American International University- Bangladesh (AIUB)

Project Report

MICROPROCESSOR & EMBEDDED SYSTEM

Section: **M**

Semester: Spring 2021

Course Teacher - **DR. FERDOUS JAHAN SHAUN**

Project Title: Fire Fighting Robot

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Project Title: Fire Fighting Robot

1. Introduction

1.1 Abstract: (Nusrat Jahan Badhon, 18-37139-1)

Fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. Fire fighters often exposed to higher risks. With the advent of technology, humans are replaced with robots in life-threatening situations. We aim to design a robot capable of detecting and suppressing fires. By designing and implementing a firefighting robot capable of detecting and extinguishing flames, disasters can be avoided with minimal risk to human life. This paper demonstrates the simulation and implementation of an autonomous firefighting robot which can automatically sense the smoke and extinguish the fire.

1.2 State of Art: (Fatima Binta Monir, 18-36711-1)

The fire fighting is a risky work where the fire fighters need to face the fire hazards to save life and properties. Different equipments such as fire extinguisher, axes and cutting equipment are used to fight against fire. Fire fighting vehicle is being used to transport firefighters to the scene as well as transport the fire fighting equipments. Over the years, throughout the world, fire losses remain high and firefighting is strenuous and dangerous. Training and research programs have been developed to confront the challenges in firefighting, whilst there are still significant losses from fires each year. The fire fighter is still facing the risk of fire hazard because they still need to go near to fire scene. To reduce the fire fighter risk during fire incident, that's why proposed a fire fighting robot . In this robot used three flame sensor and also gas sensor if those sensors sense the flame or smoke it going to extinguishing by microcontroller.

1.3 Motivation: (Arefin,Md Shoaib, 17-35328-2)

Robot, any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner. There are multiple ways robots are being used to improve safety. A robot can physically collaborate with people, they can act as assistants to prevent injury, for example as a body exoskeleton during lifting. They can perform inspection of assets such as structures or pressure vessels more frequently, with greater access, more sensors and less down time than people, leading to earlier defect detection and greater reliability. Finally, they can be used in safety critical situations to detect and reduce errors, for example in robotic surgery tracking adjacency to obscured critical blood vessels and providing warnings through an appropriate interface. Fire is a classical element that has been an equalizer on Earth prior to the start of written history. It has many positive attributes (heat, energy, cleansing, etc.) but it can be extremely dangerous when outside of control. Structure, vehicle, aircraft ship fires and wildfires can wreak havoc and cause serious injury and/or death. When the fire gets out of control, firefighters are called. But while rescuing people they often get injured because of extreme fire. By using a firefighting robot this kind of accident can be reduced. Fire Fighting is an important job but it is very dangerous occupation. Due to that, Robots are designed to find a fire, before it rages out of control. It could be used to work with fire fighters to reduce the risk of injury to victims and firefighters too. Our robotic firefighting system is designed with certain tasks in mind. In purpose of rescuing people, the robot monitors the environment thermal state and go towards the fire location and extracts water from the pump from specific angle to another angle again and again till the fire blown out. This way it can reduce risk, expand profitability and effectiveness in rescuing.

1.4 Organization of The Chapter: (Khan,Anamul Haque, 17-33696-1)

Chapter-2: Literature Review with in-depth investigation

In this section, we briefly described about the background history and pervious works and publications related to this project.

Chapter-3: Methodology and Modeling

In this chapter we are going to briefly discuss about our proposed "**Fire Fighting Robot**" project. A detail explanation about project model working procedure, required software, major component and other extra features has been shown. Also, in this part we are going introduce approximate financial cost for the whole project also estimated cost for each component. In this chapter we are going to show the expected time management to accomplish the project and contribution of each group member.

Chapter-4: Results Analysis & Critical Design Review

This part is the overview of analytical solution. All the feedback from circuit, model and connection are showed here. Simulation part of this project is also discussed here.

Chapter-5: Complex Engineering Problem

Mainly we are focusing about what types of complex engineering problem going to be solved by our proposed project with a brief comparison between previous and current technology.

Chapter-6: Conclusion

In this chapter, all the topic of this book is shortly discussed. Besides, sustainability and limitation of this project are briefly discussed. Overall, this part is a short review of the whole project. Also give all the references were we gathering the information and appendix of the project

2. Literature Review with in-depth investigation (Bishal paul, 17-35836-3)

J. Reinhart V. Khandwala (2003) was all discussed about design and the implementation of the fire-fighting robot. The key design elements of the robot to be discussed include: the assembly and construction of the robot hardware, the processing algorithm based on the sensor's response, and the navigation algorithm that will enable the robot to find an efficient path in and out of the house model.[5] Lynette Miller Daniel Rodriguez (2003) was all discussing the development of each component of the robot that is designed to find a small fire represented by a light emitting diode in a model home and extinguish it. This paper will talk about each component of the robot from the start signal to the robot platform to the line following and room finding and finishing with the fire detection.[6] Sahil S.Shah (2013) was all discussed about design a FIRE FIGHTING ROBOT using embedded system. A robot capable of fighting a simulated household fire will be designed and built. It must be able to autonomously navigate

through a modeled floor plan while actively scanning for a flame. The robot can even act as a path guider in normal case and as a fire extinguisher in emergency. Robots designed to find a fire, before it rages out of control, can one day work with fire-fighters greatly reducing the risk of injury to victims. The result shows that higher efficiency is indeed achieved using the embedded system.[7] U.Jyostna Sai Prasanna, M.V.D.Prasad (2013) was design the fire detection system using four flame sensors in the firefighting robot, and program the fire detection and fighting procedure using sensor based method. The firefighting robot is equipped with four thermistors/flame sensors that continuously monitor the temperature. If the temperature increases beyond the predetermined threshold value, buzzer sounds to intimate the occurrence of fire accident and a warning message will be sent to the respective personnel in the industry and to nearby fire station with the GSM module provided to it. [8] Swati A. Deshmukh (2015) was all discussed about the fire detection system using sensors in the system, and program the fire detection and fighting procedure using sensor-based method. [9]

3. Methodology and Modeling

3.1. Introduction: (Shabrina Rahman, 18-38514-2)

Firefighting is the act of extinguishing destructive fires. A firefighter must be able to stop fire quickly and safely extinguish the fire, preventing further damage and rescue victims to a safer location from the hazard. Technology has finally bridged the gap between firefighting and machines allowing for a more efficient and effective method of firefighting. Fire fighting robot is our capstone project and our main aim is to develop microcontroller based firefighting robot. Gas sensor machine will sense the fire, smoke and temperature at the site of disaster where fighting robots will decrease the need for firefighters to get into dangerous situations. Intelligent firefighting humanoid robots are actively being researched to reduce firefighter injuries and deaths as well as increase their effectiveness on performing tasks. The firefighting robot overcomes the problems of hitting all the obstacle and moves into the direction where it is obstacle. It reduces the load for fire fighters. Some vehicles can reach positions that fire fighters cannot, such as petrochemical complexes and warehouses fire.

3.2. Working Principal: (Afnan, Arshad Uddin ,18-37387-1)

Fire accidents have become a common disaster for our daily life. Sometimes it may lead to hazards that make it hard for the firemen to protect human life. In such cases, a firefighting robot can be highly useful to guard human lives, wealth, and surroundings from the fire accidents. So, concerning about the facts, we have decided to design a fully automated firefighting robot which can help in dealing with many fire problems in households, office, industries etc. To do so, we have implemented a software-based Fire Fighting Robot with the help of Proteus 8.9 Professional and Arduino IDE software. in proteus we added three fire fighting robot, one smoke sensor and this smoke sensor connected to Arduino uno besides in output we added 4 servo motor 2 motor for moving the robot and others two was pump the water and spreading the water. In below we are giving block diagram of our project. This block diagram is visual description of our project.

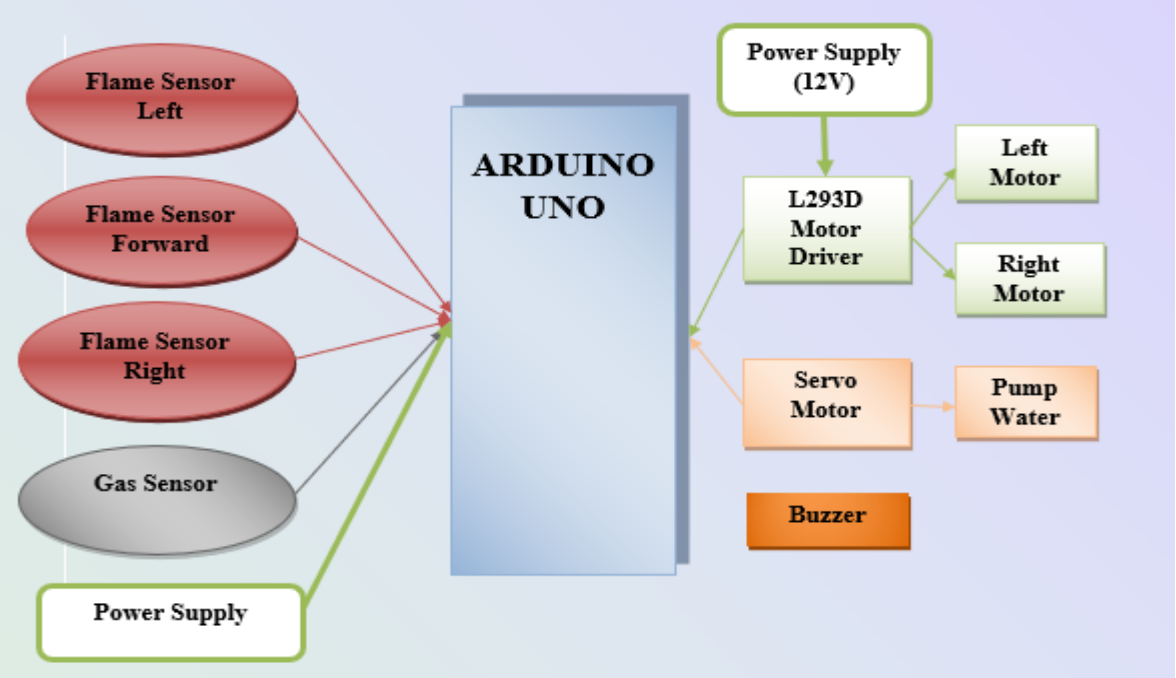

Fig.1. Block Diagram

In this figure 1(block diagram) you can see in Arduino uno analogue pin we connected three flame sensor , smoke sessor and one power supply as a input besides as output we connected one motor driver(L293D) which mainly controlling path direction of the robot , 2 servo motor one for pump the water and another for spreading the water and one buzzer for give the signal if sensor detect the danger environment or fire and smoke. Firstly, flame and gas sensors were used to detect the fire and smoke. If the fire or smoke is detected then it gives the signal and direction to microcontroller (Arduino uno) then microcontroller forward the signal through pump motor, servo motor, buzzer and corresponding the motor driver also. These two sensors can automatically detect fire and smoke & the robot navigates itself to the source of the fire & start extinguishing it by using the fire extinguishing system. Then servo motor in order to control the path where water is being sprayed on the danger area and extinguish the fire.

3.3. Description of Component: (Shabrina Rahman, 18-38514-2)

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Fig 2: Arduino uno

Flame Sensor

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire. This sensor/detector can be built with an electronic circuit using a receiver like electromagnetic radiation. This sensor uses the infrared flame flash method, which allows the sensor to work through a coating of oil, dust, water vapor, otherwise ice. Flame Sensor Module**:** The pin configuration of this sensor is shown below. It includes four pins which include the following. When this module works with a microcontroller unit then the pins are. Pin1 (VCC pin): Voltage supply rages from 3.3V to 5.3V. Pin2 (GND): This is a ground pin. Pin3 (AOUT): This is an analog output pin (MCU.IO Pin4 (DOUT): This is a digital output pin (MCU.IO).

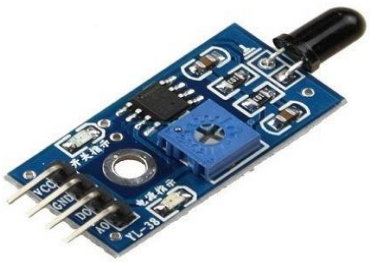

Fig 3: Flame sensor

Gas Sensor

MQ2 gas sensor is an electronic sensor used for sensing the concentration of gases in the air such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide. It is commonly an unwanted by-product of fires. Smoke Detectors are very useful in detecting smoke or fire (GAS) in buildings, and so are the important safety parameters. The smoke sensor detects smoke and provides output to the MCU.

Fig 4: Gas sensor

Buzzer

It is an electronic used to give alarm sound as it is programmed. The buzzer consists of an outside case with two pins to attach it to power and ground. Inside is a piezo element, which consists of a central ceramic disc surrounded by a metal (often bronze) vibration disc. When current is applied to the buzzer it causes the ceramic disk to contract or expand. Changing the tin then causes the surrounding disc to vibrate.

Fig 5: Buzzer

DC Motor

When a current-carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. In other words, when a magnetic field and an electric field interact, a mechanical force is produced. The DC motor or direct current motor works on that principle. This is known as motoring action. A DC motor converts DC electrical energy into mechanical energy.

Servo Motor

A servo is a small device which has an output shaft which positions on coded signal. It is a rotary or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. The servo motor is which respond to signal abruptly and accelerate the load quickly are called servo motor.

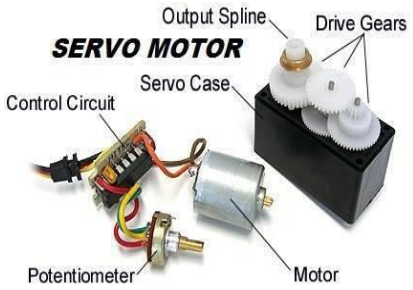

Fig 6: Servo Motor

L293D

L293D is a Motor driver integrated circuit which is used to drive DC motors rotating in either direction. It is a 16-pin IC which can control a set of two DC motors simultaneously. It means that we can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC). The L293D uses 5V for its own power and external power source is needed to drive the motors, which can be up to 36V and draw up to 600mA.

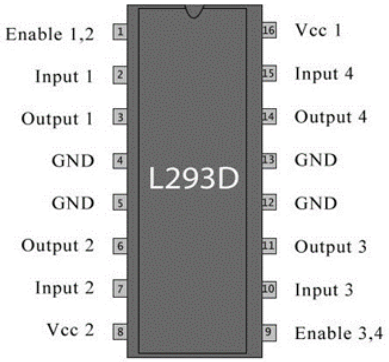

Fig 7: L293D

DC Pump

DC powered pumps use direct current from motor, battery, or solar power to move fluid in a variety of ways. Motorized pumps typically operate on 6, 12, 24, or 32 volts of DC power. Solar-powered DC pumps use photovoltaic (PV) panels with solar cells that produce direct current when exposed to sunlight. It is a simpler speed control and operation.

Logic State Switch

Digital logic gates whose inputs and output can switch between two distinct logical values of 0 and 1, can be defined mathematically simply by using Boolean Algebra. Logic state can be represented by the two digital logic states of HIGH or LOW, "1" or "0", "ON" or "OFF", and TRUE or FALSE, using electromechanical contacts in the form of switches or relays as a logic circuit element. The implementation of switching functions in digital logic circuits is nothing new, but it can give us a better understanding of how a single digital logic gate works.

3.4. Implementation and Test Setup: (Afnan, Arshad Uddin ,18-37387-1)

For implantation of project, we choose proteus 8.9 profession software. we know that flame sensor and gas sensor is not available in proteus library that's why download flame sensor and gas sensor library file as well as hex file to activated the sessor after that we took other required equipment. Others equipment we taken from proteus library such as Arduino Uno, DC Motor, Servo Motor, L293D, Buzzer, Dc Pump and Logic State Switch and connected one after another. Secondly the chose Arduino IDE for complying our desire code and implemented our code in Arduino IDE which will code represent the all operation of the microcontroller. We connect 5V supply voltage in each flame and gas sensors and 12V to the L293D. Then we bring one Virtual Terminal to see the expected output on the screen and connected its TX pin to the RX pin of microcontroller and RX pin to the TX pin of the microcontroller. After connecting all the connection, we have provided the hex file of the code in the Arduino Uno as input and run the simulation. After observing all the outputs, it can be saying that all the outputs were matched with the expected result. Thus, the software implementation was successfully achieved.

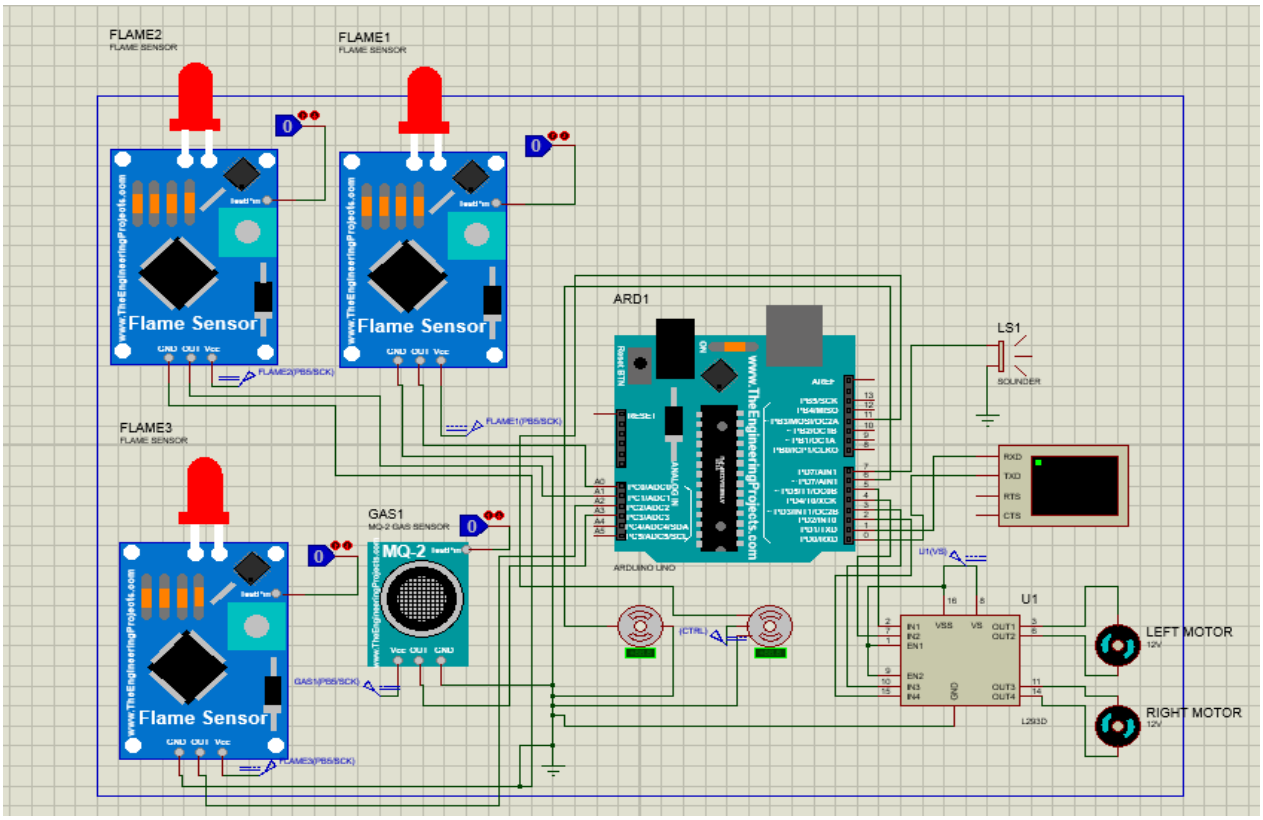

Fig.8. Schematic Environment of Fire Fighting Robot

In figure 8 we show circuit diagram of our project and all equipment connected properly. all four sensor and dc supply in connected to Arduino analogue pin such as A0, A1, A2, A3. Besides servo motor pump motor, buzzer, visual LCD display, L293D all this equipment is connected to the digital pin such as 0,1,2,3,4,5,6,7 and 11 number pins

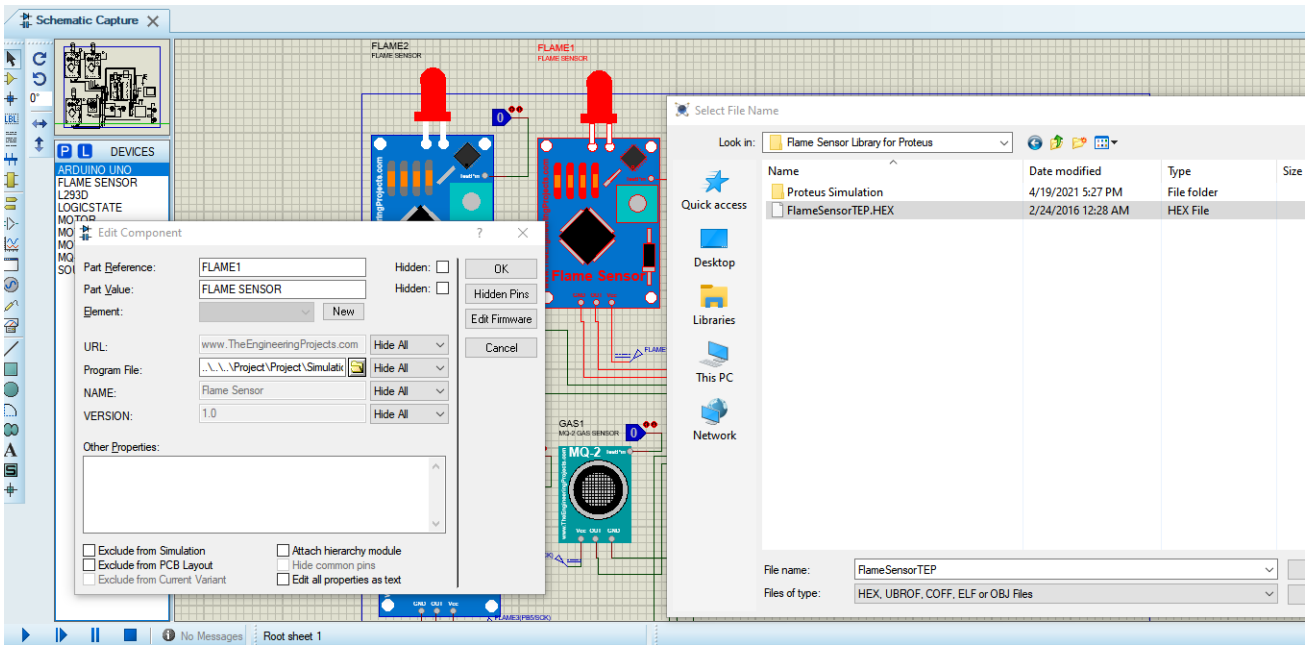

Fig 9: Flame sensor |Hex file addition

In figure 9 show that the flame Hex file added into the flame sensor 1 (left sessor). We add this Hex file to every flame sensor for activation the flame sensor.

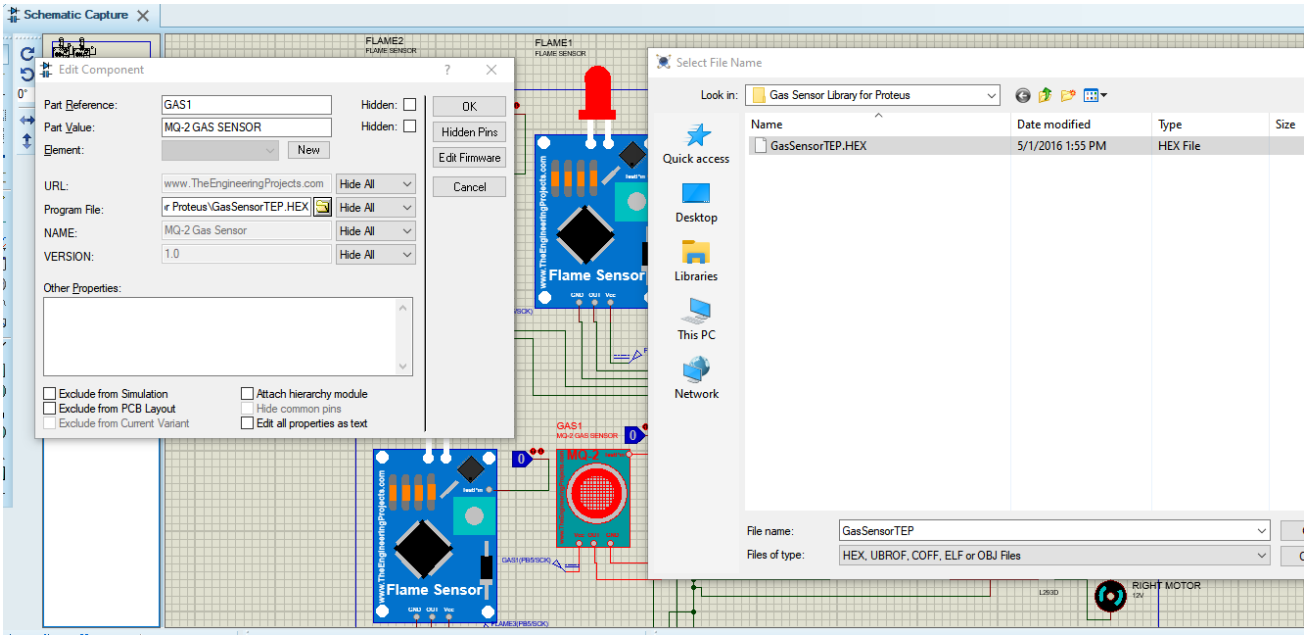

Fig 10: Gas sensor Hex file addition

In figure 10 show that the Gas Hex file added into the Gas sensor 1 (left sessor). We add this Hex file for activation the Gas sensor.

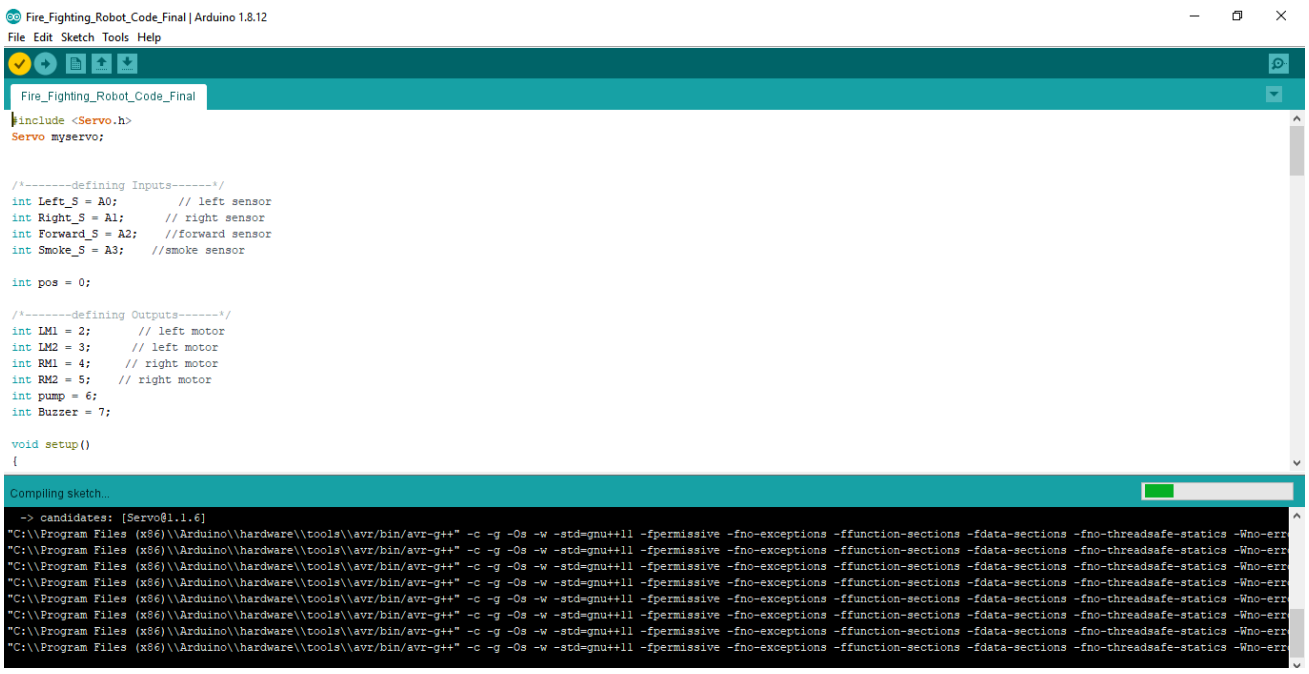

Fig 11: Code Compiling in Arduino IDE

In figure 11 show that the code compilation process in Arduino IDE Hex. For compiling the Arduino code, we code Arduino ide and we implemented the main code represented whole fire extinguished process

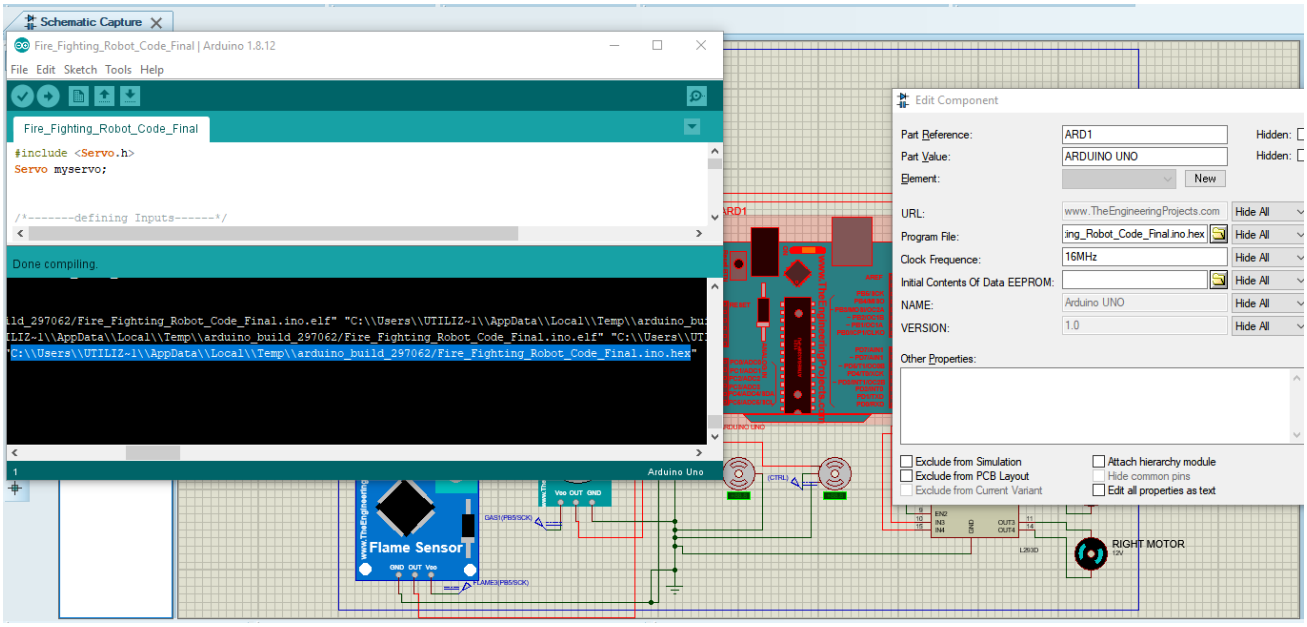

Fig 12: Compiling Hex File Add into Arduino Uno

In figure 12 show that the code compilation Hex file adding to Arduino uno. after completing the compiling, the in Arduino IDE then copy the Hex file and added into the Arduino uno, by added this microcontroller follow the code command and maintain the whole fire extinguished process

3.5. Cost Analysis: (Shabrina Rahman, 18-38514-2)

	Component's Name	Unit	Price
1	Arduino uno	1	850/-
2	Flame Sensor	3	90*3/-
3	Gas Sensor (MQ2)	1	500/-
4	Buzzer	1	90/-
5	DC Motor	2	400*2/-
6	Servo Motor	1	490/-
7	L293D	1	185/-
8	DC pump	1	279/-
9	Logic State Switch	4	20*4/-
	Total Cost		3544/-

If we want to build this project in our practical life, We need to expend 3544 taka approximately.

4. Result and Discussion: (Afnan, Arshad Uddin ,18-37387-1)

4.1. Experimental result:

Figure 13 shows the “Safe Environment” signal on the virtual terminal when no flames or gas detects.

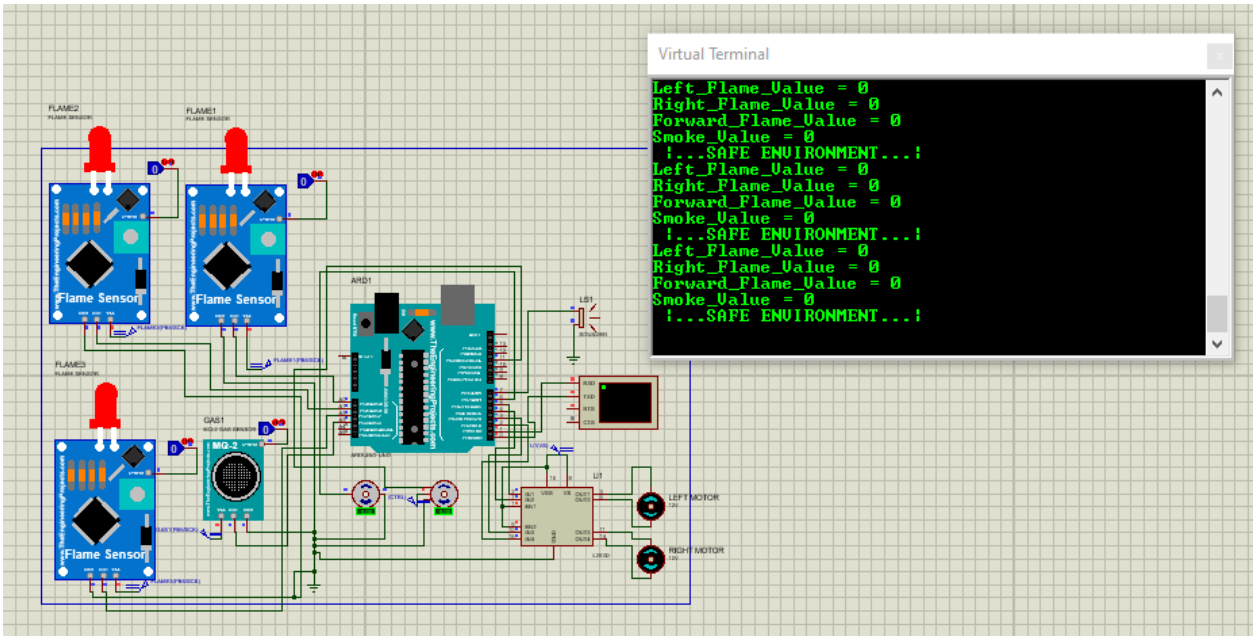

Fig.13. Output showing “Safe Environment” when no flame or smoke detects

Figure 14 shows the “Danger Environment: Warning!” signal on the virtual terminal when flame is detected on forward flame sensor.

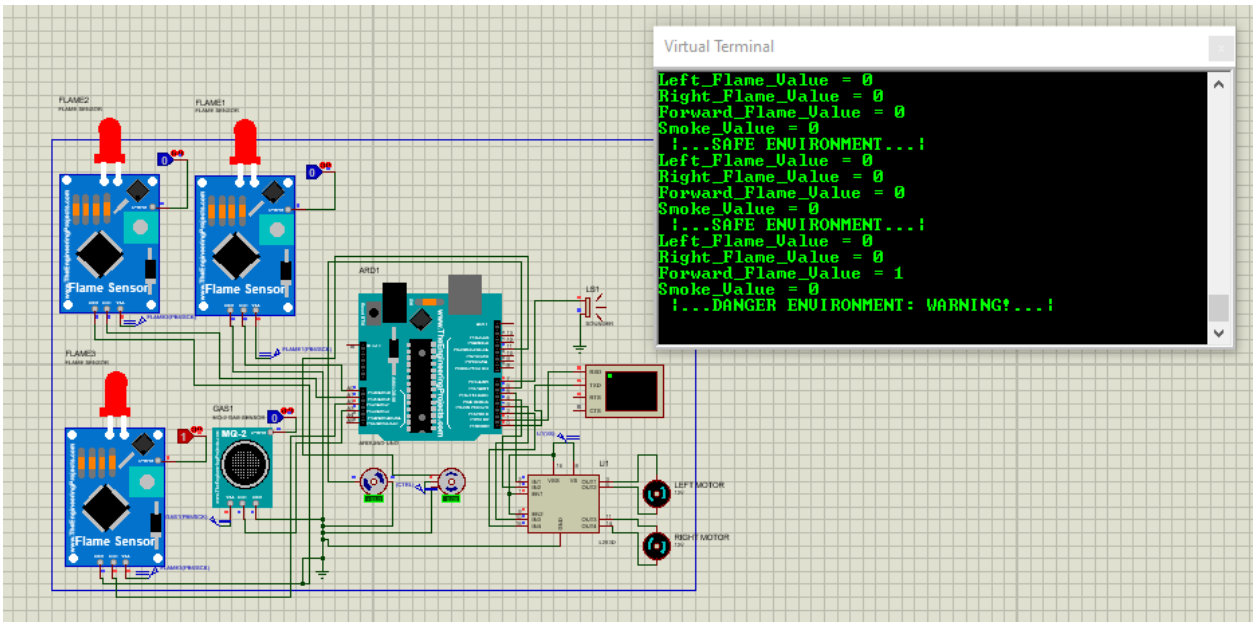

Fig.14. Output showing “Danger Environment: Warning!” when flame detects

Figure 15 shows the “Danger Environment: Warning!” signal on the virtual terminal when smoke is detected.

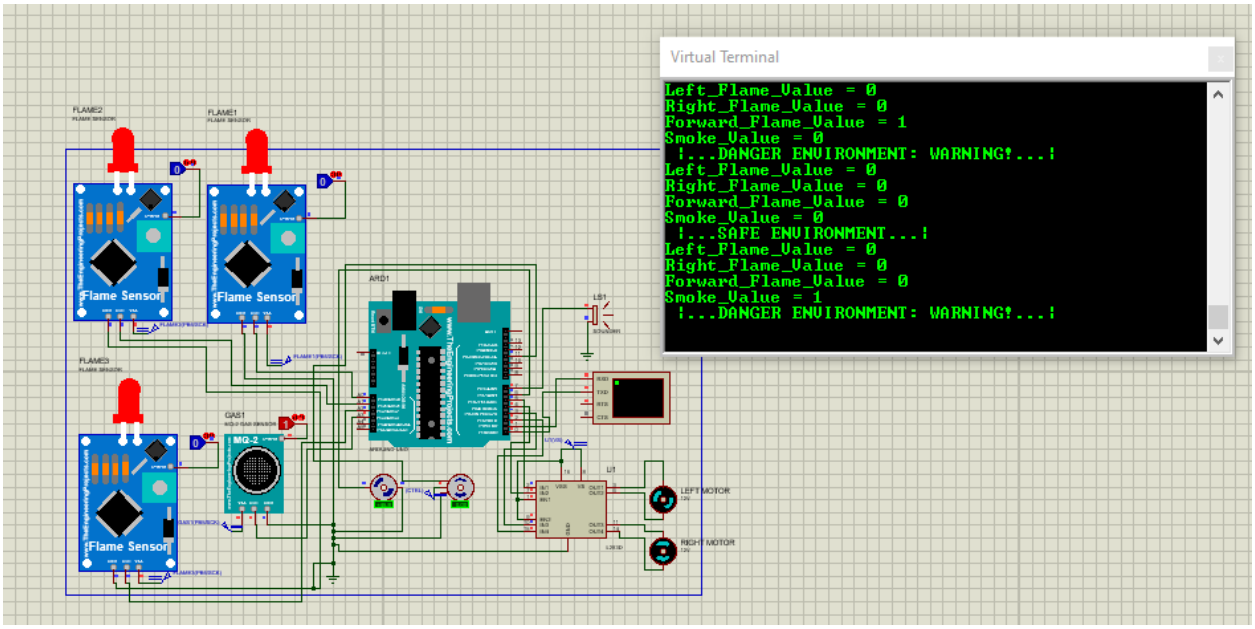

Fig.15. Output showing “Danger Environment: Warning!” when smoke detects

5. Impact of Professional Engineering Solution on Society and Environment:

(Afnan, Arshad Uddin ,18-37387-1)

A large number of fire accidents occur in world, be it natural or man-made. There are many possibilities a fire can start in industries, offices or residential houses. In worst case this can cause huge financial loss and there is always the risk of life. Fire fighters have to divide their resources between rescue and extinguishing fire. To counter this, we need a system that can be employed to fight alongside the fire fighters. The goal here is to build a Fire Fighting Robot which can autonomously find and extinguish fire before it rages out of control. This project will help to generate interest in the field of robotics while working towards a practical and obtainable solution to save lives and minimize the risk of property damage. Because of that our robot can detect fire instantly and can extinguish it before spreading. This multisensory based robot may be a solution to all fire hazards. Various sensors like flame, smoke sensors have been incorporated in this robot. If the fire is detected, a water spraying mechanism is triggered to extinguish the fire. Sound alert is also issued upon all events to alert the operator. With enough funding and scope, this design of robot can also fight against large fire with larger reserving capacity and an improved sensing unit can provide even an earlier detection of fire at all circumstances.

6. Conclusion: (Afnan, Arshad Uddin ,18-37387-1)

The Fire Fighting Robot is effective enough to fight against fire on a small scale. It can sense fire flame better at darker places. It is made as a preventer robot. In this project, an autonomous Firefighting Robot has been implemented which is capable of detecting flames & smokes and extinguishing them successfully. This robot can move forward, move left & right flawlessly. The motors and Arduino code work together to control the movement of the robot. If any of the flame sensors or smoke sensor are triggered, then buzzer will start to buzz & warning about the danger environment will be displayed on the Virtual Terminal & safe environment will be shown in case of no such detection. The motor will start to rotate & move the robot to the danger point upon receiving a signal about the danger environment & start to pump the water with the help of servo motor. This process will be continued until the fire or smoke has been extinguished completely. Then it will display about the safe environment. After successfully building the project, the simulation was run and the desired output was obtained. Proper snapshots of the results were attached. As a conclusion, the project entitled "Fire Fighting Robot" has achieved its aim and objective successfully.

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APPENDIX

```
#include <Servo.h>
Servo myservo;
/*-------defining Inputs------*/
int Left_S = A0;         // left sensor
int Right_S = A1;      // right sensor
int Forward_S = A2;    //forward sensor
int Smoke_S = A3;    //smoke sensor
int pos = 0;
/*-------defining Outputs------*/
int LM1 = 2;       // left motor
int LM2 = 3;      // left motor
int RM1 = 4;     // right motor
int RM2 = 5;    // right motor
int pump = 6;
int Buzzer = 7;
void setup()
{
pinMode(Left_S, INPUT);
pinMode(Right_S, INPUT);
pinMode(Forward_S, INPUT);
pinMode(Smoke_S, INPUT);
pinMode(LM1, OUTPUT);
pinMode(LM2, OUTPUT);
pinMode(RM1, OUTPUT);
pinMode(RM2, OUTPUT);
pinMode(pump, OUTPUT);
pinMode(Buzzer, OUTPUT);

Serial.begin(9600);
myservo.attach(11);
}
void put_off_fire()
{
delay (500);
digitalWrite(LM1, LOW);
digitalWrite(LM2, LOW);
digitalWrite(RM1, LOW);
```

```
digitalWrite(RM2, LOW);
digitalWrite(pump, HIGH); delay(500);


for (pos = 50; pos <= 130; pos += 1) {
myservo.write(pos);
delay(10);
}
for (pos = 130; pos >= 50; pos -= 1) {
myservo.write(pos);
delay(10);
}
delay(100);
digitalWrite(pump, LOW);
}
void loop()
{
int flameval1 = digitalRead (Left_S) ;
int flameval2 = digitalRead (Right_S) ;
int flameval3 = digitalRead (Forward_S) ;
int smokeval = digitalRead(Smoke_S);
Serial.print("Left_Flame_Value = ");
Serial.println(flameval1);
Serial.print("Right_Flame_Value = ");
Serial.println(flameval2);
Serial.print("Forward_Flame_Value = ");
Serial.println(flameval3);
Serial.print("Smoke_Value = ");
Serial.println(smokeval);


if (flameval1 == LOW and flameval2 == LOW and
flameval3 == LOW and smokeval == LOW) //If Fire
OR Smoke not detected all sensors are zero
{
//Do not move the robot
Serial.println(" |...SAFE ENVIRONMENT...| ");
digitalWrite(LM1, LOW);
digitalWrite(LM2, LOW);
digitalWrite(RM1, LOW);
digitalWrite(RM2, LOW);
digitalWrite(Buzzer, LOW);
}
```

```
else if (flameval1 == HIGH or smokeval == HIGH) //If
Fire OR Smoke is straight ahead

{

//Move the robot forward

Serial.println(" |...DANGER ENVIRONMENT:
WARNING!...| ");

digitalWrite(LM1, HIGH);

digitalWrite(LM2, LOW);

digitalWrite(RM1, HIGH);

digitalWrite(RM2, LOW);

digitalWrite(Buzzer, HIGH);

put_off_fire();

}

else if (flameval2 == HIGH or smokeval == HIGH) //If
Fire OR Smoke is to the left

{

//Move the robot left

Serial.println(" |...DANGER ENVIRONMENT:
WARNING!...| ");


digitalWrite(LM1, HIGH);

digitalWrite(LM2, LOW);

digitalWrite(RM1, LOW);

digitalWrite(RM2, HIGH);

digitalWrite(Buzzer, HIGH);

put_off_fire();

}

else if (flameval3 == HIGH or smokeval == HIGH) //If
Fire OR Smoke is to the right

{

//Move the robot right

Serial.println(" |...DANGER ENVIRONMENT:
WARNING!...| ");

digitalWrite(LM1, LOW);

digitalWrite(LM2, HIGH);

digitalWrite(RM1, HIGH);

digitalWrite(RM2, LOW);

digitalWrite(Buzzer, HIGH);

put_off_fire();

}

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

}
```