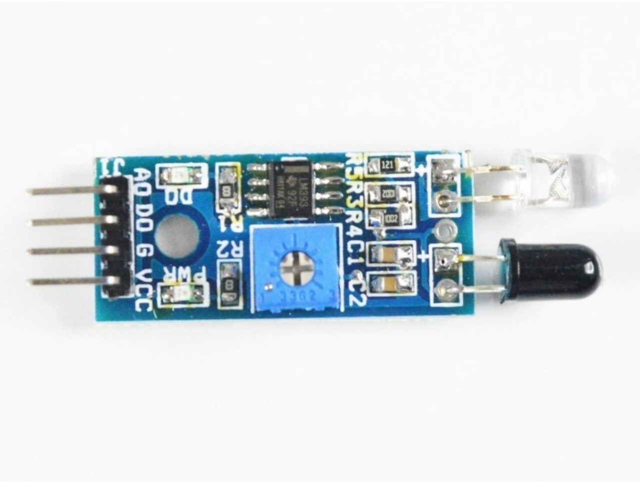

Figure 2: IR Sensor

An IR sensor module, or infrared sensor module, is an electronic device that detects infrared radiation in its surroundings. It is commonly used for proximity sensing, object detection, and remote control applications. The IR sensor module typically consists of an infrared emitter (LED) and an infrared receiver (photodiode or phototransistor) placed side by side. The emitter emits infrared light, which is then reflected by objects in its path. The receiver detects the reflected infrared light and generates an electrical signal proportional to the intensity of the received light.

The module may include additional components such as amplifiers, filters, and signal conditioning circuits to improve sensitivity and reduce interference. Some IR sensor modules also offer adjustable sensitivity or distance detection capabilities.

When an object is within the detection range of the IR sensor module, the reflected infrared light will be detected by the receiver, resulting in a change in the output signal. This change can be used to trigger actions or provide feedback in various applications. IR sensor modules are widely used in automation systems, robotics, security systems, motion detection devices, line-following robots, and remote control systems. They offer non-contact sensing capabilities and can operate effectively in different lighting conditions.

3.2.3 L293D Arduino UNO Shield V1

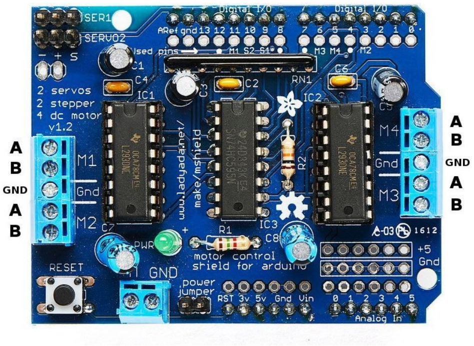

Figure 3: L293D Arduino UNO Shield V1

The L293D Arduino Uno Shield V1 is a motor driver shield designed specifically for Arduino Uno boards. It is based on the L293D IC, which is a popular dual H-bridge motor driver integrated circuit. The shield provides an easy and convenient way to control DC motors and stepper motors using an Arduino Uno. It can drive up to two DC motors or one stepper motor, allowing you to control their speed and direction of rotation.

The L293D chip on the shield provides protection features such as thermal shutdown and current limiting, ensuring safe and reliable motor operation. It also has built-in diodes to protect against back EMF (electromotive force) generated by the motors. The shield connects directly to the Arduino Uno board, fitting on top of it and utilizing the digital and analog input/output pins. It simplifies the wiring and control of motors, eliminating the need for additional motor driver circuits or complex wiring configurations.

By using the appropriate Arduino libraries and programming code, you can easily control the motors connected to the L293D Arduino Uno Shield V1. This shield is commonly used in robotics projects, automated systems, and various applications requiring motor control.

3.2.4 KY-026 Flame Sensor Module

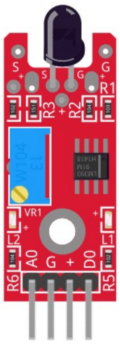

Figure 4: KY-026 Flame Sensor Module

The KY-026 flame sensor is a module that detects the presence of a flame or fire. It is designed to provide an analog output signal when it detects flames or intense light sources associated with fire. The KY-026 flame sensor module typically consists of an infrared sensor, a comparator circuit, and a potentiometer to adjust sensitivity. The infrared sensor detects the infrared radiation emitted by flames, and the comparator circuit converts the detected signal into a digital or analog output.

When the sensor detects a flame or intense light, it generates an output signal indicating the presence of fire. The analog output can be connected to an analog input pin of a microcontroller or Arduino board for further processing and decision-making. The sensitivity of the KY-026 flame sensor can be adjusted using the potentiometer to adapt to different fire intensities and ambient light conditions. By setting the appropriate sensitivity level, false positives or false negatives can be minimized.

The KY-026 flame sensor is commonly used in fire detection and safety systems, flame monitoring in industrial applications, and in various DIY electronics projects where flame detection is required.

3.2.5 12V Dual Shaft DC Gear Motor

Figure 5: 12V Dual Shaft DC Gear Motor

A dual shaft DC gear motor is a type of DC motor that features two output shafts extending from opposite ends of the motor. It combines the functionality of a DC motor with a gearbox, providing both rotational power and increased torque output.

The motor part of a dual shaft DC gear motor operates using direct current (DC) power and converts electrical energy into mechanical motion. The gearbox, which is typically integrated into the motor housing, contains a series of gears that transmit and amplify the motor's rotational force. This gear reduction mechanism increases the torque output of the motor while reducing the speed of rotation. The dual shaft design means that the motor has two output shafts, one on each end, extending in opposite directions. This configuration allows for greater versatility in applications where multiple outputs or directional control is required. It enables the motor to drive two separate mechanisms simultaneously or be connected to different components or systems.

Dual shaft DC gear motors are commonly used in various applications, including robotics, automation, industrial machinery, and automotive systems. They provide the advantages of compact size, high torque output, precise control, and the ability to drive multiple devices or mechanisms with a single motor.

3.2.6 5V DC Water Pump

Figure 6: 5V DC Water Pump

A 5V DC water pump is a small water pump that operates on a 5-volt direct current (DC) power supply. It is designed to circulate or transfer water in low-power applications, typically using a low voltage source such as a USB port or a small battery. These water pumps are compact in size and are commonly used in DIY projects, small-scale irrigation systems, aquariums, water fountains, and other applications that require a low-flow water circulation or transfer.

The 5V DC water pump typically consists of a motor, impeller, and inlet/outlet ports. When powered by a 5V DC source, the motor rotates the impeller, creating suction at the inlet and propelling water through the outlet. These pumps are known for their quiet operation, energy efficiency, and ease of use. They are often equipped with brushless motors for improved reliability and longevity. However, it's important to note that 5V DC water pumps are generally suitable for low-pressure and low-flow applications due to their compact size and lower power capabilities.

3.2.7 SG90 Servo Motor

Figure 7: SG90 Servo Motor

The SG90 180-degree servo motor is a small and lightweight motor commonly used in robotics, it is a type of servo motor that can rotate up to 180 degrees. The SG90 servo motor operates on a control signal, typically a PWM (Pulse Width Modulation) signal, which determines the position of the motor's shaft. By varying the duration of the pulse signal, the motor's shaft can be positioned at different angles within its range of motion.

Applications for the SG90 180-degree servo motor include robotic arm movements, steering mechanisms in RC cars or boats, camera gimbal control, and various other projects that require controlled angular movement. It's important to note that while the SG90 servo motor can rotate up to 180 degrees, it does not offer continuous rotation like some other servo motors. It is limited to the specified range of motion.

3.2.8 SLITD021 Mini Breadboard

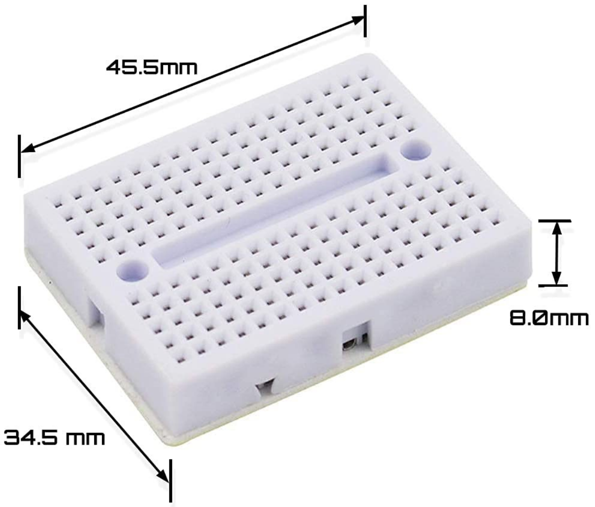

Figure 8: SLITD021 Mini Breadboard

The SLITD021 mini breadboard is a small-sized breadboard used for prototyping and creating temporary electronic circuits. It provides a platform for connecting and testing electronic components without the need for soldering. The SLITD021 mini breadboard is often used by hobbyists, students, and electronics enthusiasts for prototyping, testing circuits, and experimenting with various electronic components and modules. It offers a quick and flexible platform for creating temporary circuits without the need for permanent soldering.

It's important to note that due to its smaller size, the SLITD021 mini breadboard may have fewer holes and a limited number of terminal strips compared to standard-sized breadboards. Therefore, it may be more suitable for simpler circuits with fewer components. In summary, the SLITD021 mini breadboard is a compact and portable breadboard used for temporary circuit connections and prototyping. It features interconnected holes, terminal strips, and power rails, providing a convenient platform for experimenting with electronic components.

3.2.9 Jumper Wires

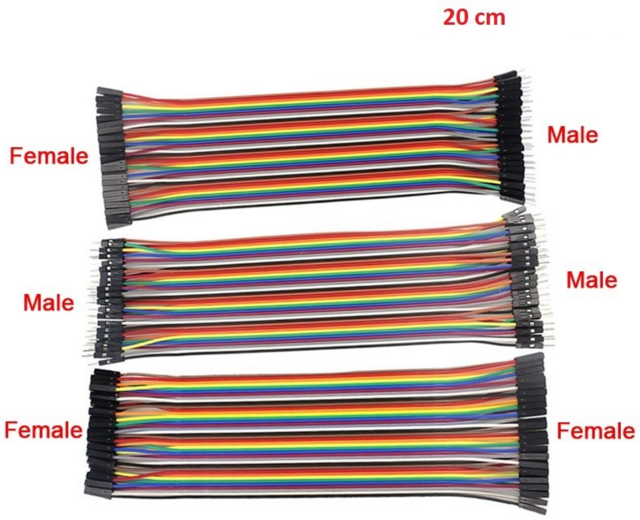

Figure 9: Jumper Wires

Jumper wires are a type of electrical wires used in electronics and prototyping projects to establish temporary connections between different components on a breadboard or circuit board. They are typically made of flexible insulated wire with pins or connectors at each end. Jumper wires come in various lengths and configurations, such as male-to-male, male-to-female, and female-to-female, allowing for flexible connections between different components.

The pins or connectors at each end of the jumper wires can be easily inserted into the holes or connectors on a breadboard, Arduino board, or other electronic components. Jumper wires are designed for temporary connections, making it easy to modify or reconfigure the circuit during prototyping or troubleshooting. Jumper wires are commonly used in electronics projects to connect components such as resistors, capacitors, LEDs, sensors, and microcontrollers. They provide a convenient way to establish electrical connections without the need for soldering or permanent wiring.

3.2.10 12V DC Rechargeable LiPo Battery

Figure 10: 12V DC Rechargeable LiPo Battery

A 12V rechargeable LiPo (Lithium Polymer) battery is a type of battery that can store and supply electrical energy at a voltage of 12 volts. LiPo batteries are known for their high energy density, lightweight design, and ability to deliver high discharge currents. The battery has a nominal voltage of 12 volts, which makes it suitable for applications that require a 12V power source. LiPo batteries are rechargeable, meaning they can be charged and discharged multiple times without significant loss of performance. They can be recharged using a compatible LiPo charger.

LiPo batteries offer a high energy density, allowing them to store a significant amount of energy in a compact size. This makes them suitable for portable and space-constrained applications. LiPo batteries are lightweight compared to other battery chemistries, making them ideal for applications where weight is a critical factor. High discharge rate: LiPo batteries can deliver high discharge currents, making them suitable for applications that require a burst of power or high power output. 12V rechargeable LiPo batteries are commonly used in a wide range of applications, including remote-controlled vehicles (RC cars, drones), portable electronics, robotics, power tools, electric vehicles, and renewable energy systems. They provide a reliable and compact power source for various devices and systems.

3.3 Software Methodology

To accomplish the project, we had to go through various software methodologies, so that we could get the one which is best to fulfil the requirements in an efficient manner. In the market,there are many software tools that are available, and even that could be different in its own way according to the purpose of using. So, in our case after careful analysis, we have chosen Aurdino/Aurdinodroid App, because of its some specific advantages. There is some other software'that we could possibly use, but we have decided to use Aurdino IDE/AurdinoDroid App for our project.

3.3.1 Procedure to Upload Program in Arduino

1. The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.
2. Download and install the Arduino Software IDE:
3. Arduino IDE 1.x.x (Windows, Mac OS, Linux, Portable IDE for Windows and Linux, ChromeOS).
4. Arduino IDE 2.x
5. Connect your Arduino board to your device.
6. Open the Arduino Software (IDE).
7. Write the program.
8. Compile the program.
9. Upload the program to the Board.

3.3.2 program Code

```
#include <AFMotor.h>
#include <Servo.h>

Servo servo;
String msg;
#define pump 13
#define ir 2
#define digi_left A0
#define digi_mid A1
#define digi_right A2
#define anlg_left A3
#define anlg_mid A4
#define anlg_right A5
int digi_left_val, digi_mid_val, digi_right_val;
int anlg_left_val, anlg_mid_val, anlg_right_val;
int ir_val;
int i;

AF_DCMotor motor2(2);
AF_DCMotor motor3(3);

void setup() {
Serial.begin(9600);

servo.attach(9);

pinMode(A0,INPUT);
pinMode(A1,INPUT);
pinMode(A2,INPUT);
pinMode(A3,INPUT);
pinMode(A4,INPUT);
pinMode(A5,INPUT);
pinMode(ir,INPUT_PULLUP);
pinMode(pump, OUTPUT);

motor2.setSpeed(80);
```

```
motor3.setSpeed(80);

digitalWrite(pump, LOW);
}

void loop() {

    ir_val = digitalRead(ir);
    digi_left_val = digitalRead(digi_left);
    digi_mid_val = digitalRead(digi_mid);
    digi_right_val = digitalRead(digi_right);
    anlg_left_val = analogRead(anlg_left);
    anlg_mid_val = analogRead(anlg_mid);
    anlg_right_val = analogRead(anlg_right);

  while(digi_left_val == 1 || digi_mid_val ==1 || digi_right_val == 1){
   Serial.print(digi_left_val);
   Serial.print(digi_mid_val);
   Serial.println(digi_right_val);
   digi_left_val = digitalRead(digi_left);
   digi_mid_val = digitalRead(digi_mid);
   digi_right_val = digitalRead(digi_right);
   anlg_left_val = analogRead(anlg_left);
   anlg_mid_val = analogRead(anlg_mid);
   anlg_right_val = analogRead(anlg_right);

   motor2.run(RELEASE);
   motor3.run(RELEASE);

   digitalWrite(pump, HIGH);
   for(i = 0; i <= 180; i++){
     servo.write(i);
     delay(10);
   }
   for(i = 180; i >= 0; i--){
     servo.write(i);
     delay(10);
```

```
   }
  }
    digitalWrite(pump, LOW);

  while(digi_left_val == 0 && digi_mid_val ==0 && digi_right_val == 0){

    if(ir_val == 1)
    {
      Serial.print(digi_left_val);
      Serial.print(digi_mid_val);
      Serial.print(digi_right_val);
      Serial.print(" || ir = ");
      Serial.println(ir_val);
      motor2.run(FORWARD);
      motor3.run(FORWARD);
      ir_val = digitalRead(ir);
      digi_left_val = digitalRead(digi_left);
      digi_mid_val = digitalRead(digi_mid);
      digi_right_val = digitalRead(digi_right);
      anlg_left_val = analogRead(anlg_left);
      anlg_mid_val = analogRead(anlg_mid);
      anlg_right_val = analogRead(anlg_right);

    }

    if(ir_val == 0)
    {
      Serial.print(digi_left_val);
      Serial.print(digi_mid_val);
      Serial.print(digi_right_val);
      Serial.print(" || ir = ");
      Serial.println(ir_val);
      motor2.run(FORWARD);
      motor3.run(BACKWARD);
      delay(1000);
      ir_val = digitalRead(ir);
      digi_left_val = digitalRead(digi_left);
```

```
      digi_mid_val = digitalRead(digi_mid);
      digi_right_val = digitalRead(digi_right);
      anlg_left_val = analogRead(anlg_left);
      anlg_mid_val = analogRead(anlg_mid);
      anlg_right_val = analogRead(anlg_right);
    }

  }
}
```

3.4 System Development

In this project, we are combining two things together, hardware and software. So, according to this, we need to be aware of each step that is required to follow. As we are coding in the microcontroller, and for the software, we need to be aware of the developing process of the application and of course the hardware which is linked to it.

4 CHAPTER

4.1 WORKING

4.1.1 Circuit Diagram

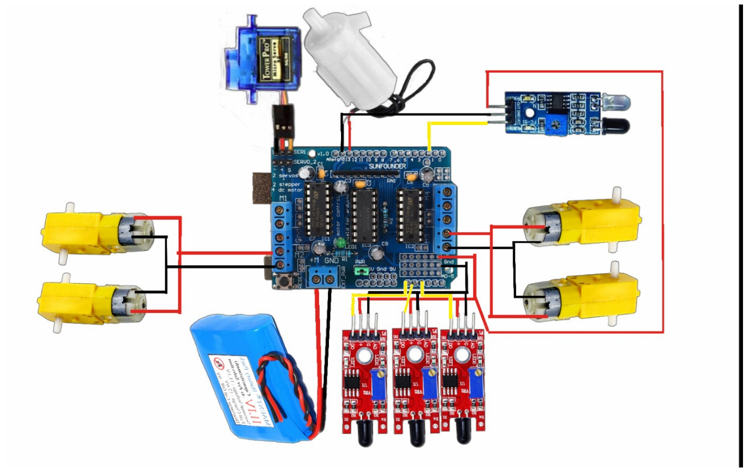

Figure 11: Circuit Diagram

4.1.2 Working Principal

1. **Sensor Setup:**The robot is equipped with three IR fire sensors strategically placed to detect the presence of fire in the surroundings. Additionally, it has an IR sensor positioned to detect objects in its path.
2. **Initial State:** The robot starts in an idle state, where it continuously run in forward direction and waits for input from the sensors.
3. **Fire Detection:** The IR fire sensors continuously monitor the environment for the presence of fire. If any of the sensors detect a fire, it initiates the fire-fighting sequence.
4. **Fire-Fighting Mode:** Upon detecting a fire, the robot immediately stops its current movement and transitions into the fire-fighting mode. It activates the water spraying mechanism to extinguish the fire. To cover a wide area an servo motor is used to spray the water from 0 degree to 180 degree.

5. **Fire Extinguishing:** The robot sprays water onto the fire to extinguish it. It can employ various mechanisms such as a water pump or a water cannon to deliver the water effectively. The robot remains stationary during this phase until the fire is completely extinguished. When there is no fire remaining it starts to move in forward direction again to find more fire.
6. **Object Detection:** While the robot is in the idle state or moving in a straight direction, the IR object detection sensor continuously scans the environment for obstacles. If an object is detected in its path, the robot enters the object detection mode.
7. **Obstacle Avoidance:** When the object detection sensor identifies an obstacle, it signals the robot to change its direction and move forward in a new path. This ensures that the robot avoids colliding with the detected object.
8. **Continuous Operation:** After extinguishing the fire or avoiding the obstacle, the robot resumes its normal operation. If no fire or obstacle is detected, it continues moving in a straight direction, constantly scanning the environment for potential fires or obstacles.
9. **Repeat Cycle:** The robot continues to operate in a cycle, moving forward until it detects a fire or an obstacle. Upon fire detection, it switches to fire-fighting mode, and upon obstacle detection, it adjusts its path to avoid the obstacle. The cycle repeats as long as there is a need to detect fires and navigate the environment.

4.1.3 Actual Ciruit

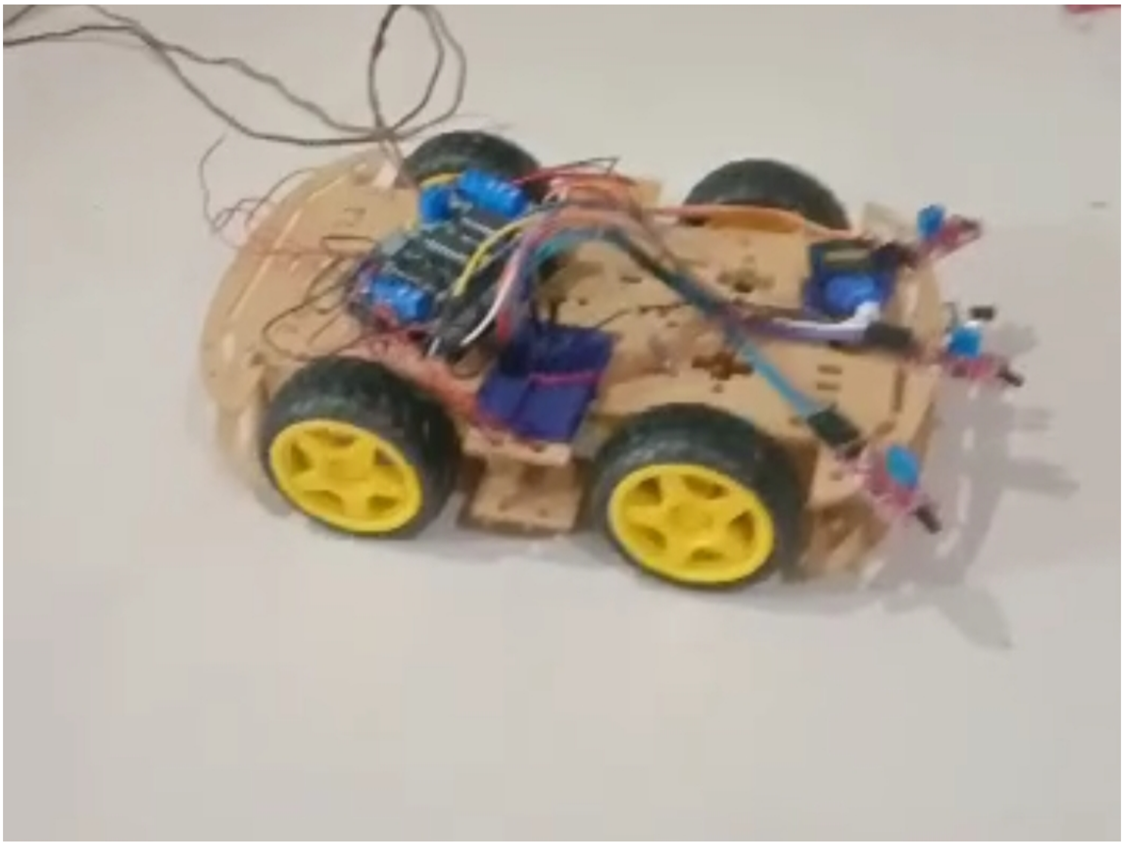

Figure 12: Prototype

5 CHAPTER

5.1 RESULT AND ANALYSIS

5.1.1 Application

This technology has a wide range of applications such as:

1. **Industrial Fire Safety:** The fire-fighting robot can be deployed in industrial settings to detect and extinguish fires, ensuring the safety of workers and preventing property damage.

2. **Residential Fire Protection:** The robot can be utilized in residential buildings, such as homes or apartments, to detect and suppress fires before they spread and cause significant damage.

3. **Forest Fire Prevention:** Deploying the robot in forested areas can aid in early fire detection and immediate fire suppression, helping to control and minimize the spread of forest fires.

4. **Emergency Response:** The fire-fighting robot can be deployed in emergency situations, such as building collapses or hazardous material incidents, to navigate through debris or hazardous environments and extinguish fires safely.

5. **High-Risk Environments:** It can be used in environments with a high risk of fire, such as chemical plants, oil refineries, or power stations, where human intervention may be dangerous or limited.

6. **Remote or Unmanned Areas:** The robot can be deployed in remote or unmanned areas where continuous monitoring and quick response to fire incidents are essential, such as oil rigs, off-shore platforms, or remote research stations.

7. **Military and Defense:** The fire-fighting robot can find application in military operations to handle fire emergencies on the battlefield, in military bases, or during training exercises.

8. **Educational Purposes:** The project can serve as a learning tool in educational institutions to educate students about fire safety, robotics, and automation.

5.1.2 Advantages

Firefighting robots offer several advantages over traditional human firefighting efforts. Here are some of the key advantages:

- **Increased Safety:** Firefighting robots can operate in hazardous and life threatening environments without risking human lives. They are designed to withstand extreme temperatures, toxic smoke, and structural collapses, reducing the risk to firefighters.

- **Enhanced Efficiency:** Robots can work continuously without getting exhausted or requiring breaks. They can swiftly navigate through narrow spaces and reach areas that might be inaccessible or dangerous for humans. This improves the overall efficiency of firefighting operations.
- **Remote Operation:** Firefighting robots can be operated remotely, allowing firefighters to maintain a safe distance while still maintaining control over the robot's actions. This remote operation capability ensures that firefighters can make informed decisions based on real-time data and adapt their strategies accordingly.
- **Access to Real-time Information:** Robots equipped with various sensors and cameras can provide firefighters with vital information about the fire, such as temperature, gas concentration, and structural integrity. This data enables better situational awareness and helps firefighters develop more effective firefighting strategies.
- **Fire Suppression Capabilities:** Firefighting robots can be equipped with specialized tools and systems for fire suppression, such as water cannons, foam sprayers, or even firefighting drones. These capabilities allow them to quickly and effectively extinguish fires or create containment lines to prevent the fire from spreading.
- **Reducing Human Exposure to Toxins:** Firefighters often face the risk of inhaling toxic smoke and fumes while combating fires. By deploying robots, human exposure to harmful substances can be significantly reduced, thereby protecting the health and well-being of firefighters.
- **Collaboration and Support:** Robots can work alongside human firefighters as part of a collaborative team. They can assist in tasks like reconnaissance, searching for trapped individuals, or carrying heavy equipment, thus augmenting the capabilities of human responders and improving overall efficiency.
- **Continuous Operation:** Firefighting robots can work non-stop without experiencing fatigue or exhaustion. This allows them to maintain a constant presence at the fire scene, even during extended operations, ensuring that critical tasks are performed consistently.

- **Training Opportunities:** Firefighting robots can be used as training tools for firefighters to simulate realistic fire scenarios and practice their skills. This helps improve their preparedness, decision-making abilities, and coordination with robotic systems in actual emergencies.

While firefighting robots offer numerous advantages, it's important to note that they are not intended to replace human firefighters entirely. They are designed to complement human efforts and enhance overall firefighting capabilities, making operations safer and more effective.

5.1.3 Limtation

While fire fighting robots have the potential to provide valuable assistance in emergency situations, they also come with certain disadvantages. Here are some of the drawbacks associated with fire fighting robots:

- **Limited adaptability:** Fire fighting robots are typically designed to handle specific types of fires or environments. They may not be equipped to handle complex or unpredictable situations that human firefighters can manage. Their rigid design and programming can limit their ability to adapt to changing circumstances, such as navigating through cluttered spaces or dealing with unique fire conditions.
- **Lack of human judgment and intuition:** Firefighters rely on their experience, training, and intuition to make critical decisions during firefighting operations. Robots, on the other hand, lack human judgment and may struggle to assess complex situations accurately. They might not be able to make nuanced decisions or respond appropriately to unexpected scenarios, potentially leading to suboptimal firefighting outcomes.
- **Technical limitations:** Fire fighting robots rely on sensors, cameras, and other technical components to perceive their surroundings and perform their tasks. However, these technologies can have limitations. For example, poor visibility due to smoke, heat, or debris can hinder the robot's ability to navigate or locate fire sources accurately. Additionally, technical malfunctions or failures can render the robot ineffective during firefighting operations.
- **Limited mobility and accessibility:** Fire fighting robots might face challenges in accessing certain areas, such as confined spaces or high-rise buildings with narrow staircases. Their physical design and size can limit their ability to reach locations where fires might be present. Human firefighters, with their agility and problem-solving skills, are often better equipped to navigate challenging environments and access hard-to-reach areas.
- **Lack of human empathy and communication:** During firefighting operations, effective communication and empathy are crucial for coordinating efforts and ensuring the safety of individuals involved. Robots, being machines, lack the ability to establish personal connections, provide reassurance, or understand and respond to human emotions effectively. This aspect of human interaction can be vital in emergency situations and may be challenging for robots to replicate.

- **Cost and maintenance:** Fire fighting robots can be expensive to develop, acquire, and maintain. They require regular maintenance, software updates, and repairs, which can be costly and time-consuming. Fire departments and organizations need to allocate significant resources to purchase, train personnel to operate the robots, and keep them operational. This financial burden may limit the widespread adoption of fire fighting robots, particularly for smaller fire departments with limited budgets.

While fire fighting robots have the potential to assist and enhance firefighting operations, addressing these disadvantages will be essential to ensure their effectiveness and integration alongside human firefighters.

6 CHAPTER

6.1 CONCLUSION AND FUTURE SCOPE

6.1.1 Conclusion

The system design as the control center, executes with the same design and sensors fire warning silent. Similar to the present condition robots for the fire, the proposed robot for the firefights. Special low-cost fire designed to follow remarkable monitoring sensors via the GSM module will more accurately warn the fire service, Improving firefighting capability. The multi-faceted fire detection capability embeds the framework. The robot is more likely to fight fire in the face of barriers. A related category of robots is a special aspect of this robot. It would be financially stable, particularly if limited work on exceptional materials is to be resumed on the assumption, the real-time state of this setup. The monitor robot and other special features can appear as extensions and can be included.

6.1.2 Future Scope

The future scope of firefighting robots is promising and encompasses various areas of development and application. Here are some potential areas of growth and advancement:

1. **Enhanced Fire Suppression Capabilities:** Firefighting robots can be designed to have improved fire suppression capabilities, such as advanced water cannons, foam dispensers, or even specialized firefighting agents. These robots could autonomously assess fire situations, identify the most effective suppression methods, and efficiently extinguish fires in hazardous environments.

2. **Remote Monitoring and Surveillance:** Firefighting robots equipped with advanced sensors, cameras, and communication systems can be deployed to monitor and assess fire situations in real-time. They can provide valuable information to incident commanders, enabling them to make informed decisions and deploy firefighting resources effectively.

3. **Search and Rescue Operations:** Firefighting robots can be equipped with sensors and tools to aid in search and rescue operations during fire incidents. They can navigate through smoke-filled environments, identify potential survivors, and assist in evacuating individuals from dangerous areas, reducing the risk to human firefighters.

4. **Autonomous Coordination and Collaboration:** Future firefighting robots can work together in a coordinated manner, communicating with each other to optimize firefighting efforts. They can collaborate to create a synchronized approach, share information about the fire's behavior and spread, and dynamically adjust their strategies to combat the blaze more effectively.

5. **Hazardous Material Handling:** Firefighting robots can be specifically designed to handle hazardous materials, including chemical spills or radioactive substances. They can be equipped with specialized equipment and protective measures to safely contain and mitigate hazardous incidents, protecting human responders from exposure to dangerous substances.

6. **Structural Assessments:** Robots with advanced imaging and sensing capabilities can be deployed to assess the structural integrity of buildings during and after a fire. By gathering data on the extent of damage, these robots can help determine the safety of the structure and guide post-fire recovery efforts.

7. **Multi-Terrain Capabilities:** Firefighting robots can be developed to operate in various terrains and environments, including urban areas, forests, and industrial complexes. By adapting to different landscapes and conditions, they can provide effective firefighting support in diverse scenarios.

8. **Human-Robot Collaboration:** The future of firefighting robots also involves closer integration and collaboration with human firefighters. These robots can work alongside human responders, assisting them in tasks such as carrying equipment, relaying information, or performing repetitive and physically demanding tasks, thereby enhancing overall firefighting capabilities.

It's important to note that while the future prospects for firefighting robots are promising, their development and implementation will require rigorous testing, safety protocols, and ongoing refinement to ensure their reliability and effectiveness in real-world firefighting scenarios.

7 CHAPTER

7.1 Reference

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8 CHAPTER

8.1 Appendix

8.1.1 Hex Code

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