Fire Fighting Robot Using Arduino Uno and Flame Sensor

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Abstract

In the age of technology, the world is slowly turning towards the automated system and self-travelling vehicles, fire fighters are constantly at a risk of losing their life. According to National Crime Records Bureau (NCRB), it is estimated that more than 1.2 lakh deaths have been caused because of fire accidents in India from 2010-2014. Even though there are a lot of precautions taken for Fire accidents, these natural/man-made disasters do occur now and then. In the event of a fire breakout, to rescue people and to put out the fire we are forced to use human resources which are not safe. With the advancement of technology especially in Robotics it is very much possible to replace humans with robots for fighting the fire. This would improve the efficiency of fire-fighters and would also prevent them from risking human lives. Today we are going to build a Fire Fighting Robot using Arduino, which will automatically sense the fire and start the water pump In this project, we will learn how to build a simple robot using Arduino that could move towards the fire and pump out water around it to put down the fire. This advanced fire fighting robotic system independently detects and extinguishes fire. Fire spreads rapidly if it is not controlled. In case of a gas leakage there even may be an explosion. So, in order to overcome this issue, our system comes to the rescue. This fire fighting robotic system is powered by Arduino Uno development board it consists of servo motor for obstacles detection and free path navigation, it is also equipped with the fire flame sensor for detecting and approaching fire it also makes use of water tank and spray mechanism for extinguishing the fire. Water is pumped from the main water tank to the water nozzle with the help of 5V pump.

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Chapter 1

Introduction

Now a days mobile robots are very useful in construction sites, warehouses and manufacturing plants. Mobile robots can also be used in material handling applications which applications are growing day by day. For analyzing different items and for handling materials mobile robots can be used. Wireless navigation is also possible for movements of mobile robot, can be controlled through android. Fuzzy logic control mechanism is used to control robot. That model does not need any mathematical model controlling. Previously Fire Fighting Robots were controlled by using different electronics devices .But this reduces the scope of control of firefighting robot .However ,with the advanced techniques we can build the same robot by using android application to control the actions of the robot . With the help of such robots, fireman's work really decreased and movements of robot are so much effective. By using an android app fireman man detect the fire and can able to extinguish it .At the same time robot can detect the obstacles and can avoid them by using ultrasonic sensors. Our project is designed to build an android application which can control operations of the firefighting robot. Fireman can send commands to robot through Bluetooth module which is mounted on robot itself. Smart phones has facility of Bluetooth, through that Bluetooth fireman can control the movement of firefighting robot. For fire detection it is using two sensors. One is temperature sensor and second is smoke detector. Fire extinguishing system will be get activated when fire detection system detects fire .Sprinkler will start sprinkling water when it detects fire. At the transmitting end android application is used and at receiving end two motors are interface to micro-controller.

The control circuitry of the robot is built on Arduino UNO. There are three fire sensors interfaced in the control circuitry in the forward, left and right side of the robot. A motor fan is attached on the robot which will actually simulate the functioning of a water pump. This is a prototype model. In a production model, a motor pump should be attached in place of the fan. Apart from the component's interfacing in the circuit, the main significance is of the Arduino sketch running on the controller circuit. It is the Arduino sketch which provides the software intelligence to sense fire intensity using fire sensors, move robot in the direction where fire intensity is more and increase or decrease speed of motor pump. The Arduino sketch is written and compiled using Arduino IDE.

1.1 Organization of report

Chapter 2 contains Literature Survey, Chapter 3 contains Hardware implementation, Block Diagram and List of Components. Chapter 4 contains Software used and Code. Chapter 5 contains Applications. Chapter 6 contains Future Scope. Chapter 7 contains Future Scope.

Chapter 2

Literature Survey

In today's era firefighting is a dangerous issue. Many authors are working on different techniques for firefighting. Author Ratnesh Malik et al. has developed an approach towards firefighting robot. The robot is designed and constructed which is able to extinguish fire. The robot is fully autonomous. It implements the concept likes environmental sensing and awareness, proportional motor control. The robot processes information from its sensors and hardware elements. Ultraviolet, Infrared and visible light are used to detect the components of environment. The robot is capable of fighting tunnel fire, industry fire and military applications are designed and built. Ultraviolet sensors are used to detect fire. Once fire is detected, robot sounds an alarm. Then the robot activates an electronic valve which release sprinkles of water on the flame. Detailed concept of robot is explained which automatically detects fire and extinguishes it in short time by the use of sensors, microcontroller etc. This robot is used in places where human lives are at high risk. Author Kristi Kokasih et al. has developed intelligent firefighting tank robot. Tank robot is made from acrylic, plastic, aluminum and iron. Robot components are two servo motors, two DC motors, ultrasonic sensor, compass sensors, flame detector, thermal array sensor, white detector (IR and photo transistor) , sound activation circuit and micro switch sensor. The objective is to search certain area, find and extinguish the flame for different flame positions, room configuration with disturbance. Robot is activated through DTMF transmitter and receiver. Control of an Autonomous Industrial Fire Fighting Mobile Robot is developed by H.P. Singh et al. The paper describes the construction and design of mobile firefighting robot. The system contains two optically isolated D.C. motors. Robot performs analog to digital conversion of the data provided by infrared sensors. Five infrared sensor are used. Two sensors control the motion of the robots and three are for flame detection. The extinguisher comprises of D.C water pump and a water container. The basic theme of the paper is to sense the flames of fire and extinguish it. For this infrared sensor is used as input sensor which senses the infrared rays coming out of the fire. The microcontroller controls the extinguishing system. Wireless firefighting robot is developed by Swati Deshmukh et al. It comprises of machine which has ability to detect fire and extinguish it. The firefighting robot can move in both forward and reverse direction and can turned in left and right directions. Thus fire fighter can operate the robot over a long distance and there is no need for human near the area on fire. Light dependent resistors are used for detection of fire. These resistors are highly sensitive devices and are capable of detecting very small fire. The robot provides security at home, buildings, factory and laboratory. It is an intelligent multisensory based security system which contains firefighting system in daily life. Cell phone controlled robot with fire detection sensors developed by Lakshay Arora consist of mobile phone which controls a robot by making a call to the mobile phone which is attached to the robot. During the call activation period, if any button is pressed on the phone, the tone corresponding to the button pressed is heard at the other end of the call that is placed on the robot. The robot perceives Dual-Tone Multiple-

Frequency (DTMF) tone with the help of phone mounted on the robot. The received code is processed by the microcontroller and then the robot performs actions accordingly. In the proposed system DTMF technology is used to position the shaft of motor at a required point with different sensors, each performing its own task. Rugged, Simple and cost effective system is proposed here. Android Phone controlled Robot Using Bluetooth is developed by Arpit Sharma et al. various techniques of Human Machine interaction using gestures are presented. Gestures are captured by using the accelerometer. The paper analyses the motion technology to capture gestures using an android smart phone which has inbuilt accelerometer and Bluetooth module to control kinetics of the robot. The microcontroller controls the signals of the Bluetooth module. Features like user friendly interface, lightweight and portability OS based smart phone has overtaken the sophistication of technologies like programmable glove, static cameras etc. making them obsolete.

Author SaravananP has designed and developed an Integrated Semi-Autonomous Fire Fighting Mobile robot. The System controls four D.C. motors powered by Atmega2560 and controlled autonomously by navigation system. Navigation system comprises of integrated ultrasonic sensors and infrared sensors. The robot is fitted with wireless camera which captures the video and transmits it to the base station. The fire detection comprises of LDR and temperature sensor. If there is a fire the sensor detects it and the robot will be moved to the source and extinguishes it. The extinguishing system consists of a BLDC motor with water container. The SABOT can be operated manually for extreme conditions. It comprises of a GUI support through which robot can be controlled from the base station. Intelligent Fire Extinguisher System is developed by Poonam Sonsale. The paper proposes of an adaptive fusion algorithm for fire detection. It uses a smoke sensor, flame sensor, temperature sensor for fire detection. It contains intelligent multisensory based security system that contains a firefighting system in daily life. The security system can detect abnormal and dangerous situation and notify. Intelligent buildings are expected to be safer convenient and efficient living environments for society. The purpose of Intelligent Fire Extinguisher System is to extinguish flame in a certain amount of time. The system detects the fire location and extinguish fire by using sprinklers. As being Intelligent System, it cuts off the electricity of area where fire has been caught and starts the sprinklers only of that area.

Chapter 3

Hardware Implementation

We have implemented our project using Arduino UNO as main hardware. The block diagram below explains the flow diagram of our project followed by the list of components we used during our project. We have provided detailed information about each component used along with their features.

3.1. Block diagram

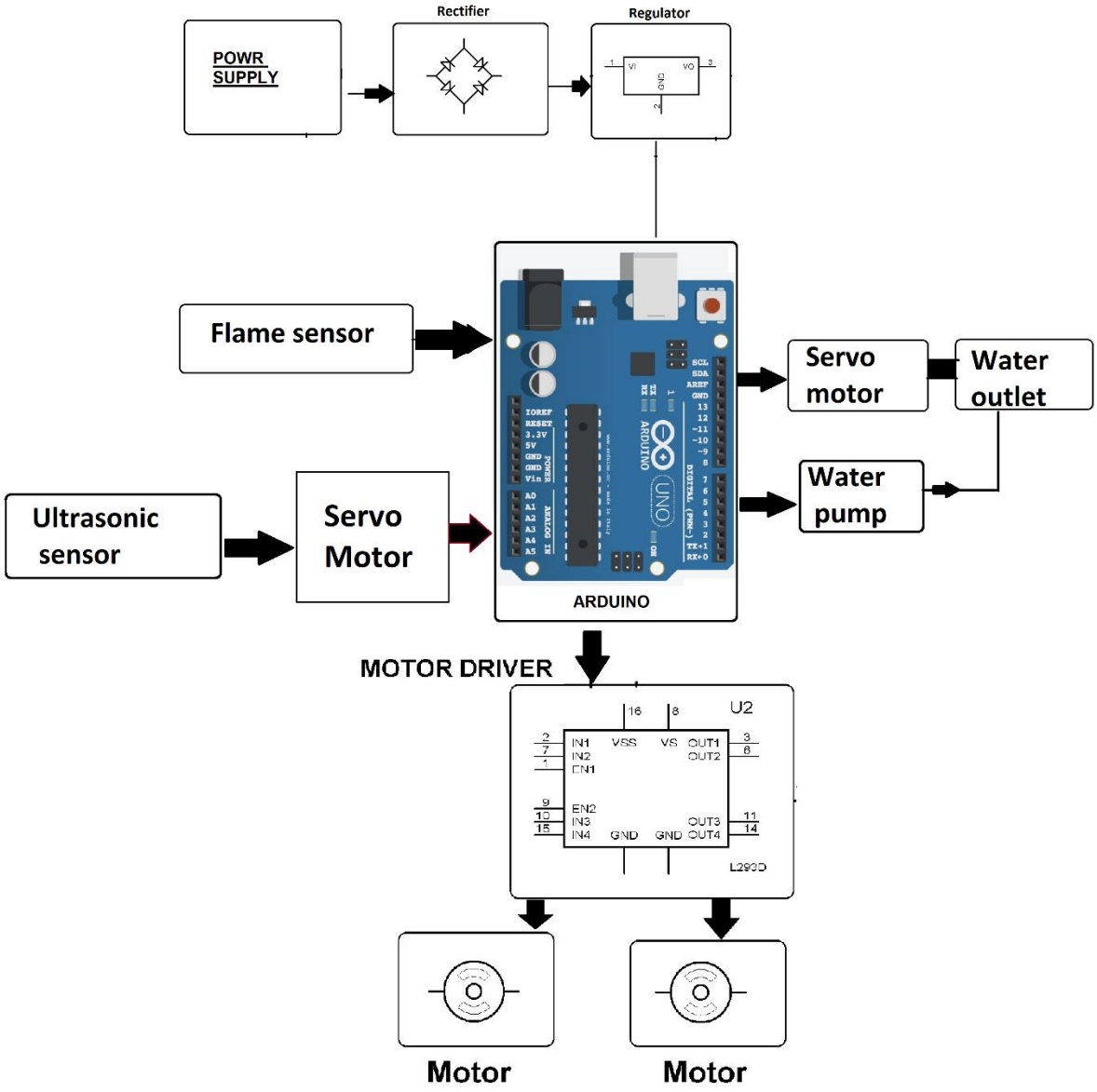

Figure 3.1 Block Diagram of Fire Fighting Bot

3.2 Circuit Diagram

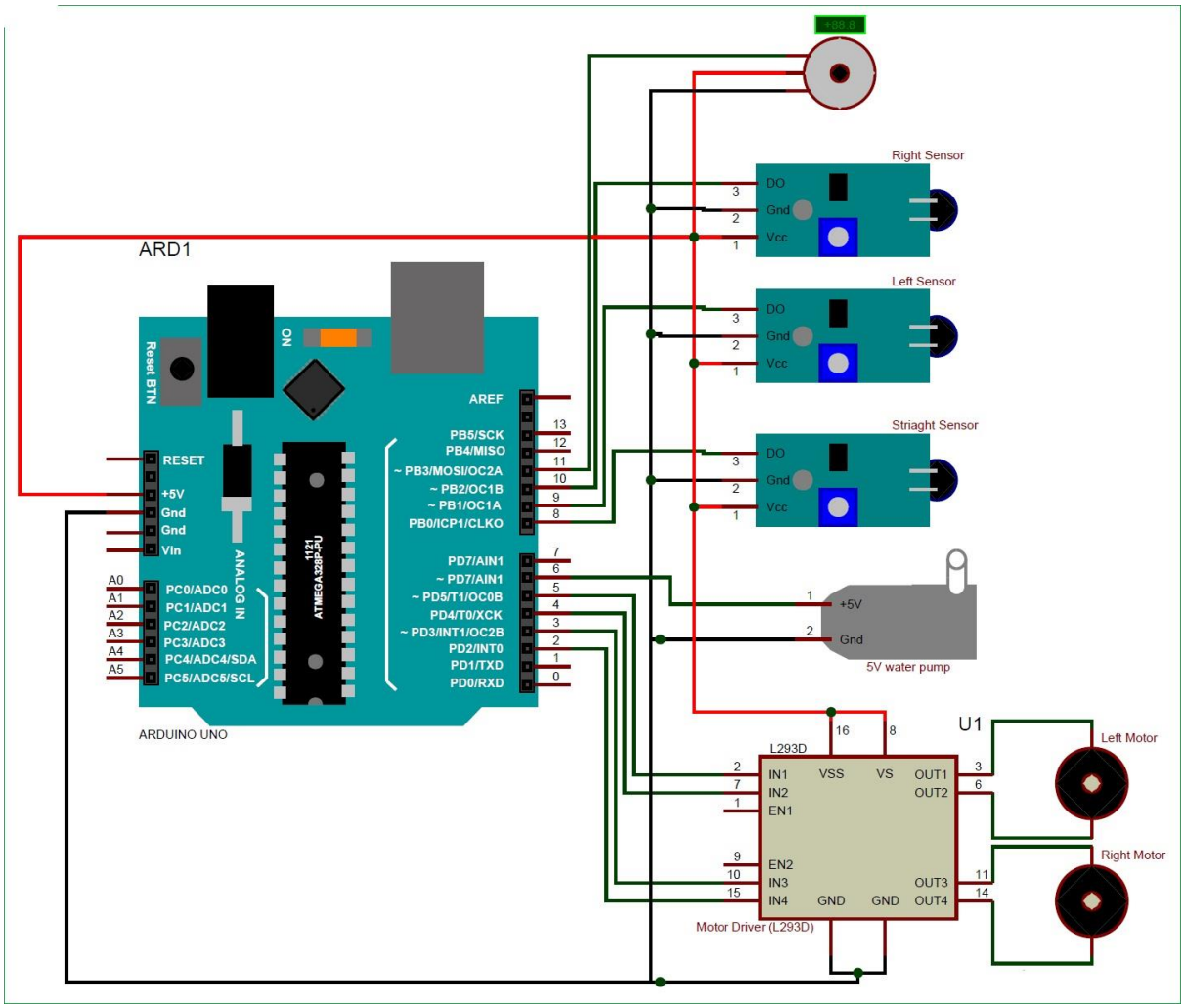

Figure 3.2 Circuit Diagram of Fire Fighting Bot

3.3 List of Components

3.3.1 Arduino Uno

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and

Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

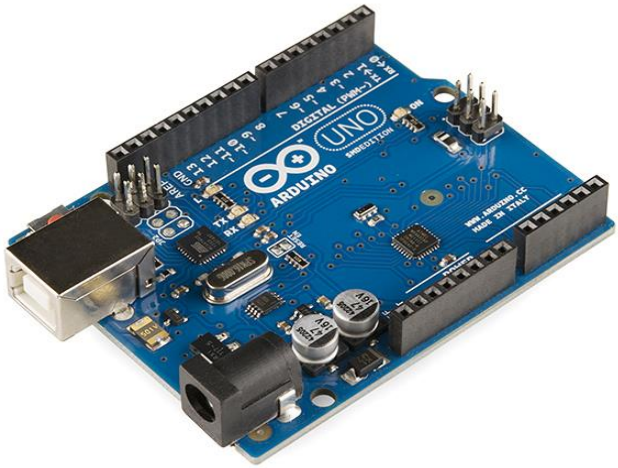

Fig 3.3.1: Arduino UNO

3.3.2 Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

A servo motor is a closed-loop system that uses position feedback to control its motion and final position. In industrial type servo motors the position feedback sensor is usually a high precision encoder.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Fig 3.3.2: Servo Motor

3.3.3 Flame Sensor

This sensor as its name suggests detects flame. To be clearer it detects heat around itself. This sensor module comes with three pins: VCC, GND and SIG. It works well with 5V and gives a digital output. This sensor module has an on-board comparator which compares the analog voltage, from the sensor, with a threshold voltage that can be set via potentiometer (also available on board). This potentiometer helps to adjust the range of its detection.

This sensor module can be used to detect flame/fire in the range of 760nm to 1100 nm wavelength of light. Small flames can be detected at a distance of roughly 80cm, while bigger flames can be detected from farther distances. It can be used to directly drive other modules as it has digital output of 15mA. The sensor must maintain some distance from the flame, so as not to damage it.

Features:

- Operating Voltage: 3.3V-5V
- Detection angle: 60° approximately
- Digital Output

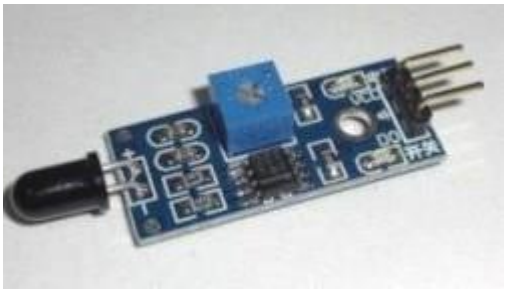

Fig 3.3.3: Flame Sensor

3.3.4 L293D Motor Driver Module

The Arduino Motor Shield is based on the L293D, which is a Half-bridge driver designed to drive inductive loads such as relays, solenoids, DC and stepping motors. It lets you drive two DC motors with your Arduino board, controlling the speed and direction of each one independently. You can also measure the motor current absorption of each motor, among other features. The shield is also compatible with DTMF module, which means you can quickly create projects by plugging DTMF modules to the board.

Specification of L293D Motor Driver Shield:

- Operating Voltage - 5V to 12V.
- Motor controller: L293D, Drives 2 DC motors or 1 stepper motor.
- Max current: 600mA per channel.
- Peak Output Current -1.2 Amp.

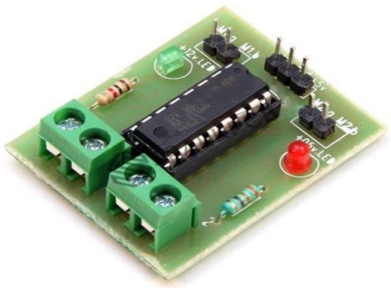

Fig 3.3.4: L293D Motor Driver Module

Chapter 4

Software Implementation

4.1 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program, also included with the IDE distribution

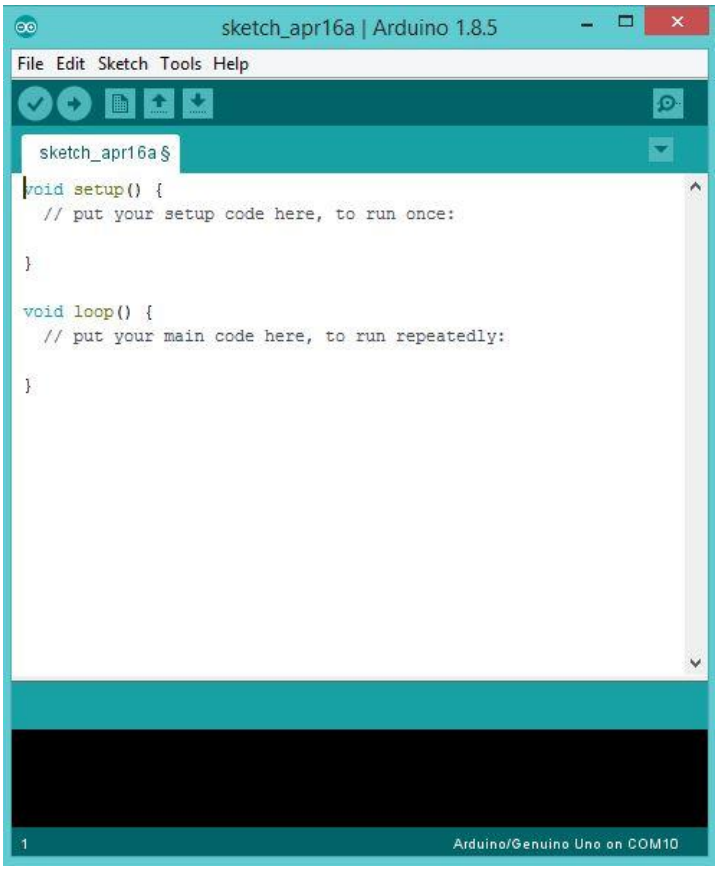

Fig 4.1: Arduino IDE

4.2 Code

```
#include <Servo.h>

Servo myservo;

int pos = 0;
boolean fire = false;

/*-------defining Inputs------*/
#define Left_S 7    // left sensor
#define Right_S 0     // right sensor
#define Forward_S 8 //forward sensor

/*-------defining Outputs------*/
#define LM1 2       // left motor
#define LM2 3       // left motor
#define RM1 4       // right motor
#define RM2 5       // right motor
#define pump 12

void setup()
{
  pinMode(Left_S, INPUT);
  pinMode(Right_S, INPUT);
  pinMode(Forward_S, INPUT);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
  pinMode(RM2, OUTPUT);
  pinMode(pump, OUTPUT);

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

void put_off_fire()
{
  Serial.begin(9600);
    delay (500);

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

```
   digitalWrite(RM1, LOW);
   digitalWrite(RM2, LOW);

  digitalWrite(pump, HIGH); delay(1000);

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

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

  fire=false;
}

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


   if (digitalRead(Left_S) ==1 && digitalRead(Right_S)==1 && digitalRead(Forward_S)
==1) //If Fire not detected all sensors are zero
   {
     Serial.print("No fire");
   //Do not move the robot
   digitalWrite(LM1, HIGH);
   digitalWrite(LM2, HIGH);
   digitalWrite(RM1, HIGH);
   digitalWrite(RM2, HIGH);
   }

   else if (digitalRead(Forward_S) ==0) //If Fire is straight ahead
   {
     Serial.print("f fire");
   //Move the robot forward
   digitalWrite(LM1, HIGH);
   digitalWrite(LM2, LOW);
   digitalWrite(RM1, LOW);
   digitalWrite(RM2, HIGH);
```

```
    fire = true;
    }

    else if (digitalRead(Left_S) ==0) //If Fire is to the left
    {
      Serial.print("l fire");
    //Move the robot left
    digitalWrite(LM1, LOW);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, HIGH);
    }

    else if (digitalRead(Right_S) ==0) //If Fire is to the right
    {
    //Move the robot right
    Serial.print("r fire");
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, LOW);
    }

delay(300); //Slow down the speed of robot

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

Chapter 5

Applications

1. It can used in server rooms.
2. It can be used in power plant control rooms, flight control centres.
3. Disaster area rescue and monitoring.
4. It can be used at hazardous places to fight fire where fire fighters cannot go.
5. Robot can be used to extinguish fire at small places which cannot be accessed by Humans.

Chapter 6

Future Scope

1. Smart and full automated robot
2. Internet of Things (IOT) can be implemented and used to monitor and controlled wireless through internet.
3. Camera and video streaming can be implemented to obtain more information about the target location.
4. It Can be used in chemical and oil industry, nuclear plants, mine fields and dangerous substance transport.

Chapter 7

Conclusion

We successfully implemented and developed this fire-fighting robot using various components. Robot detects fire through flame sensors and extinguish the fire itself using water pump mechanism. The movement of this robot vehicle is controlled by Arduino as per the code. If Fire is detected then water pump is operated to use as fire extinguisher.

This robot is mostly used as Home purpose or the rooms with smaller area of coverage. The day is not far when this technology will push its way into your house hold, making you more lazy. This report presents the major features and functions of the various concepts that could be used in this field in detail through various categories. Since this initial work cannot address everything within the proposed framework and vision, more research and development efforts are needed to fully implement the proposed framework through a joint effort of various entities.

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