Acknowledgement

We would like to express our special thanks of gratitude and appreciation to our module teachers Mr. Sugat Man Shakya and Mr. Nabin Acharya for giving us this wonderful opportunity to work on this IoT project regarding the Fire Hazard Alert System, who helped us in doing research and gave us insights on IoT and also tips for working efficiently as a team.

Abstract

There always have been many cases of fire hazards which happens suddenly and causes unthinkable harm/danger to health, property and even lives. We hear the news about people losing their lives and getting burned dure to the fire hazards. People usually panic in these situations and are not able to think properly due to which there are more people victim to these fire hazards. As nothing is more important than a person's life, we should install fire safety components in the household and work environment to prevent all these accidents and dangers.

Fire Hazard Alert System- an IoT device is one of the fire safety components that can detect various types of combustible gases and smokes and notify or alert you about the occurrence of the fire hazard and also automatically opens your door of the room by sensing the increase in the temperature in the room and create an escape route for you.

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1. Introduction

The Internet of things (IoT) is a collection of technologies employing sensors and actuators to let us know how common place items like tools, vehicles, and even living things are. In addition, it serves as a general word for the expanding class of gadgets that are not standard computing equipment but linked to the internet to send or receive data.

As nothing is more important than a person's life, we should install fire safety components in the household and work environment to prevent all these accidents and dangers. Fire Hazard Alert System- an IoT device is one of the fire safety components that can detect various types of combustible gases and smokes and alert you about the occurrence of the fire hazard and also automatically opens your door of the room by sensing the increase in the temperature in the room and create an escape route for you.

1.1 Current Situation

According to NFPA data, home — the place people feel safest from fire — is actually where they are at greatest risk, with three-quarters (75 percent) of all U.S. fire deaths occurring in homes.

Multiple factors contribute to this much smaller window of escape time, including the way newer homes tend to be constructed and the fact that modern home furnishings are often made with synthetic materials that burn faster and generate toxic smoke, making it extremely difficult to see and breathe.

"To many, the concepts of home escape planning and practice may sound so simple that their value is underestimated, but the reality is that these advance preparations can truly mean the difference between life and death in a home fire - now more than ever," said Carli. "Ask anyone who's experienced a home fire and they will tell you how dark, scary, and disorienting a home fire can become within moments. Having a practiced plan with all members of the household builds the muscle memory needed to get out as quickly and safely as possible." (NFPA, 2022)

1.2 Problem Statement and Project as a solution

Problem:

Prevention is always preferable than treatment. Additionally, taking preventive measures is absolutely essential when it comes to fire. Fire is a destructive force that spreads rapidly and has the power to cause unimaginable damage to property, human health, and even life. People usually get scared and panic and goes into the panic state in these situations and are not able to think properly due to which there are more people who are victim to these fire hazards. Therefore, we should install fire safety equipment in our homes and places of employment.

Solution:

Fire Hazard Alert System- an IoT device is one of the fire safety components to prevent the potential harm caused by gas leakage or any other fire hazards which may lead to fire spreading and risking the danger to a person lives by alerting the person about the occurrence of the fire hazard and also automatically opens the door, creating an escape route for the person in the room by sensing the rise in the temperature of the room.

1.3 Aim and Objective

1.3.1 Aim

The aim of this project is to prevent the potential harm caused by gas leakage or any other fire and also create an escape route for the person as there is extreme rise in temperature of the room.

1.3.2 Objectives

- To alert the person when there is a gas leakage or any other fire hazards.
- To open the escape route as there is increase in temperature than the normal temperature.
- To remind or present the idea of what should be done when there is a gas leakage or fire spread.
- To direct them to safety in the state of panic caused by the fire hazard.
- To provide the product users with a feeling of security in case of any fire hazards.
- A buzzer to alert the person as well as the other person nearby.

2. Background

2.1 System Overview

This project aims to deliver a working prototype of a Fire Hazard Alert System. Utilizing the MQ-2 sensor to detect combustible gases and a buzzer to produce an audible alert, the system also features temperature monitoring with the DHT-11 sensor for fire detection. In the event of an abnormal rise in temperature, the system automatically activates the Micro Servo Motor SG90 to open escape routes, ensuring safety and facilitating rescue efforts. The prototype implements two sensors: MQ-2 (detects smoke and LPG leakage) and DHT-11 (monitors temperature to detect fire) interfacing with Arduino microcontroller. The Arduino microcontroller is connected to a Buzzer, and SG 90 Servo Motors. In real life scenario, MQ-2 sensor and DHT-11 sensor sense the presence of smoke/LPG leakage and monitor temperature respectively and send signal to Arduino. In case smoke/LPG leakage is detected, the alert mechanism is triggered by the buzzer and if the room temperature monitored by DHT-11 exceeds a certain threshold, it triggers the SG 90 Servo Motors which simulates an automatic door opening mechanism to secure an escape route from fire and also makes rescuing much easier.

2.2 Design Diagram

2.2.1 Hardware Architecture

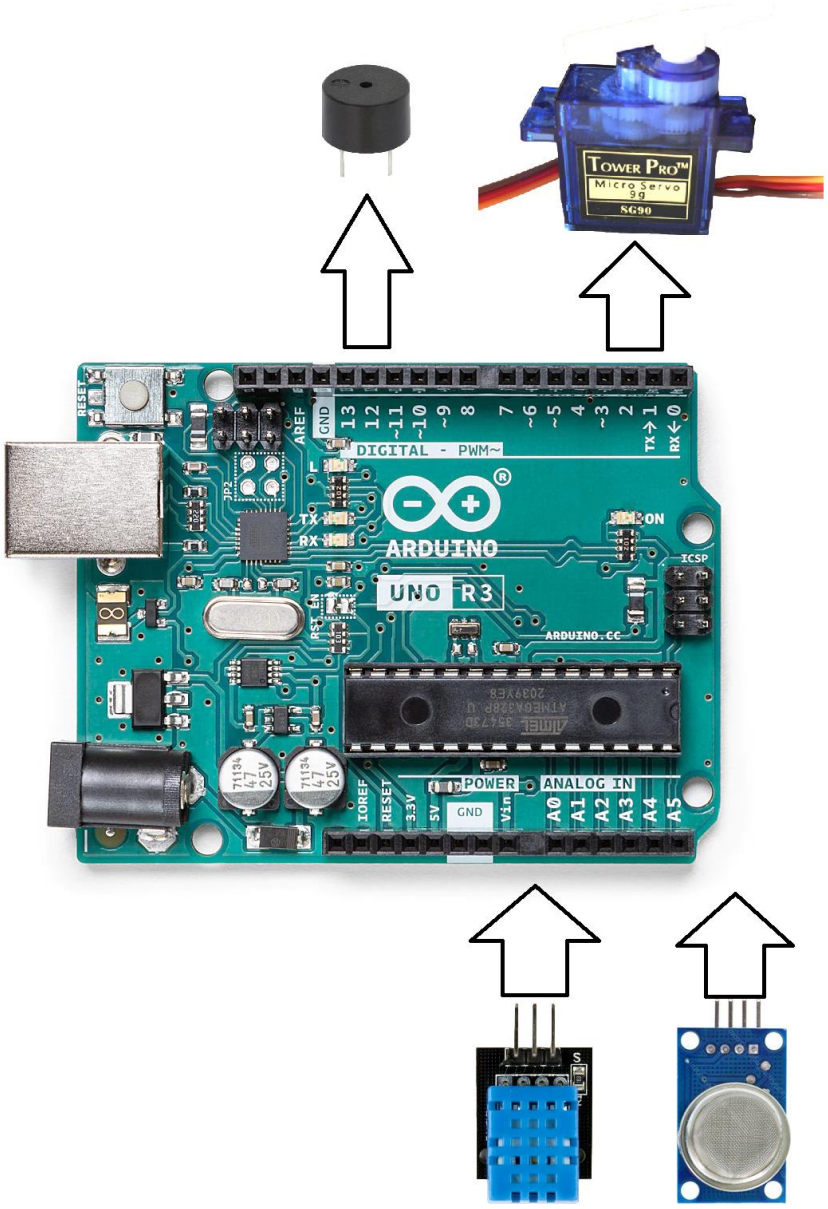

Figure 1 System Architecture of Fire Hazard Alert System

2.2.2 Flowchart

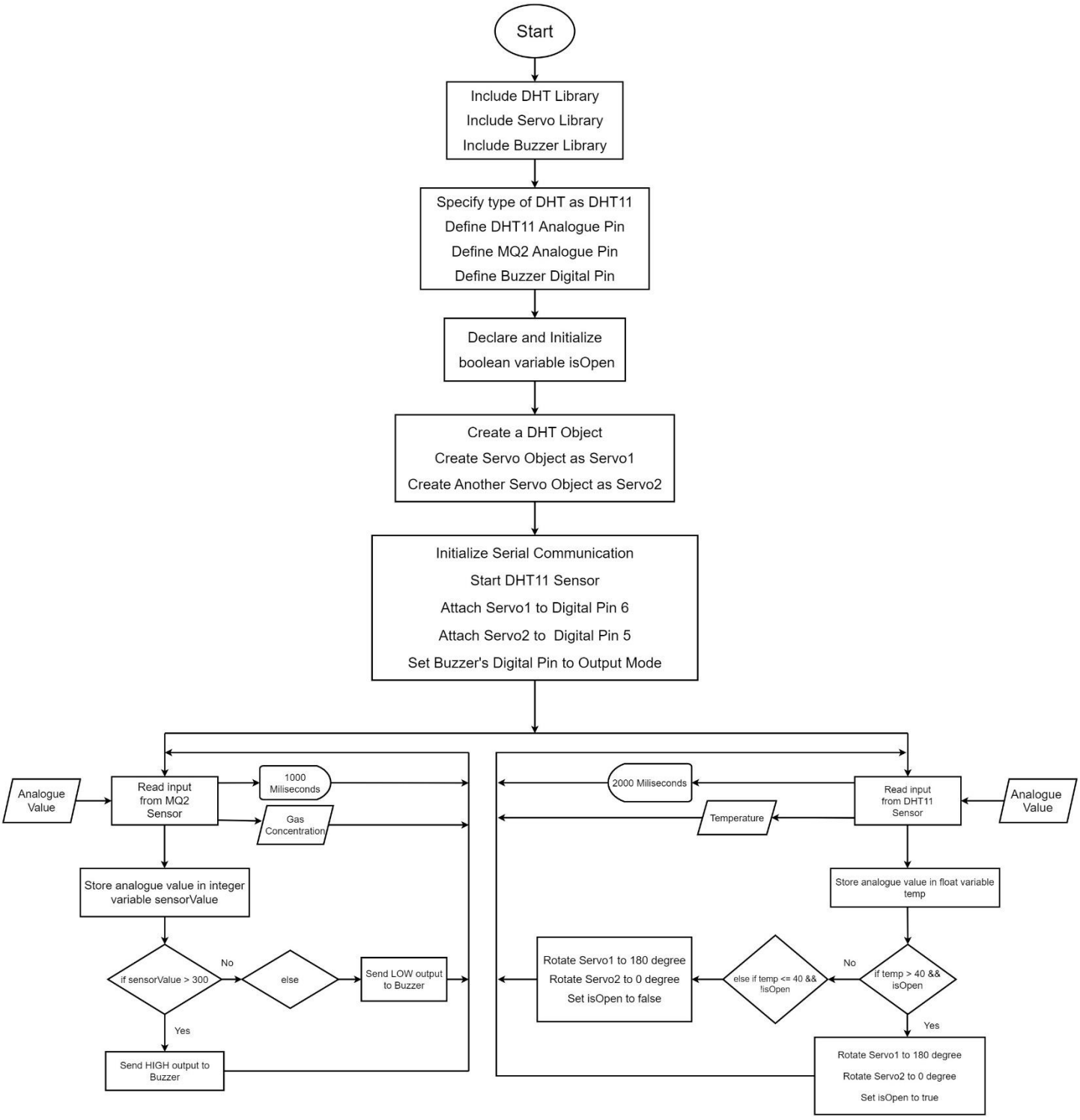

Figure 2 Flowchart of Fire Hazard Alert System

2.2.3 Circuit Diagram

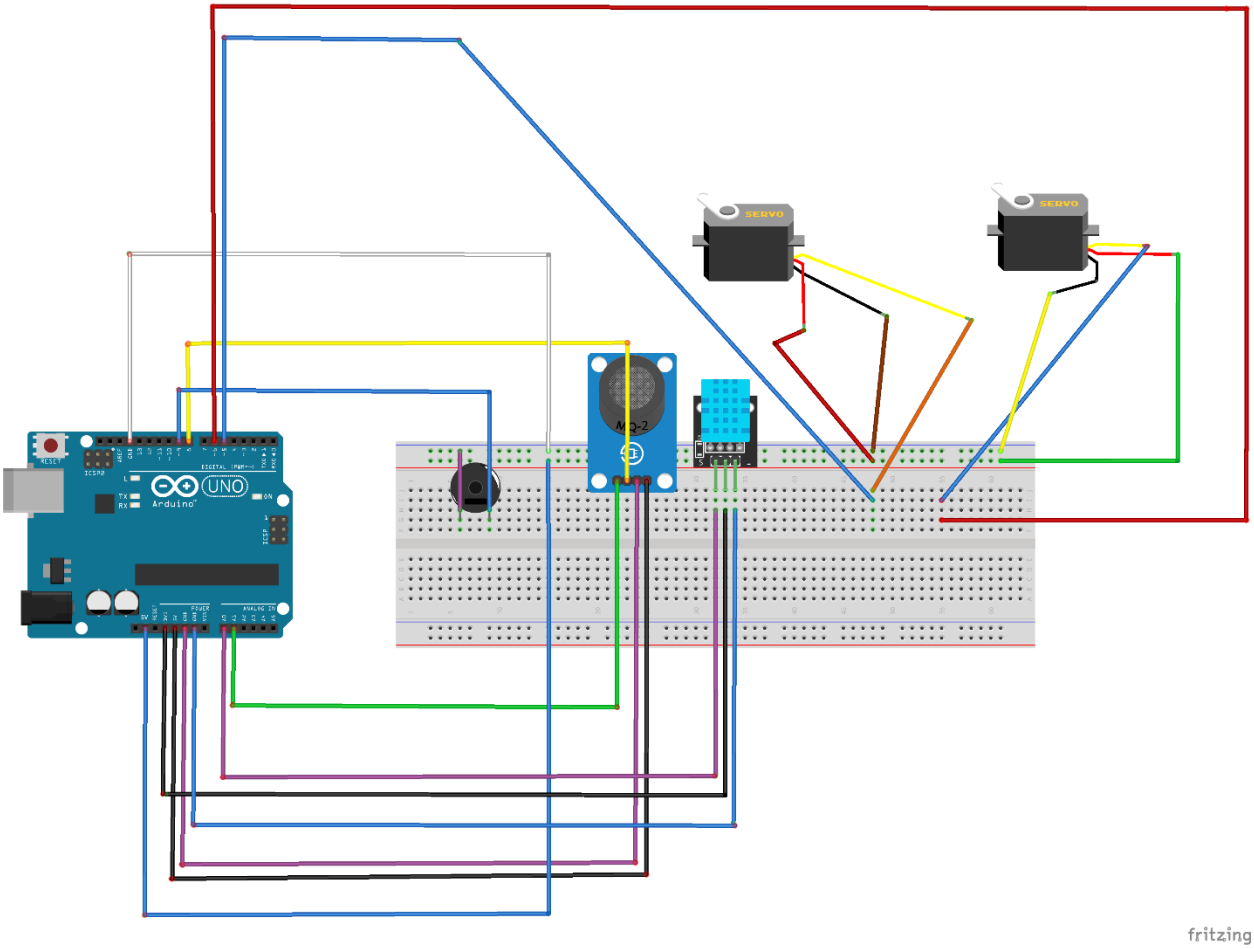

Figure 3 Circuit Diagram of Fire Hazard Alert System

2.3 Requirement Analysis

2.3.1 Hardware Resources

i. Arduino UNO

Arduino is an open-source electronics platform accompanied with a hardware and software to design, develop and text complex electronics prototypes and products. Arduino hardware is a programmable circuit board called a microcontroller. Arduino Software is an IDE (integrated development environment) through which developers write and upload the code to the microcontroller (Yadav, 2022).

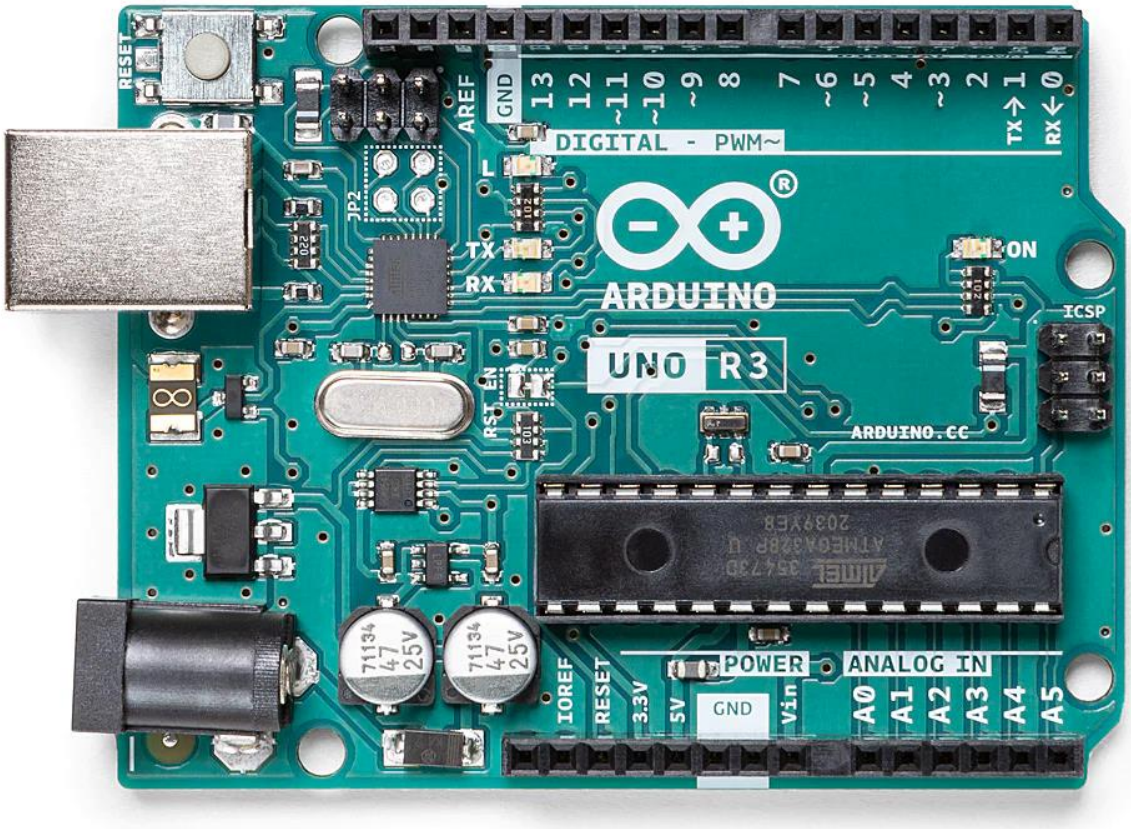

Figure 4 Arduino UNO R3

ii. MQ-2 Gas Sensor

The MQ-2 gas sensor is an electrical device used to measure the levels of gases in the air, including carbon monoxide, methane, hydrogen, alcohol, and LPG. The MQ2 gas sensor is simple to use and has two different outputs. It not only provides a binary indication of the presence of combustible gases, but also an analogue representation of their concentration in air. (LastMinuteEngineers, 2022)

Figure 5 MQ-2 Gas Sensor

iii. DHT-11 Temperature Sensor

The DHT-11 is a basic, ultra-low-cost digital temperature and humidity sensor. This device's operational voltage varies from 3.5V to 5.5V. When measuring, the device uses 0.3 mA, and in standby mode, it uses 60 uA. This gadget produces serial data as its output. It can operate between 0°C and 50°C and between 20% and 90% humidity. The instrument has an accuracy of 1% for humidity and 1°C for temperature. (components101, 2022)

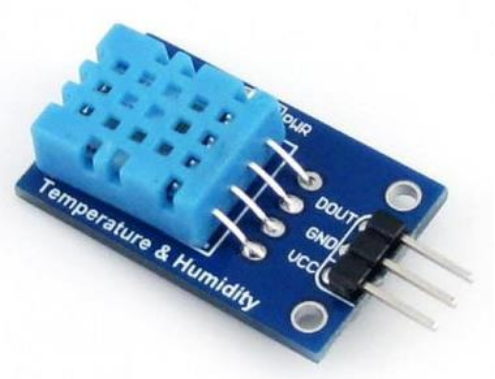

Figure 6 DHT-11 Sensor

iv. Micro Servo Motor SG90

Micro Servo Motor SG90 is a tiny and lightweight motor with high torque. tiny, light, and powerfully efficient. Servo rotates around 180 degrees (90 in each direction) and functions similarly to larger types of servos. These servos can be controlled by any servo code, hardware, or library. Good for novices who don't want to create a motor controller with feedback and gear box because it can fit in compact spaces.

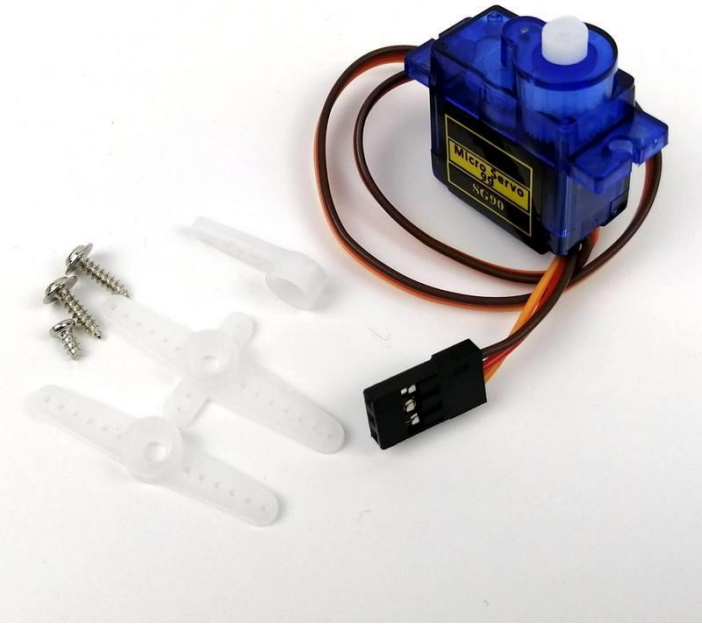

Figure 7 Micro Servo Motor SG90

v. Buzzer

A buzzer is an audio signaling device. A buzzer is an efficient component to include the features of sound in our system or project. Buzzer uses a DC power supply that ranges from 4V – 9V. It is an extremely small & solid two-pin device thus it can be simply utilized on a breadboard or PCB. So, in most applications, this component is widely used. (elprocus, 2022)

Figure 8 Buzzer

vi. Jumper Wire

A jump wire is an electrical cable with connectors or pins at each end. It is also known as a jumper, jumper wire, or DuPont wire. Without the necessity for soldering, it is frequently used to connect the parts of a breadboard, prototype, or test circuit. Jumper wires can also be "tinned" at the ends rather of having connections.

Figure 9 Jumper Wire

vii. Breadboard

A breadboard is a plastic board with several tiny holes all over it. In order to build a prototype of an electronic circuit, these holes are utilized to put electrical components. A battery, switch, resistor, and LED, for instance, can all be incorporated into a circuit using a breadboard. A prototype electronic circuit can be tested and built using a breadboard. (Schousek, 2018)

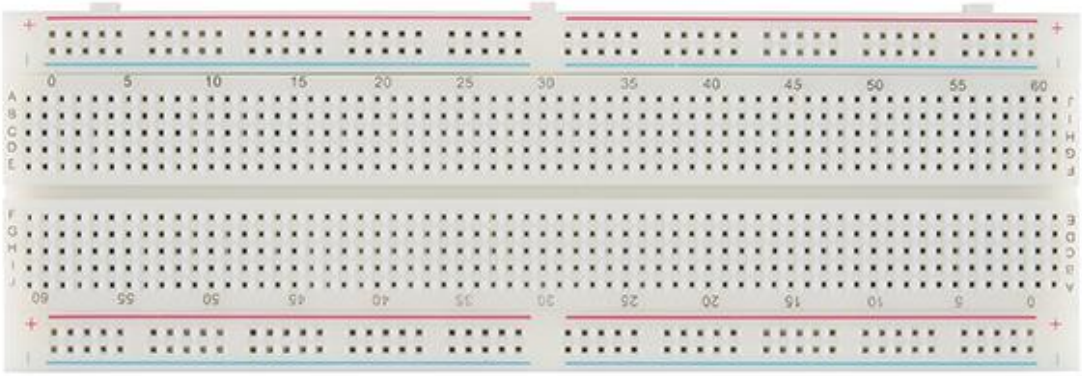

Figure 10 Breadboard

2.3.2 Software Resources

i. Arduino IDE

The Arduino Software, also known as the Arduino Integrated Development Environment, is a program that has a text editor for writing code, a message area, a text console, a toolbar with frequently used functions, and a set of menus. To connect to the Arduino hardware, upload programs to it, and interface with the hardware, use the Arduino IDE. Arduino IDE makes it easy to write code and upload it to the Arduino microcontroller offline.

ii. Fritzing

Fritzing is a free and open-source program that enables users to design and document electronic circuits using interactive diagrams, known as breadboard view, schematic view, and PCB layout view. The software is mainly used for documenting and sharing electronic projects in an organized manner. It has a library of parts which has various electronic components and connectors, making it simple to create and edit circuit diagrams and layouts. Additionally, it is also used as an educational tool and it is compatible with Windows, Mac, and Linux operating systems. It is used to make the system architecture of the project.

3. Development

This section contains the development phase of this project where we can know about the different important steps taken for making this IoT device. Here are some of the steps for developing this IoT project.

3.1 Planning and Design

Initially, we researched about various different IoT systems and decided on creating an IoT based system for preventing fire hazards and leading the person to safety. It was a simple idea but we wanted to add some unique elements into it.

Eventually we finalized into making a project about “Fire Hazard Alert System” which is an IoT device is one of the fire safety components to prevent the potential harm caused by gas leakage or any other fire hazards which may lead to fire spreading and risking the danger to a person lives by alerting using a buzzer about the occurrence of the fire hazard and also automatically opens the door, creating an escape route for the person in the room by sensing the rise in the temperature of the room.

As only detecting smoke is not enough, we added automated doors that will open as there is rise in temperature. Some of the major things we used for this project are Arduino UNO with gas sensor (MQ-2 Gas sensor) and Temperature sensor (DHT-11 Temperature Sensor) for detect any gas leakage and abnormal rise in temperature respectively in a room and used servo motor to represent an automatic door opening system where the door will open automatically as there is sudden increase in temperature. Therefore, the system will detect the smoke or any gas leakage and alert the person using a buzzer and as there is rise in temperature of the room the temperature sensor will detect it and the doors will automatically open creating an escape route for the person.

3.2 Resource Collection

A letter was written to the resource department at Islington College requesting to provide the components required to develop the IoT project. Most of the hardware resources were collected from the resource department at Islington College.

The college provided us the requested resources that were available at the resource department. The components are: Arduino UNO, DHT-11, Breadboard, Jumper Wire and Buzzer. Some resources were missing at the resource department. Therefore, the remaining resources which were unavailable in the resource department Tower Pro SG 90 Micro Servo Motor and MQ 2 Gas Sensor were searched for at the market and bought by the team. Altogether, our resources were stored in a transparent plastic box and the components were used in the development of the project.

The software resources Arduino IDE and Fritzing were downloaded from their websites. Arduino IDE and Fritzing was recommended by our tutor Mr. Nabin Acharya. He introduced us to these software programs and we started the development with the help from the internet content i.e., videos and documentations.

3.3 System Development

Here are some of the phases needed for the system development to make it fully functional and useable.

3.3.1 Phase 1

In this phase, we connected DHT-11 temperature sensor with the Arduino to check if it works properly and can measure the temperature by connecting its signal pin to A0, VCC to 3.3V and "–" to GND of Arduino with the help of breadboard in between.

Table 1 Connection of pins between DHT-11 and Arduino

Sensor Name	Sensor Pins	Arduino I/O pins
DHT-11 Sensor	Signal(S)	A0
	VCC	3.3V
	-	GND

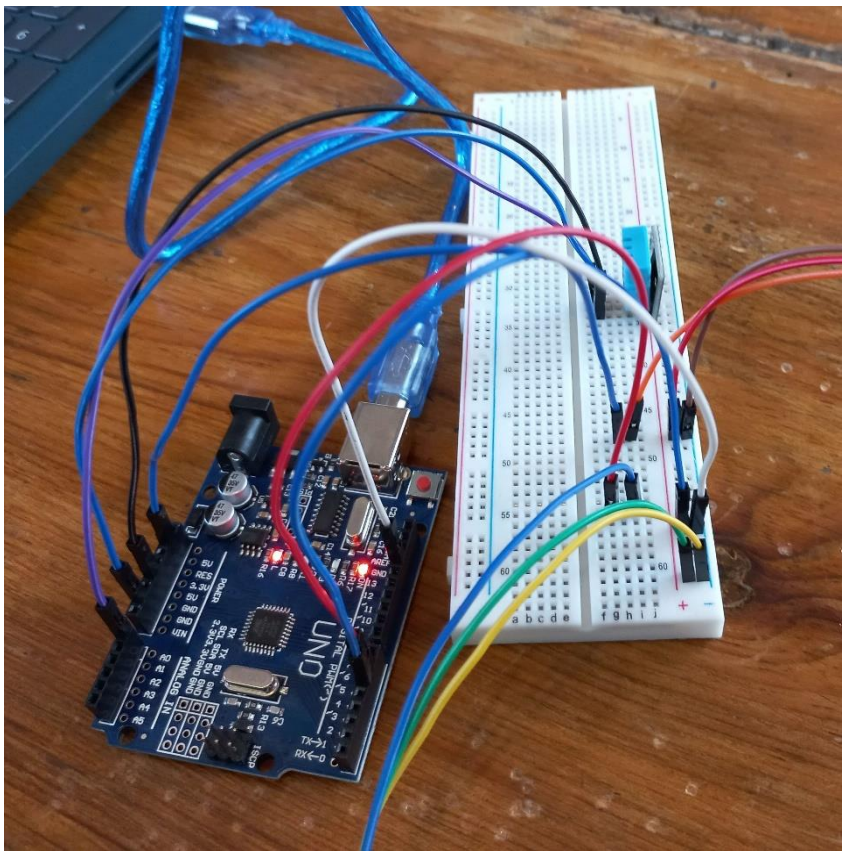

Figure 11 Connecting DHT-11 sensor and Arduino

3.3.2 Phase 2

In this phase we connected two servo motors for checking it functionality and with some coding set it to automatically open the door when the temperature is above 40 degrees Celsius. We connected the pins of the servo motor according to the connection given in the table below. The red wire which is VCC pin of both servo motor is connected to the 5V of Arduino. The yellow wire and orange wire from both of the servo motor which is SIG pin is connected to the D5 and D6 of Arduino. Black and Brown wire of Servo Motor is connected which is GND pin is connected to the GND of Arduino.

Table 2 Connections of pins between Servo Motors and Arduino

Motor Name	Motor Pins	Arduino I/O pins
SG90 – Servo Motor	VCC	5V
	SIG	D5 & D6
	GND	GND

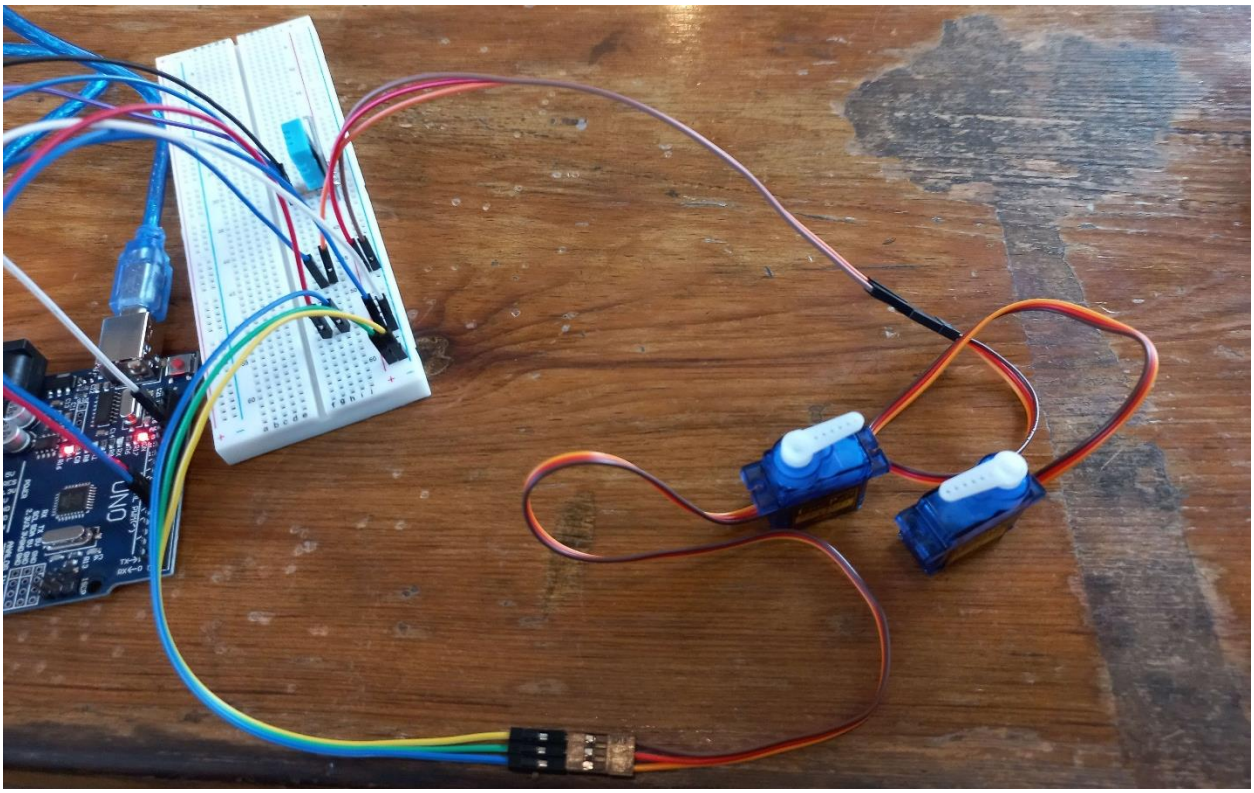

Figure 12 Connecting Servo Motor to the breadboard and Arduino

3.3.3 Phase 3

This is the final phase of development where we implement the smoke and combustible gases detection and alert mechanism by using MQ-2 sensor and Buzzer whereby MQ-2 sensor detects the presence of combustible gases and buzzer produces an audible alert sound in response to the sensor's detection of gases. The connection of MQ-2 and buzzer with Arduino can be shown in the table below:

Table 3 Connected pins between the MQ-2 Sensor, Buzzer and Arduino

Name	Pins	Arduino I/O pins
MQ-2 Sensor	A0	A1
	D0	D8
	GND	GND
	VCC	5V
Buzzer	+	D8
	-	GND

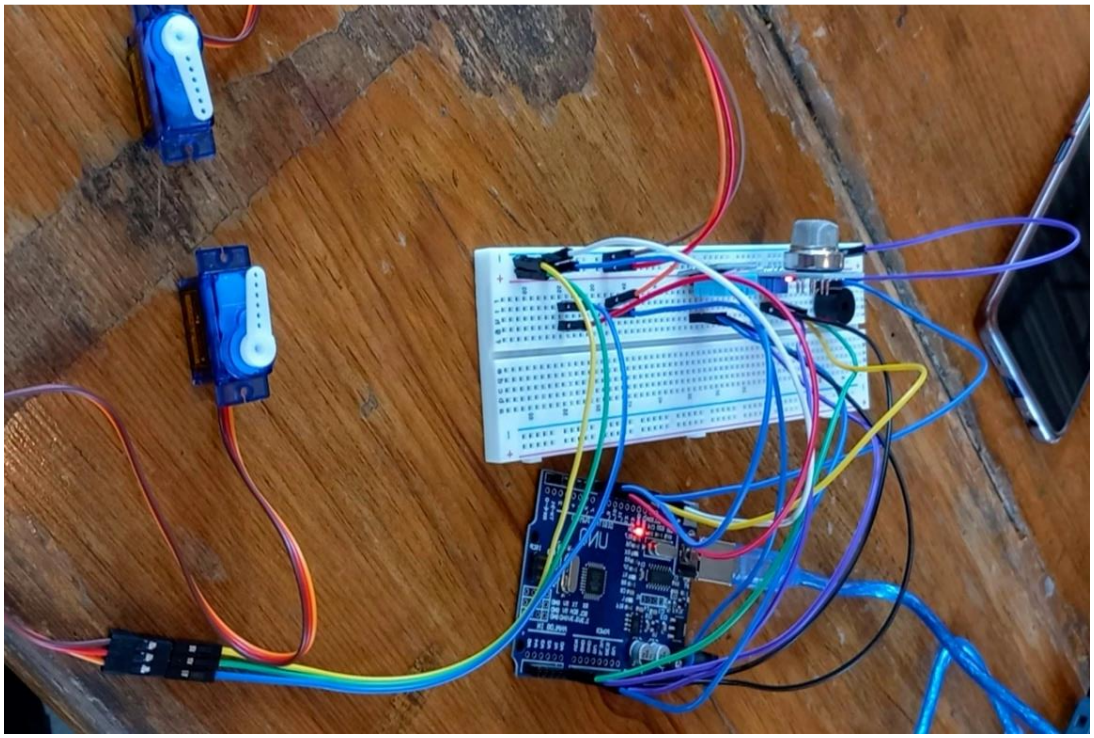

Figure 13 Connecting the MQ-2 sensor and Buzzer with Arduino

3.4 Coding

This is the coding section of this system where all the coding is done to run and give meaning to the hardware resources.

Fire Haxard Alert System | Arduino IDE 2.0.2

File Edit Sketch Tools Help

Arduino Uno

Fire Haxard Alert System.ino

```
#include <DHT.h>  // include the DHT library
#include <Servo.h>  // include the Servo library
#include <MQ2.h>  // include the MQ2 library

#define DHTTYPE DHT11  // specify the type of DHT sensor
#define DHT_PIN A0  // analogue pin DHT11 sensor is connected to
#define MQ2_PIN A1  // analogue pin MQ2 sensor is connected to
#define BUZZER_PIN 9  // digital pin buzzer is connected to

bool isOpen = false;  // boolean variable to track status of door

DHT dht(DHT_PIN, DHTTYPE);  // create a DHT object
Servo servo1;  // create a Servo object
Servo servo2;  // create another servo object

void setup()
{
  Serial.begin(9600); // start serial communication
  dht.begin(); // start the DHT sensor
  servo1.attach(6); // attach the servo1 to  digital pin 6
  servo2.attach(5); // attach the servo2 to digital pin 5

  pinMode(BUZZER_PIN, OUTPUT);

}

void readMQ2()
{
  // Read the data from the MQ2 sensor and print it to the serial monitor
  int sensorValue = analogRead(MQ2_PIN);
  Serial.print("Gas Concentration: ");
  Serial.println(sensorValue);

  // Update the buzzer based on the MQ2 sensor reading
  if (sensorValue > 300)
```

Figure 14 Screenshot of Code - Part 1

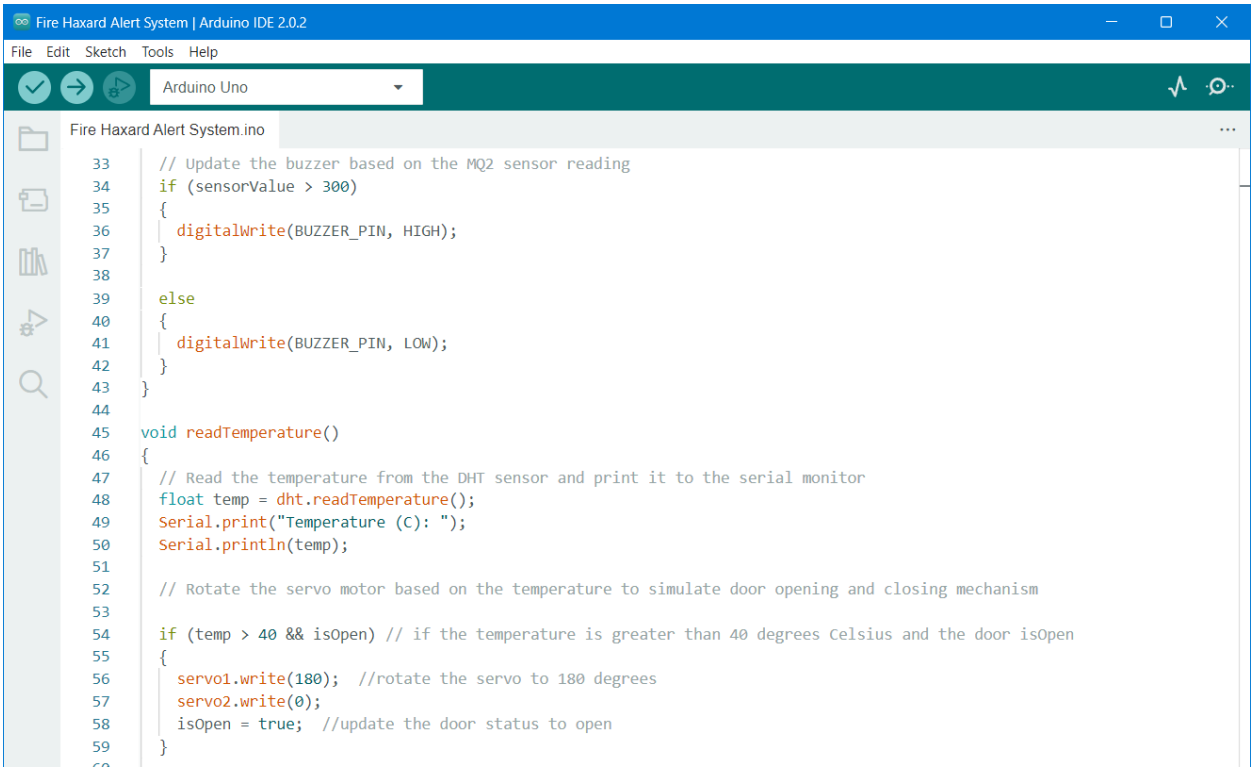

Figure 15 Screenshot of Code - Part 2

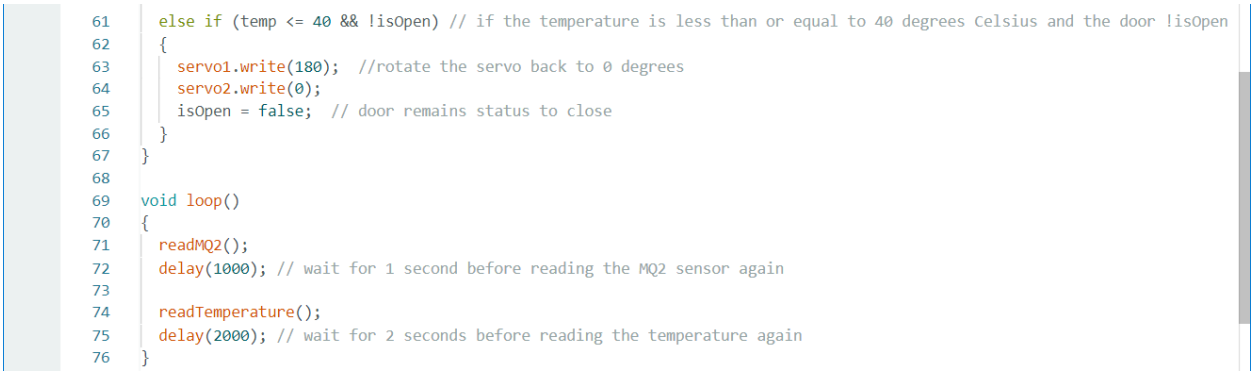

Figure 16 Screenshot of Code - Part 3

4. Results and Findings

We were able to exactly get the intended results for “Fire Hazard Alert System” which is an IoT device is one of the fire safety components to prevent the potential harm caused by gas leakage or any other fire hazards by alerting the people using a buzzer and also automatically opens the door, creating an escape route for the person in the room by sensing the increase in the temperature of the room.

4.1 Testing

4.1.1 Test 1

Table 4 Test to check if the MQ-2 sensor detects and alerts or not

Test No.	1
Objective	To alert the person when any combustible gas or smoke is detected.
Action	Releasing the combustible gas near the MQ-2 sensor using a lighter.
Expected Outcome	The buzzer would make an alerting sound when MQ-2 sensor detects combustible gas.
Actual Result	The buzzer made an alerting sound when MQ-2 sensor detected combustible gas.
Conclusion	The test was successful.

Figure 17 Screenshot of Serial Monitor showing gas concentration above threshold for Test 1

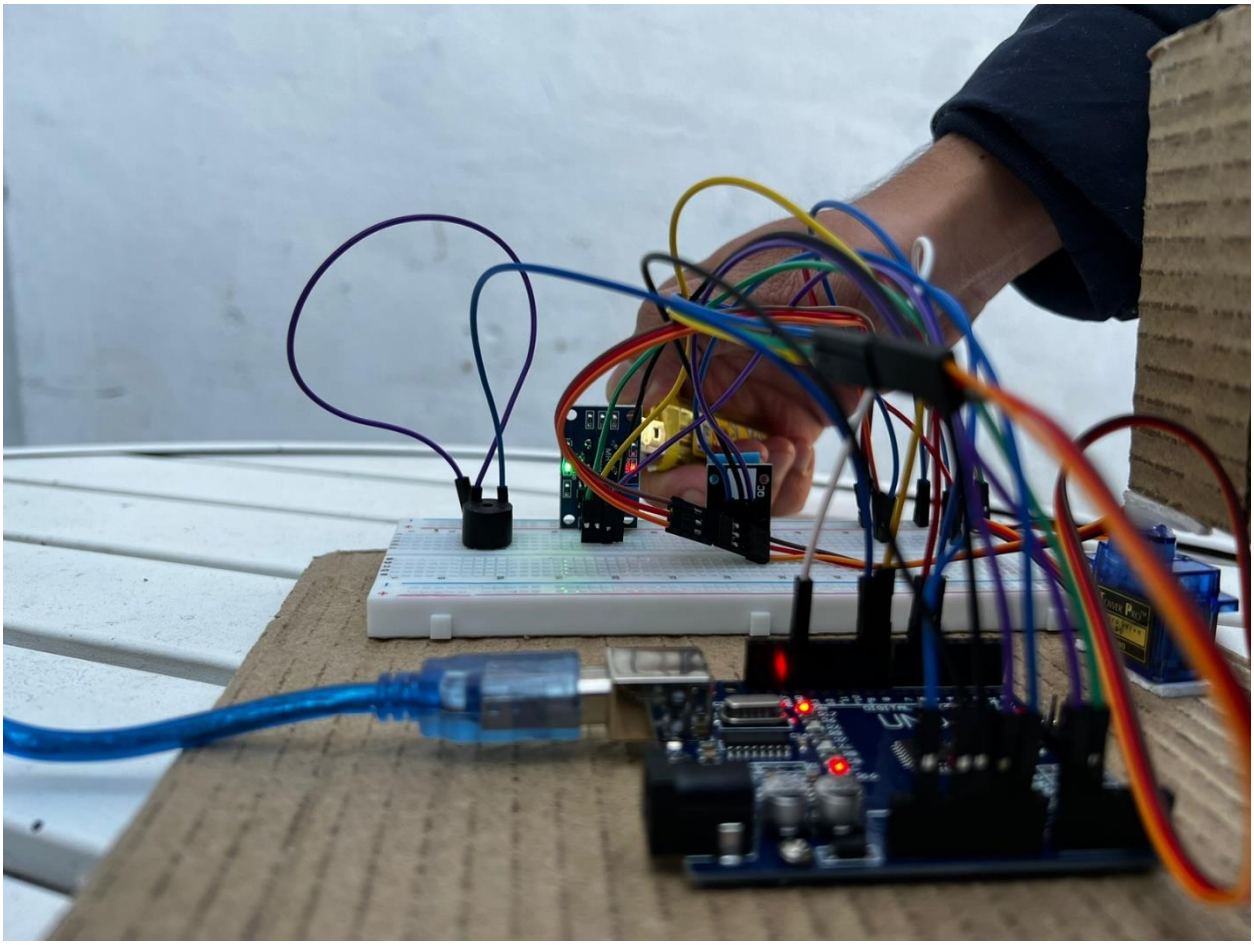

Figure 18 Picture of MQ-2 sensor detecting the combustible gas

4.1.2 Test 2

Table 5 Test to check if the motor rotates when high temperature is detected or not

Test No.	2
Objective	To simulate door opening mechanism by rotating servo motor when high temperature is detected.
Action	Keeping the burning lighter near the DHT-11 sensor to increase the nearby temperature.
Expected Outcome	The servo motor would rotate and represent the opening of a door when high temperature is detected.
Actual Result	The servo motor rotated which represented the opening of a door when high temperature was detected.
Conclusion	The test was successful.

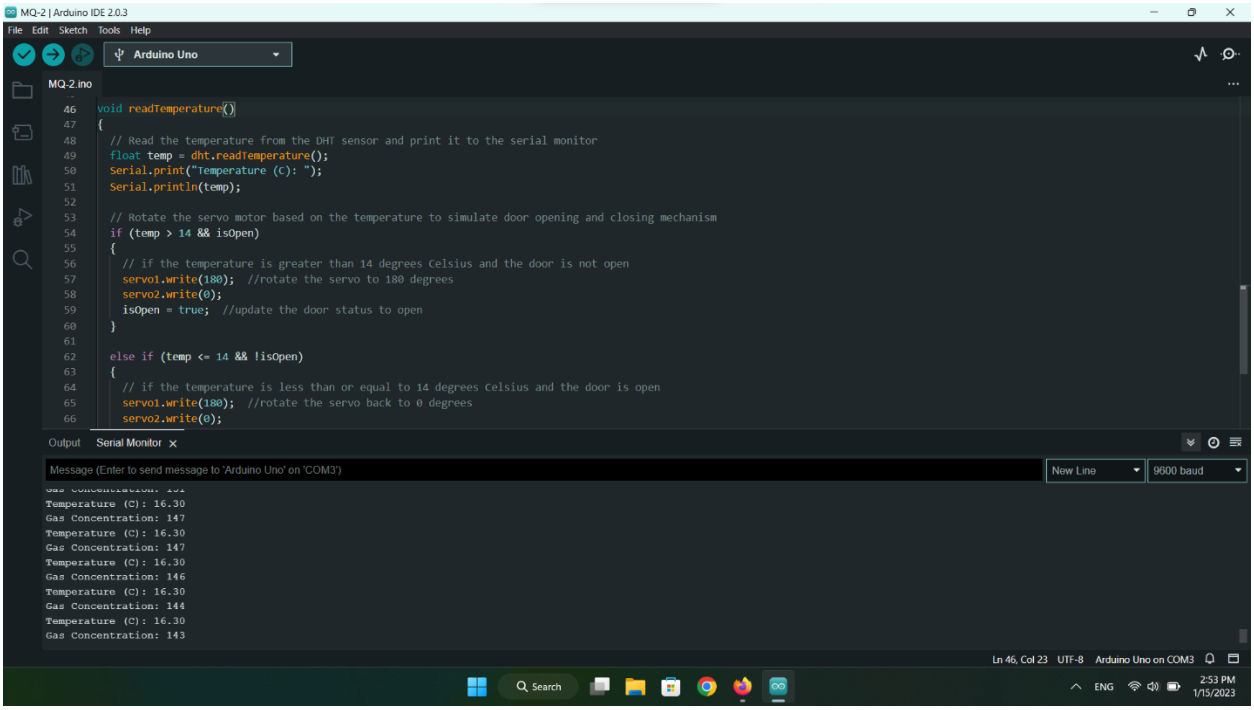

Figure 19 Screenshot of Serial Monitor showing temperature above the threshold for Test 2

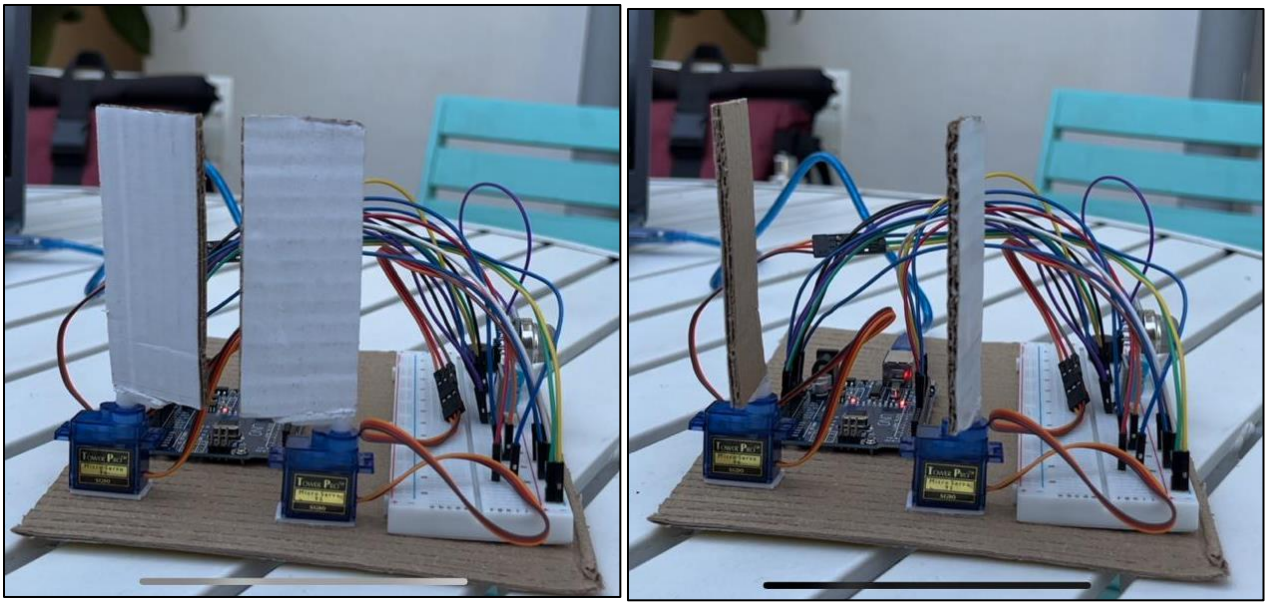

Figure 20 Servo motor representing door opens when high temperature is detected as in the pictures

5. Future Works

There is always room for improvements and new better updates to improve the already fully functional Fire Hazard Alert System. There are few things that can be added in the future to make it more convenient and user friendly. LCD display can be added to display the readings of temperature and humidity.

We can add WIFI module and connect it to our devices which will make it possible to get notified on our phone if there are any gas leakage or fire outbreak. We can also make it to automatically notify our close relatives or friends if there is any occurrence of fire hazards. If there are any fire outbreaks then we can make it possible for the system to notify and give tips to the person to get to safety and prevent from any possible danger. We can use better sensor for more accurate readings so that there aren't any wrong readings and fake alerts which will cause panic to the people. Making it possible to display the type of gas or smoke it detects and notify the users.

6. Conclusion

Fire Hazard Alert System- an IoT device is one of the fire safety components that can detect various types of combustible gases and smokes and alert you about the fire hazard and also automatically opens the door of the room by sensing the increase in the temperature in the room when there is a fire breakout and create an escape route which is mainly used for preventing all the danger to the person's life.

Even though we are in the process of completing this project there is lot of research and learning from this project which gave us in-depth insights on IoT devices, Arduino UNO and use of many other various. Our Tutor explained and helped us with all the problems and process for making this IoT device. This research was more practical and knowledgeable.

There is a lot of research and learning from this project which gave us in-depth insights into IoT devices, Arduino UNO and the use of many other variables. Our Tutor explained and helped us with all the problems and processes for making this IoT device. This research was more practical and knowledgeable.

The three cores of this project were research, creativity and development. Our team could build this potentially essential IoT device because of these three major aspects. The team members went through a lot of research about IoT devices, their requirements for development and the development processes. Our aim was to find a project concept which could be presented in a basic form and also be executed on a larger scale in the future with more hardware and software resources so the Fire Hazard Alert System was selected. Through the device developing phase, the team became familiar with the Arduino hardware and software, Breadboards, and all the other components used in the project and how to make them all work together to build a life-saving technology.

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8. Appendix

8.1 Appendix A: Source Code

```
#include <DHT.h>
#include <Servo.h>
#include <MQ2.h>

#define DHTTYPE DHT11
#define DHT_PIN A0
#define MQ2_PIN A1
#define BUZZER_PIN 9

bool isOpen = false;

DHT dht(DHT_PIN, DHTTYPE);
Servo servo1;
Servo servo2;

void setup()
{
  Serial.begin(9600);
  dht.begin();
  servo1.attach(6);
  servo2.attach(5);

  pinMode(BUZZER_PIN, OUTPUT);

}
```

```
void readMQ2()
{
  int sensorValue = analogRead(MQ2_PIN);
  Serial.print("Gas Concentration: ");
  Serial.println(sensorValue);

  if (sensorValue > 300)
  {
    digitalWrite(BUZZER_PIN, HIGH);
  }

  else
  {
    digitalWrite(BUZZER_PIN, LOW);
  }
}

void readTemperature()
{
  float temp = dht.readTemperature();
  Serial.print("Temperature (C): ");
  Serial.println(temp);

  if (temp > 40 && isOpen)
  {
    servo1.write(180);
    servo2.write(0);
```

```
    isOpen = true;
  }

  else if (temp <= 40 && !isOpen)
  {
    servo1.write(180);
    servo2.write(0);
    isOpen = false;
  }
}

void loop()
{
  readMQ2();
  delay(1000);

  readTemperature();
  delay(2000);

}
```

8.2 Appendix B: Design Diagrams

8.2.1 Block Diagram

The diagrams below showcase the block diagram of this Fire hazard Alert System:

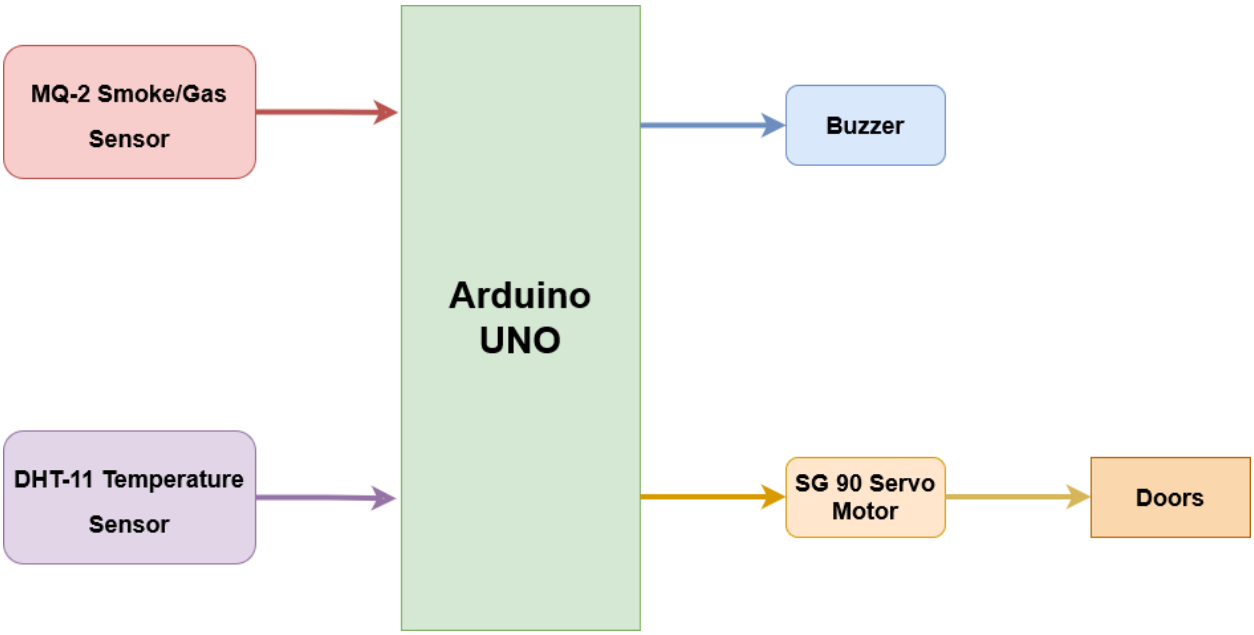

Figure 21 Block Diagram of Fire Hazard Alert System

8.2.2 Individual Contribution Plan

This is the pictorial representation of the distribution of the individual task to keep it simple and more understandable.

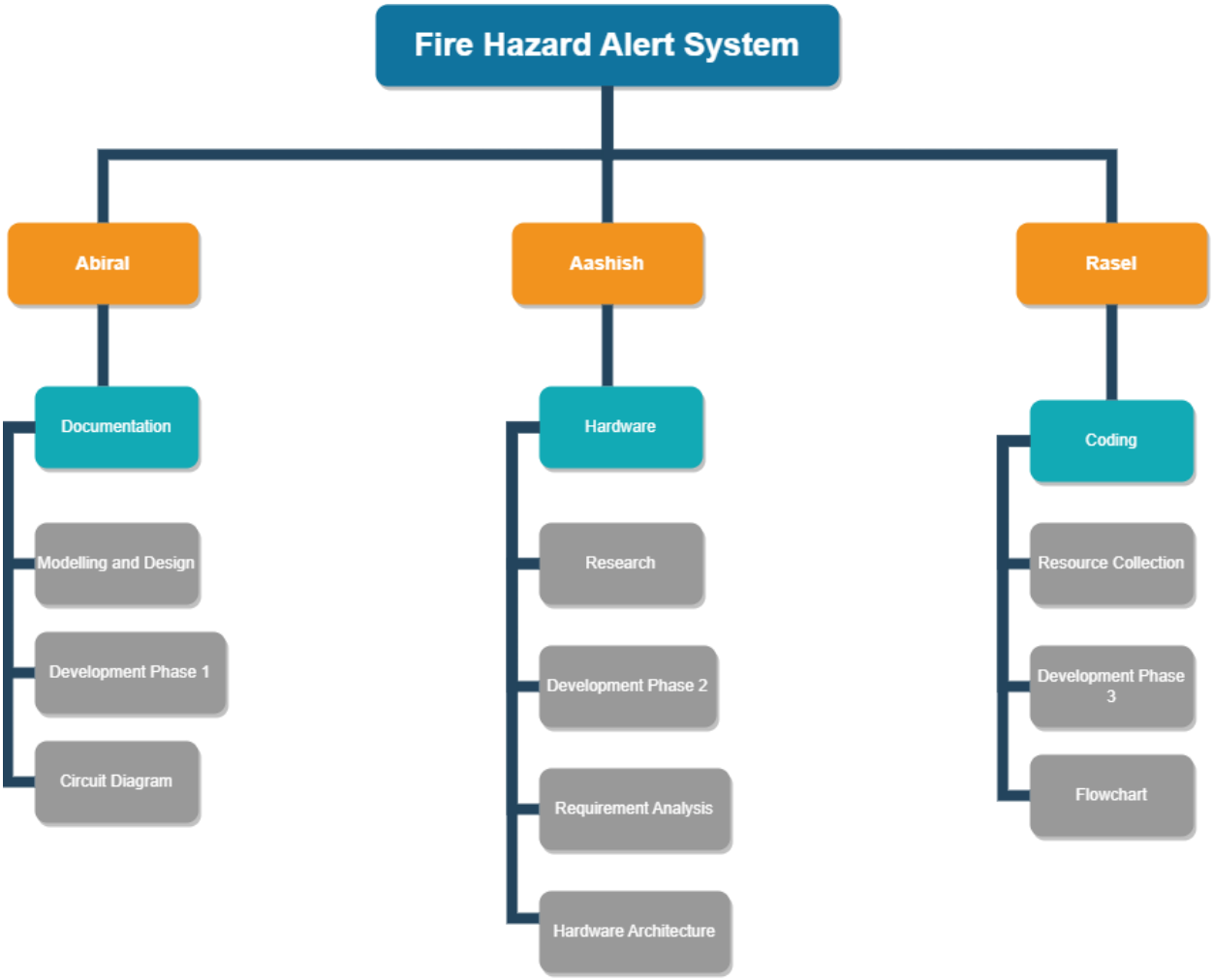

Figure 22 Individual Contribution Plan