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CS5053NI/CC5068NI– Cloud Computing & IoT

Fire Detection System

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Group members

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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgement

We would like to express gratitude towards Module leader Sugat Man Shakya and our tutor Ayush Pradhanang for providing us with an opportunity to collaboratively develop a IOT based project for understanding how such devices function. We would also like to thank ever senior and colleagues who helped us during our need. Our team has developed a prototype for Fire detection which will be helpful in preventing fire hazards from harming the human life.

We as a team have developed and worked together with multiple ideas and knowledge which has helped us understand much more about the concepts of Internet of Things.

Abstract

Flame detectors are essential fire safety equipment that identify fires before they start by employing technologies like infrared sensors. We receive numerous reports of fires during the winter for various reasons. If we place fire sensors in our homes, schools, hospitals, or on any other equipment that has the potential to catch fire, we can prevent fatalities and save priceless property. These gadgets serve as the first line of defense, spotting the flicker of a budding flame before it explodes into a conflagration, thanks to the unwavering eye of infrared sensors. This research explores the many uses and technical improvements of flame detectors, from investigating various sensing technologies to tackling industrial difficulties like oil pipeline fires, with the ultimate goal of guiding us in selecting the optimal fire safety solution.

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1. Introduction

1.1. Introduction to the project

The Internet of Things, or IoT, is a paradigm shift that connects everyday objects, sensors, and physical devices so they can exchange data and communicate with each other over the internet. Smart cities and homes, as well as industrial automation and healthcare, are made possible by this networked web of intelligent devices. Internet of Things (IoT) offers new opportunities for automation and innovation in addition to increasing efficiency through the collection, analysis, and sharing of real-time data. IoT is having a profound effect on many different industries as it develops, changing the way we interact with our environment and opening the door to a world that is more intelligent and connected.

The application of Internet of Things (IoT) flame detection technology is a significant development in fire safety. Flame Detection IoT systems seek to transform early fire detection and response by incorporating smart sensors and networked devices. By utilizing real-time data analytics and remote monitoring capabilities, these intelligent systems surpass conventional approaches by promptly detecting possible fire incidents. The combination of flame detection and IoT reduces response times and lessens the impact of fires by enabling proactive measures in addition to improving alert reliability. By strategically utilizing linked devices to improve fire prevention and emergency response capabilities, this technological intersection greatly contributes to the creation of safer environments, from homes to workplaces.

1.1.1. Current Scenario

In order to provide accurate and timely fire safety, flame detection technology has greatly advanced, placing an emphasis on IoT integration, sophisticated sensors, and AI. Real-time data analysis is a key component of IoT-enabled flame detection systems, which guarantees quick and precise identification of possible fire incidents. The goal of innovations is to reduce false alarms by

using complex algorithms. These solutions are used by industries to satisfy particular needs in challenging circumstances.

In current context of Nepal, 18,722 fire incidents have taken place in Nepal from 2014 AD to March 2023 as per National Disaster Risk Reduction and Management Authority. These incidents have caused lives of 769 innocent lives. Forest fires and other fire hazards has caused death of almost 100 peoples every year on average (TheHimalayanTimes, 2023).

1.1.2. Problem Statement and Project as a Solution

The increasing number of fire incidents presents a serious risk, with significant loss of life and property. This problem affects people personally and calls into question the effectiveness of current fire safety protocols. Conventional fire detection systems frequently fall short in terms of prompt identification and action. Our project intends to present a flame detection solution to address this urgent challenge. With the use of cutting-edge technologies, such as data analytics and IoT-enabled sensors, our suggested system aims to improve flame detection’s accuracy and responsiveness. This initiative recognizes the global urgency to reduce the devastating impact of fires, extending beyond geographic boundaries. We hope that this project will help to increase fire safety on a larger scale.

1.2. Aims and Objectives

1.2.1. Aims

The main aim for this project is ensuring early and accurate identification of potential fire incidents in a variety of environments. This vital safety technology aims to reduce response times, stop fires from spreading, and lessen possible harm to people and property.

1.2.2. Objectives

The objectives of this project are given as follows.

a) **Enhance Localized Safety:** Develop IoT-based flame detection systems focused on improving safety within specific environments, ensuring timely response and protection without relying on remote monitoring.

b) **Real-time Alerting:** Use local alarm systems to promptly detect and notify anyone nearby of fires. This will allow for the prompt implementation of containment or evacuation procedures.

c) **Energy-Efficient Operation:** Give energy efficiency top priority when designing Internet of Things devices for flame detection; by maximizing power consumption, you can prolong system lifespan and lessen environmental impact.

d) **User-Friendly Operation:** Provide flame detection systems that are simple to use and intuitive so that end users can respond to alerts and take necessary safety precautions with little to no training.

2. Background

2.1. System Overview

Flame detectors are pivotal components of modern fire safety systems, designed to promptly identify and respond to potential fire hazards. Evolving from early industrial sensors, these detectors operate on optical, infrared, and ultraviolet principles, distinguishing flames from background heat sources. Deployed across industries, from manufacturing to aerospace, flame detectors have seen recent advancements with smart systems and IoT integration, enhancing accuracy and connectivity. Their ongoing development reflects a commitment to bolstering fire safety in diverse environments.

This flame detection system, employs a synergy of hardware and software components, anticipates efficient functionality and reliable fire detection. The hardware components, including the Arduino UNO R3 microcontroller, infrared flame sensor, jumper wires, breadboard, buzzer, LED bulb, and resistors, form a comprehensive setup for sensing and responding to the presence of flames. The infrared flame sensor, connected to the Arduino UNO R3 microcontroller through jumper wires on a breadboard, captures infrared radiation emitted by a flame. The Arduino IDE facilitates the development of a program that interprets the sensor data. Upon detecting a flame, the Arduino triggers a response: activating the buzzer to audibly signal the presence of fire and illuminating the LED bulb for visual indication.

2.2. Diagrams

2.2.1. Block Diagram

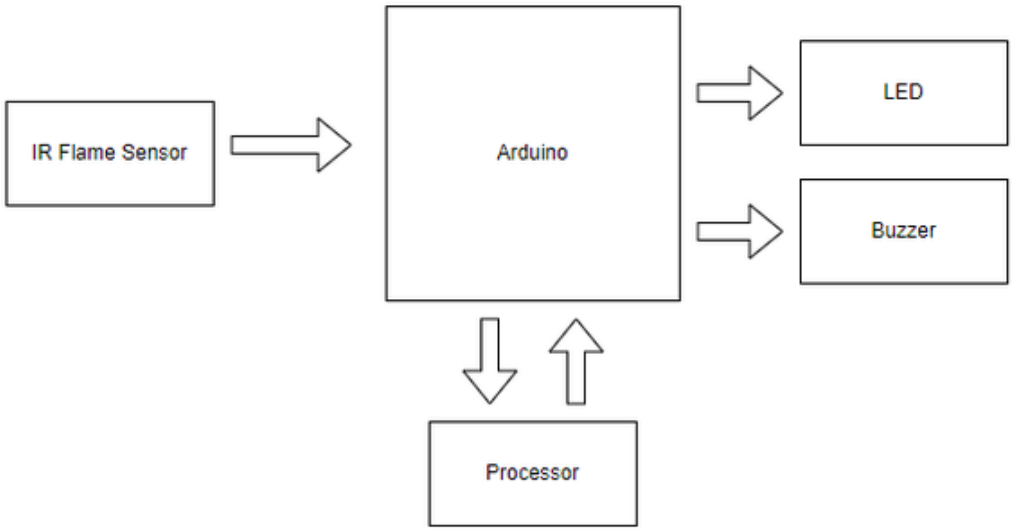

Figure 1 Block diagram

2.2.2. Flow Chart

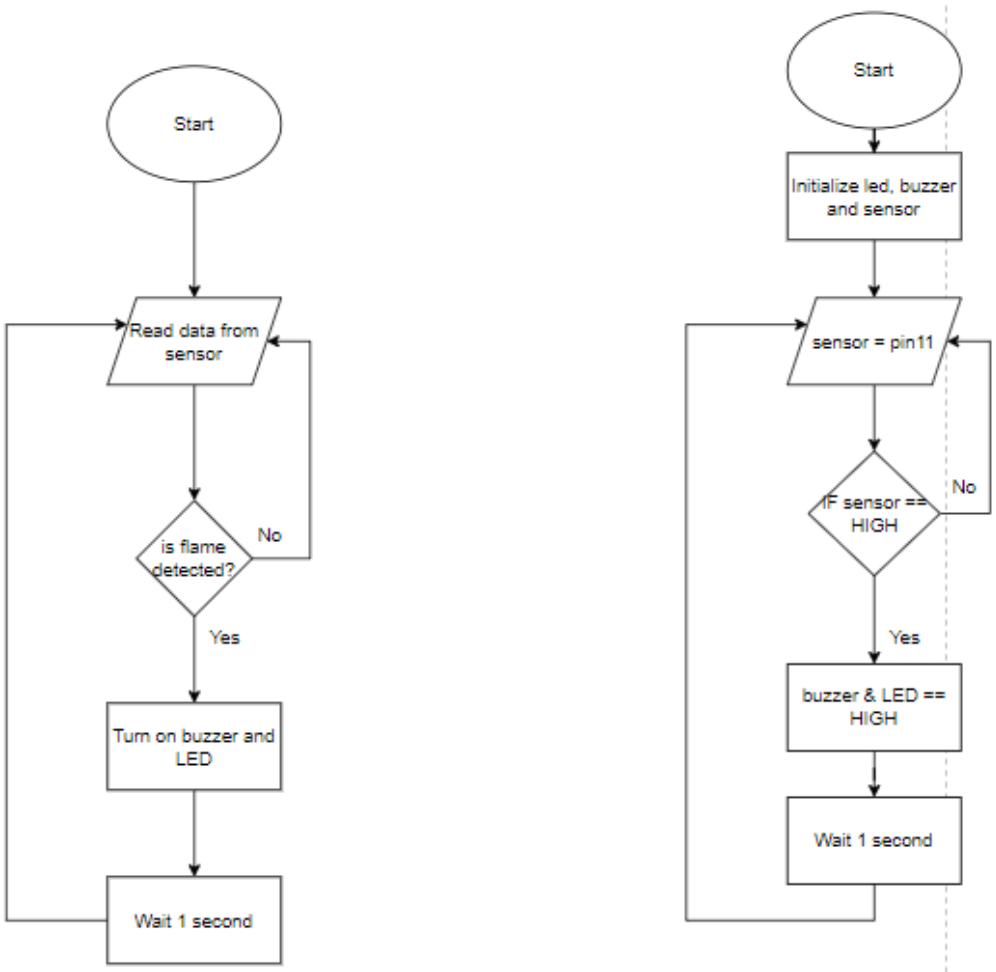

Figure 2 Flow chart of our application and code.

2.2.3. Schematic Diagram

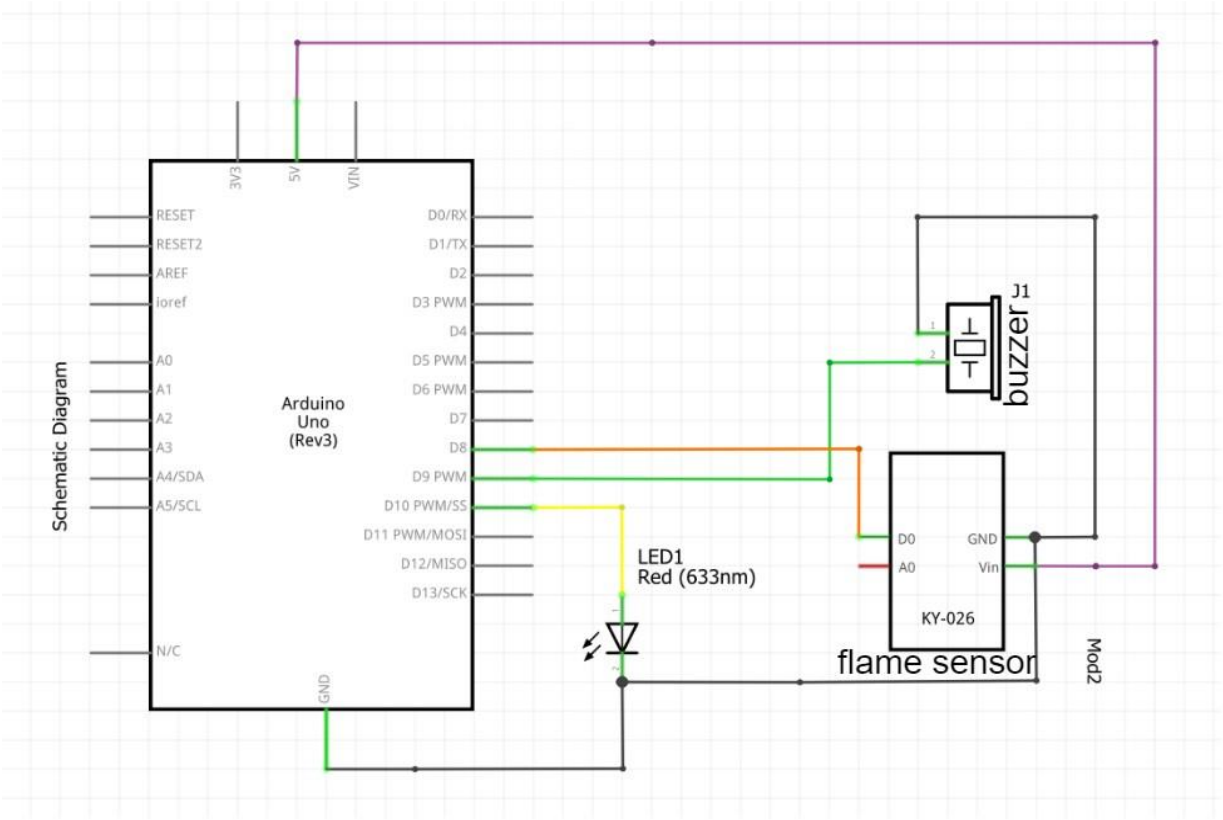

Figure 3 Schematic diagram

2.2.4. Circuit Design

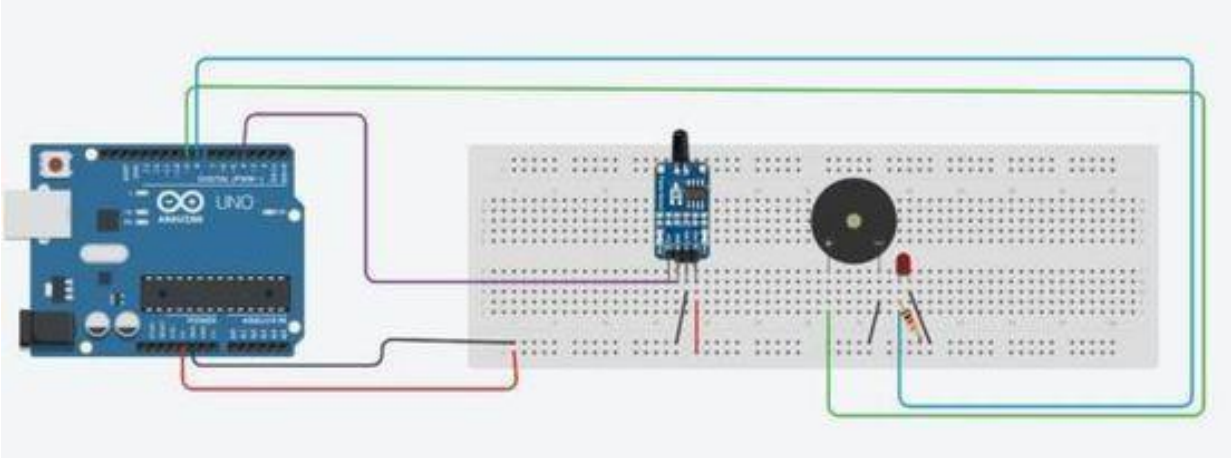

Figure 4 System circuit design.

2.2.5. System Architecture

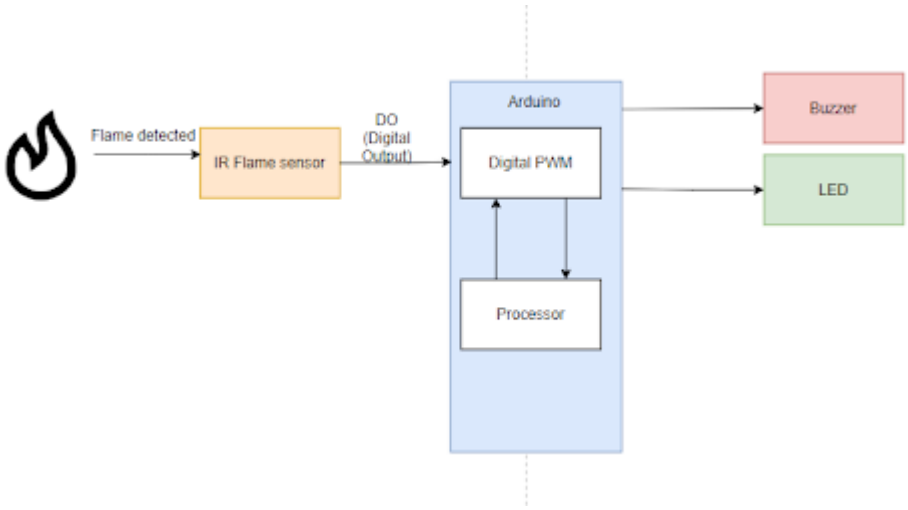

Figure 5 System Architecture.

2.3. Requirement Analysis

2.3.1. Software Requirements

a) **Arduino IDE**
b) **Tinkercad:**
c) **Fritzing**

2.3.2. Hardware Requirements

a) **Arduino UNO R3:** The Arduino UNO R3 is a circuit board that uses a microcontroller chip. It is an open-source electronics platform and a collection of microcontroller boards used for prototyping and developing interactive electrical creations. The Arduino platform offers a simple and adaptable environment for both novice and expert developers to interact with hardware and construct projects including sensors, actuators, and other electrical components. It features a resonator, analog inputs, input/ output pins, a USB port, a power jack, and a reset button. It is an excellent hardware tool for novices to use to develop various variety of IOT Systems. This can be used with the help of Arduino IDE where the code will be written (Arduino, 2021).

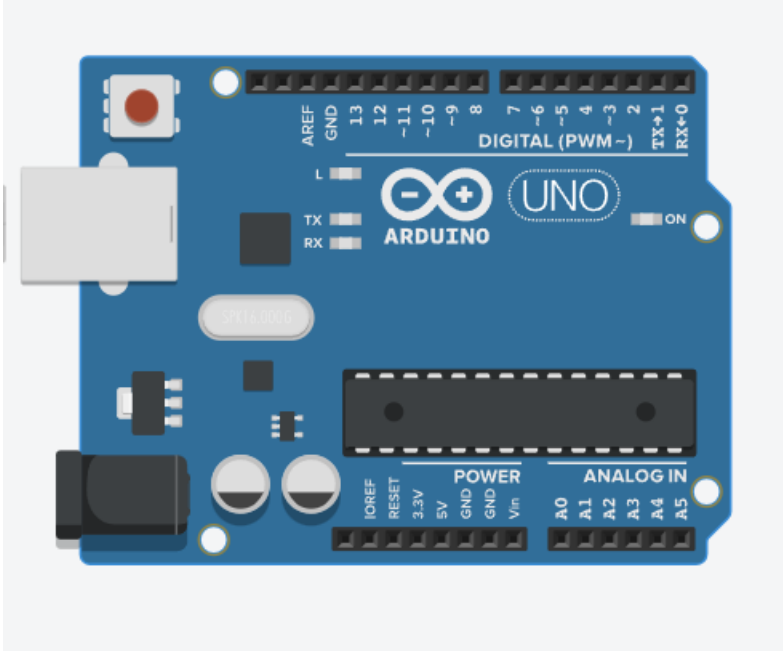

Figure 6:Arduino

b) **Jumper Wire:** Jumper wires are essentially known as simple electrical wires with connectors at each end which allows for connections between sensors, actuators, circuit boards and breadboard.

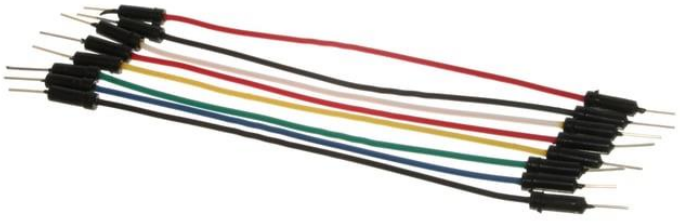

Figure 7: Jumper wire

c) **Infrared (IR) Flame Sensor:** IR Flame sensor is one of the crucial components in fire detection system which detects the presence of fire.

It uses the power of infrared technology to detect the specific heat signature emitted by flames or fire. An emitter, a detector, and related electronics make up an infrared sensor. The emitter circuit and the receiver circuit are the two circuits needed to create an infrared sensor (Hub, 2018).

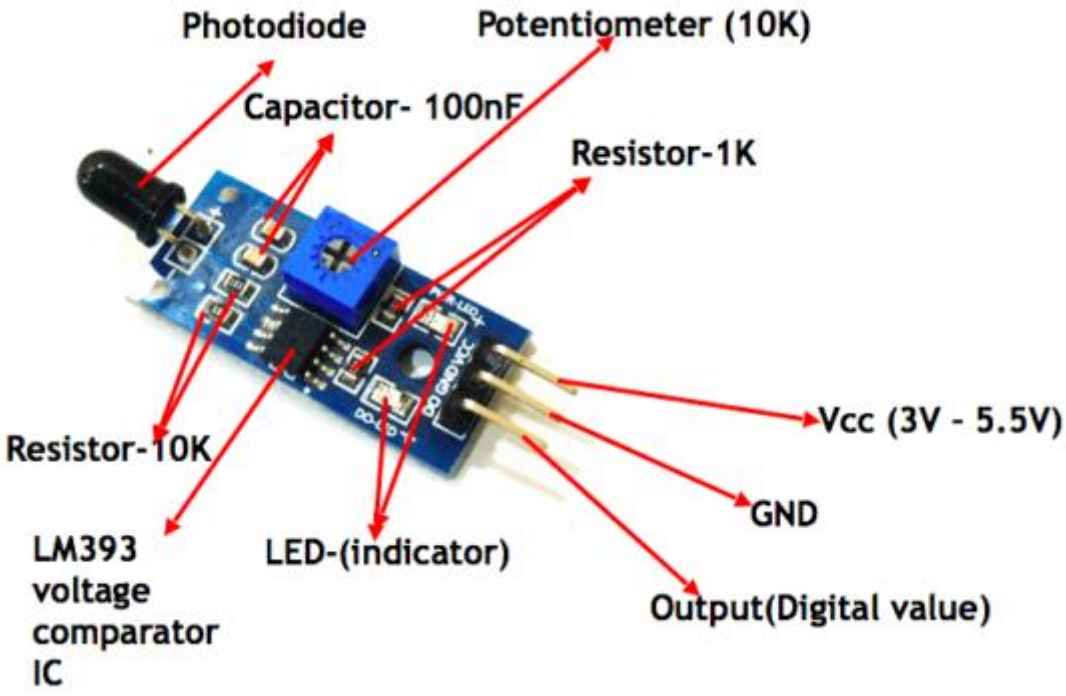

Figure 8: Flame sensor

d) **Breadboard:** A Breadboard is a board base used to temporarily build electronic circuits and plug in electronic parts as building blocks, without needing to solder. It serves as a temporary construction platform, allowing you to easily insert and remove components like resistors, capacitors, transistors, and integrated circuits (ICs) by simply pushing their leads into the hole The hole in the board takes care of the flow of electric current (CircuitBread, 2019).

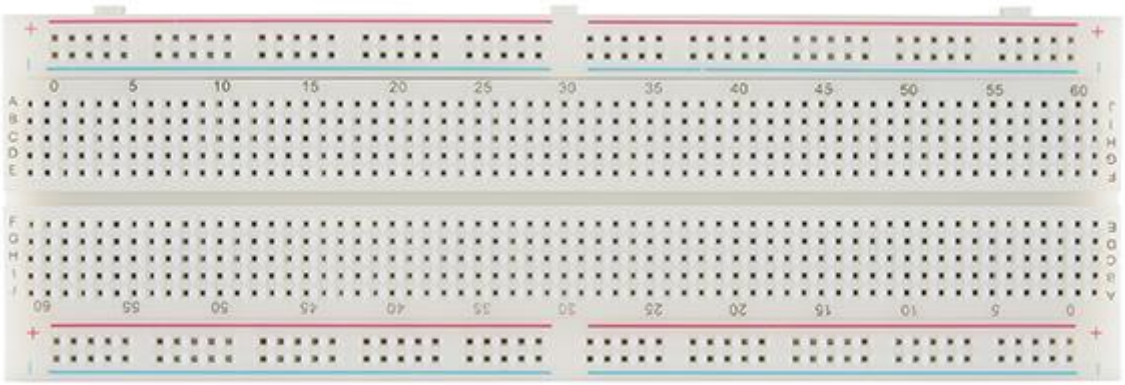

Figure 9: Breadboard

e) Buzzer: A buzzer is a small electronic device which generates sound on the input given to the device. It is intended to produce audio alerts or notifications in a variety of applications, providing consumers with an easy-to-use and efficient means of receiving information. Buzzers are a versatile and affordable tool that adds to any project and provide audio feedback.

Figure 10: Buzzer

f) LED Bulb: An LED bulb is a light emitting diode bulb is a semiconductor device that emits light by emitting photons when current flows through it which utilizes solid state technology to generate light.

Figure 11:LED Bulb

3. Development

3.1. Planning and Designing

First of all, every team member gathered together to finalize the topic of the IOT project. We had initially planned for creating an Irrigation System but due to various factors, we had to divert to Fire Detection System. As we discussed through multiple project ideas, we considered the project ideas that were not seen popularly on a daily basis. Fire detection system is a module that most of the people have ignored as their need for safety. Some of the businesses with advance environment have used fire detection system but the local business has ignored such precautions which cause them extreme losses.

As we finalized the topic for our project, every team member gathered to create a sample design using Canva. We finalized the components which included IR flame sensor, Arduino UNO R3, Breadboard, buzzer, LED bulb and jumper wires. We started the initial design process by creating a simple block diagram which shows the flow of the system. The diagram we concluded with is given below.

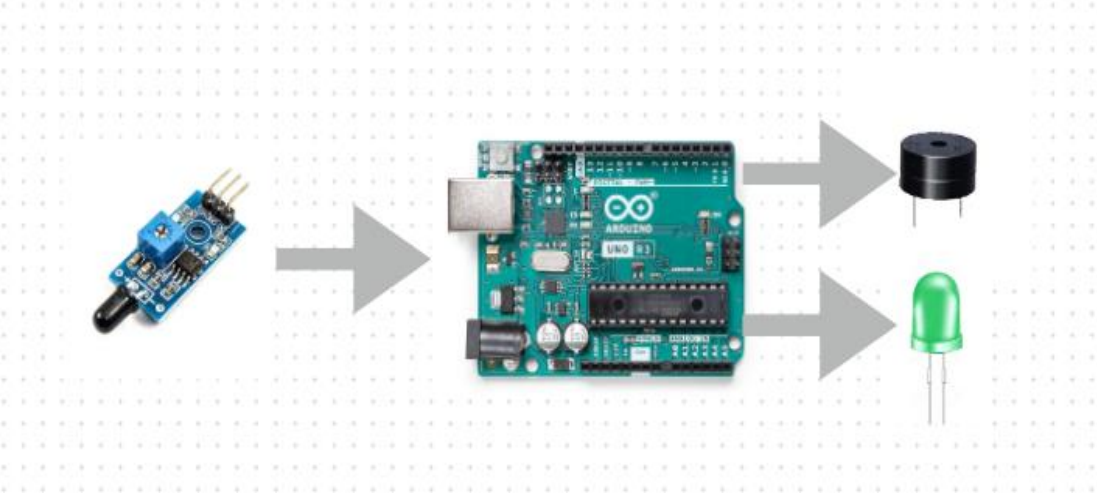

Figure 12 Initial system overview.

3.2. Resource Collection

For collecting all the components that we require in this project, we wrote a letter to the resource department of Islington College with a signature from Cloud Computing and Internet of Things module leader Mr. Shishir Subedi. We were informed that IR flame sensor was not available in the department, and we had to collect it from external sources. We were able to collect every other component (Arduino Uno, jumper wires, buzzer, LEDs) from our college. So, we contacted various stores and outlets and got a good deal from Himalayan Solutions. Our team leader (Rishan Chhunju) took the responsibility for collecting the sensor.

3.3. System Development

Step 1: In the development process of our prototype, we have assembled the system as we did in the tinker cad. First of all, we connected the Arduino to the breadboard so that components can be connected without the need of soldering.

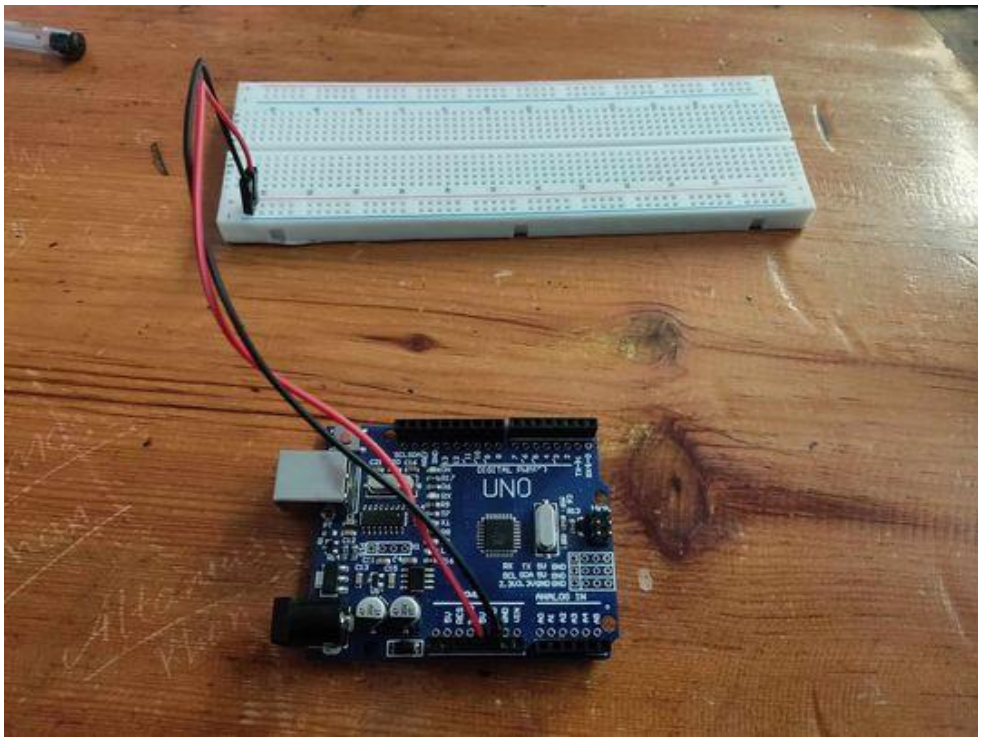

Figure 13 Connecting arduino to breadboard.

Step 2: We connected the sensor's positive and negative side to the breadboard and the digital output (DO) pin was connected to pin 11 in the Arduino.

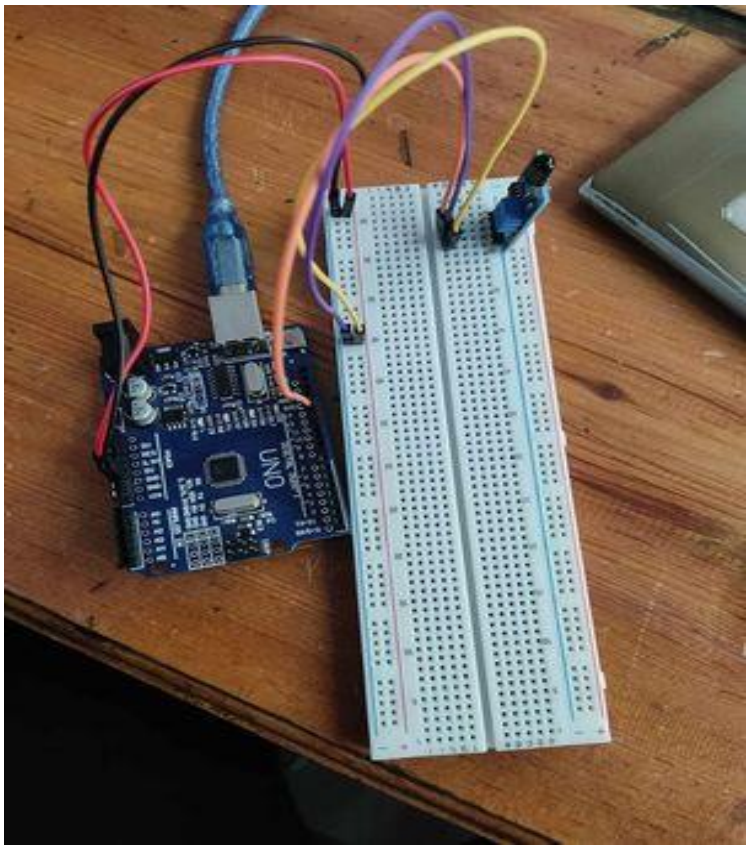

Figure 14 Connecting sensor to the system.

Step 3: The buzzer was then connected to the breadboard. The negative side was connected to the breadboard's negative side and positive to pin number 10 in the Arduino.

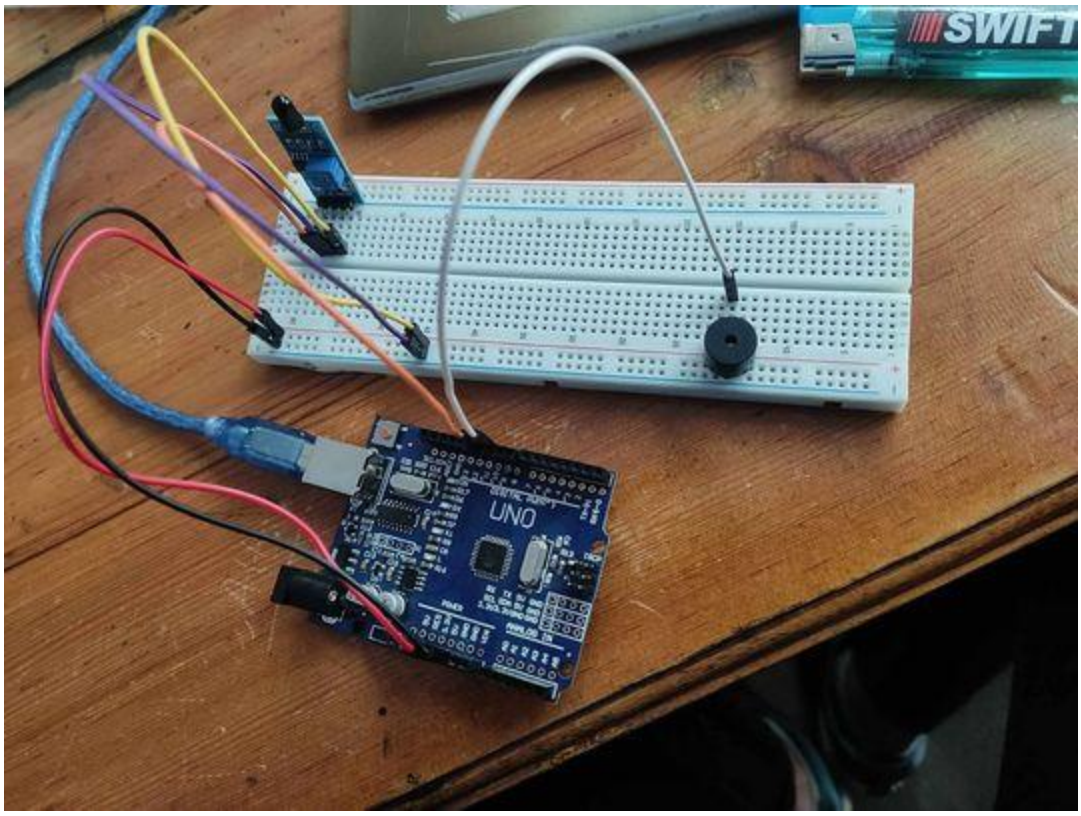

Figure 15 Connecting buzzer in the arduino

Step 4: The LED was also connected to the breadboard as similar as buzzer, but the positive side was also assisted with a resistor. The positive side was then connected to the pin 9 of Arduino.

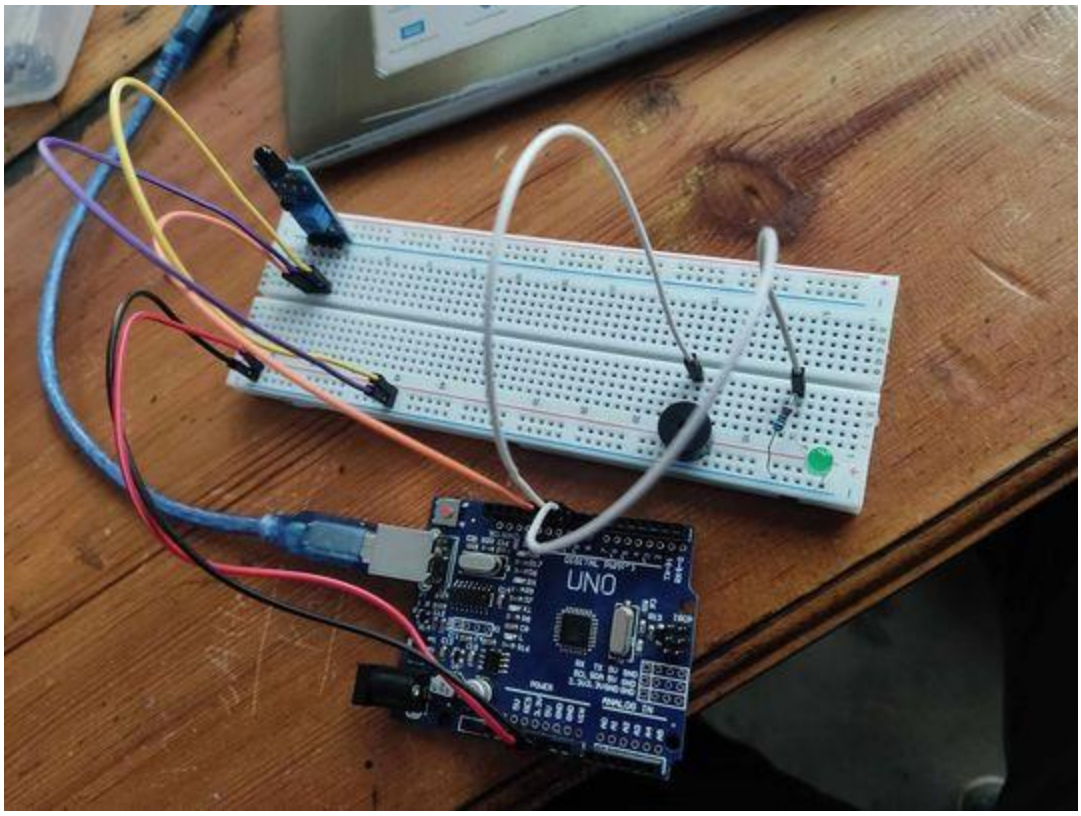

Figure 16 Connecting LED to the system.

The pin connection is given below:

Component name	Pin name	Breadboard	Arduino
Flame sensor	VCC GND DO	+ve -ve	 Digital (11)
Buzzer	+ve -ve	 -ve	Digital (10)
LED	+ve -ve	 -ve	Digital (9)

4. Results and finding

4.1. Results

The flame detection device uses compatible hardware and software components, predicting performance and fire detection. Hardware components which consist of the Arduino UNO R3 microcontroller, infrared flame sensor, jumper twine, breadboard, buzzer, LED bulbs, and resistors form a complete machine for sensing and responding to the presence of flames. The Arduino IDE which is as software program is a crucial component that guarantees clean code, compilation and upload to Arduino UNO R3, This combination of hardware and software program additives allows unique manage of detection algorithms and correct interpretation of infrared indicators of flame sensors, triggering the perfect response through buzzers and LED bulbs ,through the integration of hardware and software components the system's framework and working conditions are completed which also allows for real-time monitoring and adaptation, thereby fulfilling the expectations of a well-built flame detection device.

A flame sensor is a basic heat detector that uses infrared technology to detect the presence of flames. The working of this flame detector Arduino is almost like that of IR sensor interface but there is a difference instead of IR light emitted by IR emitter the IR light coming out the fire is detected, which is then amplified, digital and analog signal then is sent to the microcontroller to do further processing. The sensor also has an onboard power and an onboard LED status which will blink whenever the sensor detects fire in its provided radius. Finally, then the sensor will provide both visual and analog output to the given user.

4.2. Testing

Test no.	1
Objectives	To check the flow of power supply to the sensor through Arduino and breadboard.
Action Required	The sensor was connected to Arduino and breadboard.
Input	Arduino is connected to the laptop for power supply.
Expected Result	The sensor should be activated by turning on its light.
Conclusion	The sensor was activated, and the light was turned on.

Table 1 Test 1

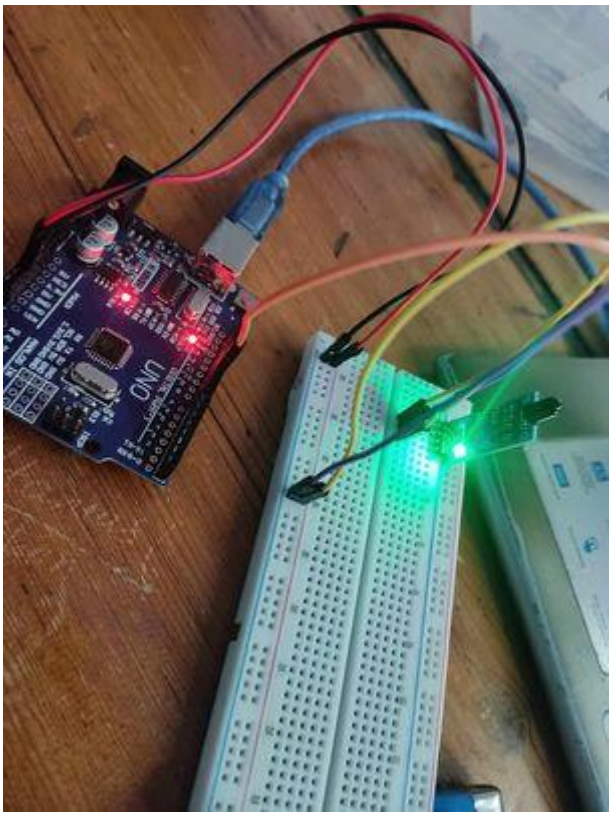

Figure 17 Testing sensor.

Test no.	2
Objectives	To connect every component and establish a power supply.
Action Required	The led and buzzer were connected to positive side of the breadboard for testing.
Input	Arduino is connected to the laptop for power supply.
Expected Result	Each component should have a flow of current.
Conclusion	The components had a power supply.

Table 2 Test 2

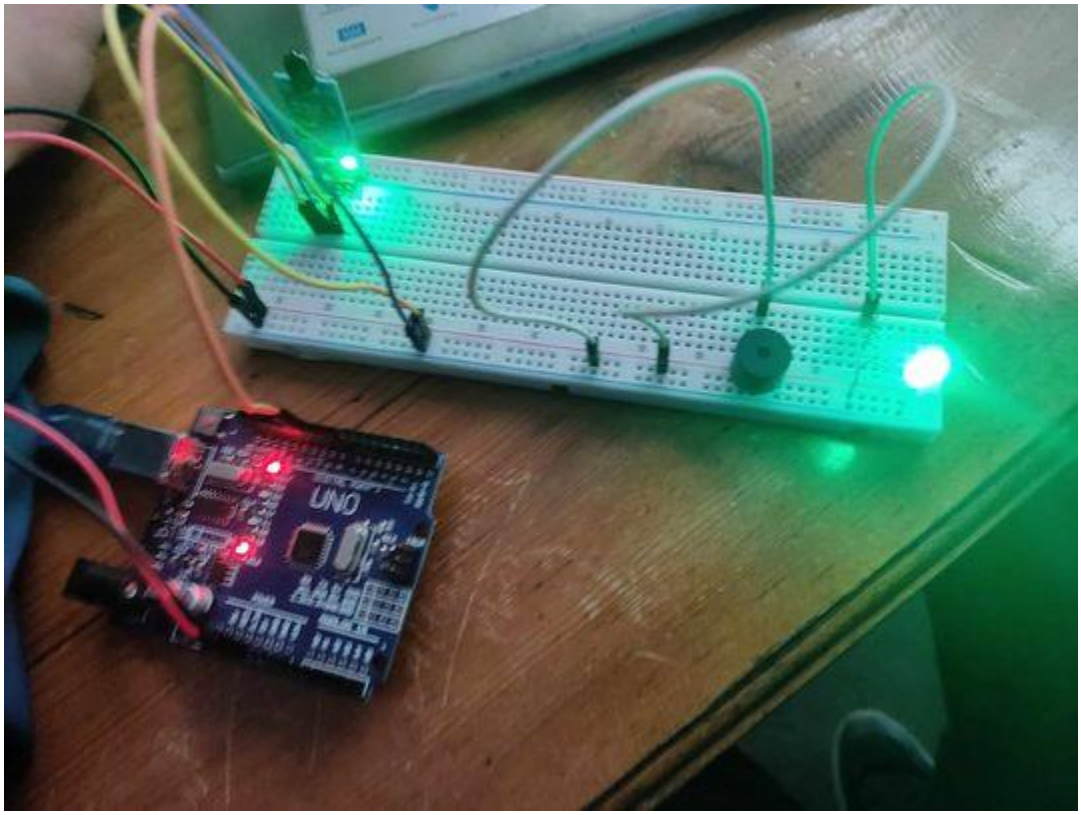

Figure 18 Testing actuators.

Test no.	3
Objectives	To successfully compile and upload the code to the Arduino.
Action Required	The code is written in the Arduino IDE and uploaded to Arduino circuit board.
Input	The code written in Arduino IDE was uploaded in the Arduino.
Expected Result	Code compiles and uploads to the Arduino successfully.
Conclusion	The code is compiled and uploaded the Arduino.

Table 3 Test 3

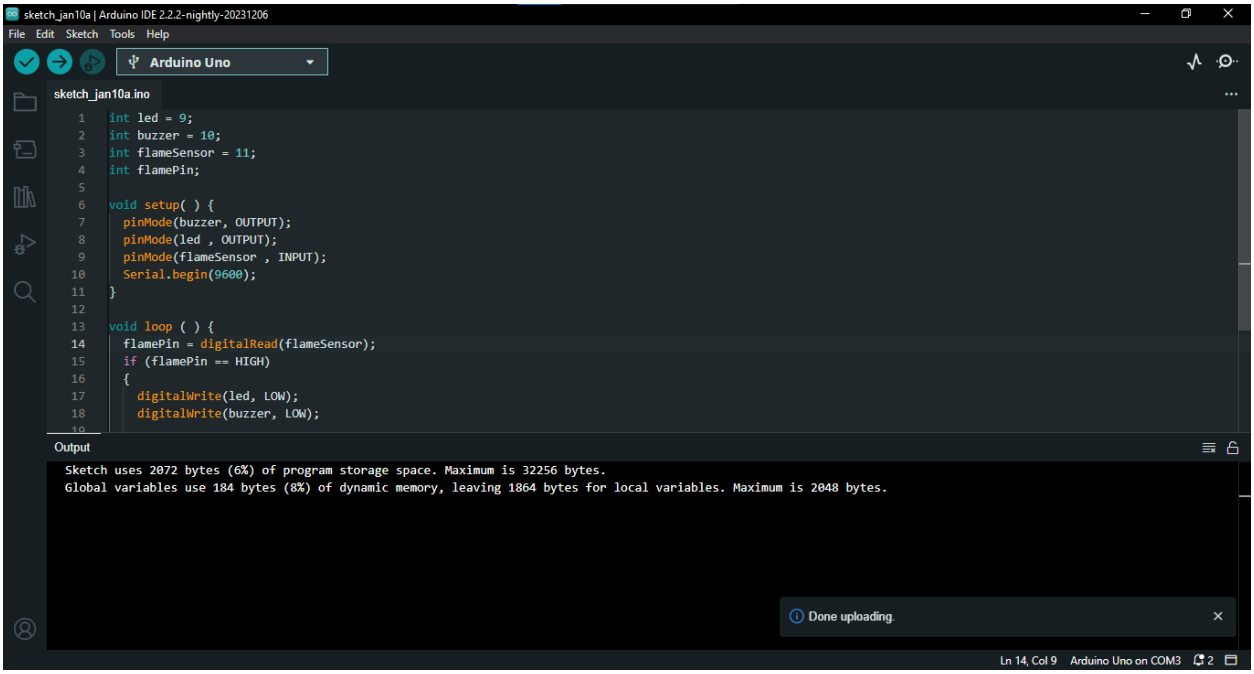

Figure 19 Uploading code to Arduino.

Test no.	4
Objectives	To check if the sensor could detect the fire and if the actuators could be enabled alongside.
Action Required	Now the positive side of buzzer and led are connected to Arduino.
Input	A fire is made with the lighter.
Expected Result	The sensor should be able to detect it and the buzzer and led should be enabled.
Conclusion	The sensor was able to detect it and the actuators were enabled.

Table 4 Test 4

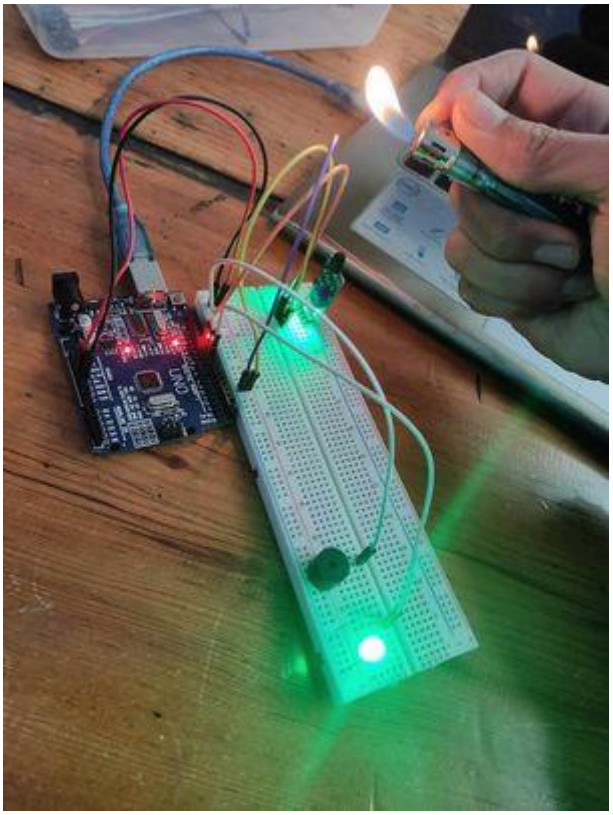

Figure 20 Successful testing of the system.

Test no.	5
Objectives	To check if the sensor will detect the fire from a longer distance.
Action Required	A lighter is used to simulate a small fire.
Input	A small fire is made.
Expected Result	The fire should be detected.
Conclusion	The fire was not detected.

Table 5 Test 5

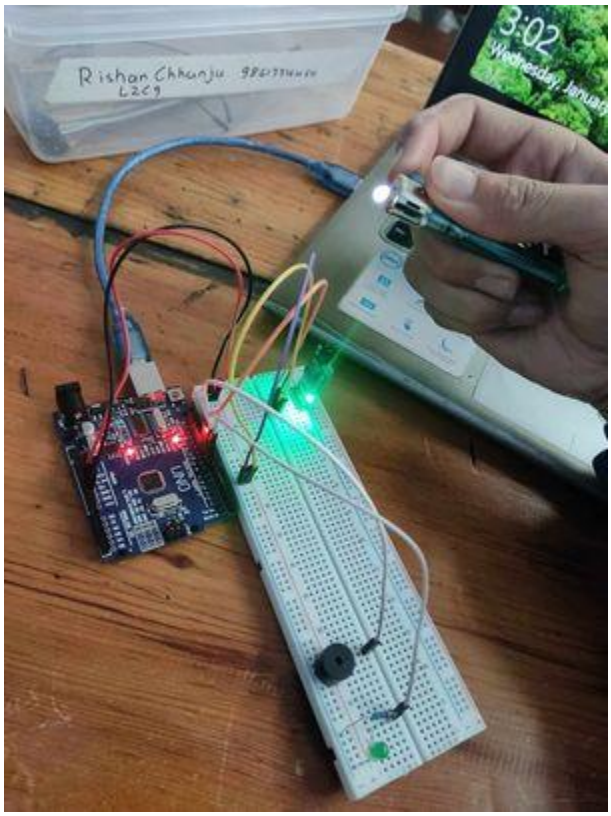

Figure 21 Testing the system with smaller fire.

5. Future works

As we dive deeper into our IoT assignment associated with flame detection integrated with the usage of Arduino, there are various diverse ways for this project to excel and be superior in the future. Firstly, upgrading to a higher quality of flame sensor could make the precision of flame detection drastically higher. As the device adapts and gets to know techniques for recognizing flame patterns, the precision of our flame detecting machine will further be greater allowing it to alter more intelligently to various environmental conditions as well as be able to analyze from those scenarios.

Additionally, integration of environmental sensors, including temperature and humidity sensors could be able to provide supplementary records for a more complete knowledge of potential fire incidents. Furthermore, we can integrate the usage of GPS modules which would permit actual-time area monitoring of the device, providing precious insights into the geographical distribution of capacity heat incidents.

On top of that, leveraging cloud services like AWS would be capable of facilitating seamless records garage, evaluation, and remote monitoring. We can also incorporate using superior verbal exchange modules or explore IoT protocols like MQTT, which would enable seamless integration with other clever systems and improve actual-time records transmissions. Integrating a low-energy mode and robust conservation techniques can also be carried out for an extended lasting device, which can be beneficial to faraway or off-grid locations. These are several of the few key upgrades which may be conducted in our contemporary project to decorate it and polish it for further use.

6. Conclusion

In our second year, first semester we were provided with the task of constructing a group project in the module of cloud computing and IOT , a group was randomly synergized by our module teacher and with that we as a team divided our work and dived into this topic, where we picked the topic of flame sensor and started a working project with the focus on use of an Arduino on our provided project, our team engaged in a collective effort that resulted in a successful completion for a working flame sensor detector.

With the task at hand and vision on our minds we got going into working as a team collectively and dealing with different issues that arises while trying something out for the first time. The common issues started showing for us such as wiring placements, code issues, team altercations and implementation of different ideas collided. Although such challenges came into existence a solution was paved by us as well as there is a common saying teamwork makes the dreamwork we collectively and individually split our works and dealt with the issues we faced along the way.

In conclusion, our team effort to provide a functional real world-based project was a successful endeavor for us. With the conditions of utilizing Arduino and detecting a flame sensor, we were able to fulfill this task of creating a precise and efficient working flame detection machine. The project was a huge success as it not only helped us showcase our technical ability, but it has also helped us to understand the real-world scenarios and practical use of IoT and its applications in the field of security and safety. As we recall on our collective efforts, we feel that it is evident that our project provides an example of the potential of youths and how such projects can be implemented with basic understandings to address practical challenges which is faced on a day-to-day basis. As a team our experience has helped us and broadened our perspective on the topic of IoT and the vast structure of interconnected devices, showing us the endless possibilities which the ever-evolving world of tech represents.

7. References

Arduino, 2021. *Arduino.* [Online]
Available at: https://store.arduino.cc/products/arduino-uno-rev3
[Accessed 9 1 2024].

CircuitBread, 2019. *CircuitBread.* [Online]
Available at: https://www.circuitbread.com/ee-faq/what-is-a-breadboard
[Accessed 9 1 2024].

Hub, 2018. *Arduino flame sensor interface.* [Online]
Available at: https://www.electronicshub.org/arduino-flame-sensor-interface/
[Accessed 4 1 2024].

TheHimalayanTimes, 2023. *The himalayan times.* [Online]
Available at: https://thehimalayantimes.com/kathmandu/surge-in-electrical-short-circuit-fires-wreaking-havoc
[Accessed 9 1 2024].

8. Appendix

8.1. Software Requirements

a) **Arduino IDE:** Arduino IDE is a development environment where we can write the codes for operating an Arduino based system. In this IDE, codes are based on C programming language.

b) **Tinkercad:** Tinkercad is an online website which we used for designing the overall circuit for our prototype. Here we have used tinkercad to draw design diagrams.

c) **Fritzing:** It is an open-source hardware project which enables anybody to use electronics as a creative medium. It provides a software tool, an online community, and services reminiscent of Processing and Arduino, promoting an artistic environment that enables users to record and distribute their prototypes, instruct students in electronics, design and produce expert PCBs, and educate electronics in a classroom.

8.2. Individual Contribution Plan

Name	Contribution
Rishan Chhunju	Proposal: Introduction and Report formatting. System Development Report: Development, Design and Planning and Testing. Application Development: Establishing connection between components, setting up IDE and code. Presentation: Working mechanism of code and system.
Rakhit Thapa	Proposal: Expected Outcomes and Deliverables. System Development Report: Results and Findings, Future Works, and Conclusion. Application Development: Checking connection and testing. Presentation: Future works
Sristi Shrestha	Proposal: Aims, Objectives and Conclusion System Development Report: System Overview, Diagrams and Requirement Analysis. Application Development: Establishing connection between components. Presentation: System Connection
Safal Shrestha	Proposal: Requirement Analysis System Development Report: Introduction, Aims and Objectives Application Development: Establishing connection between components. Presentation: Introduction

Table 6 Individual Contribution Plan.

8.3. Code for Arduino

```
int led = 9;
int buzzer = 10;
int flameSensor = 11;
int flamePin;

void setup( ) {
  pinMode(buzzer, OUTPUT);
  pinMode(led , OUTPUT);
  pinMode(flameSensor , INPUT);
  Serial.begin(9600);
}

void loop ( ) {
  flamePin = digitalRead(flameSensor);
  if (flamePin == HIGH)
  {
    digitalWrite(led, LOW);
    digitalWrite(buzzer, LOW);

  }
  else
  {
    digitalWrite(led, HIGH);
    digitalWrite(buzzer, HIGH);
  }
  delay(1000);
}
```