LONDON METROPOLITAN UNIVERSITY

islington college
(इस्लिङ्टन कलेज)

Module Code & Module Title
CS5053NI/CC5068NI– Cloud Computing & IoT

<< Fire Alarm System with Water Sprinkler>>

Assessment Type
40% System Development Report

Semester
2023 Spring/Autumn

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Assignment Due Date: 12 January 2024
Assignment Submission Date: 11 January 2024
Submitted to: Mr. Sugat Man Shakya
Word Count: 3804

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 show our gratitude towards our module leader Mr. Sugat Man Shakya and our class tutor Mr. Suryansh Mathema Sir who gave us the opportunity on working on this IoT project. We are thankful for the tutors for providing various ideas that we could pursue also providing locations where we could buy the required devices from and at last for guiding us and helping us throughout this project.

Abstract

The purpose of this project is to design and implement an advanced fire alarm system that enhances fire safety in residential and commercial buildings. The system utilizes state-of-the-art technology to detect and alert occupants about potential fire incidents promptly. By integrating smoke detectors, heat sensors, and carbon monoxide detectors, the system ensures comprehensive coverage and early detection of fire hazards.

Incorporating an Arduino-based flame sensor, the fire alarm system can detect the presence of flames and provide an additional layer of early fire detection. The flame sensor, coupled with the advanced control panel, enhances the system's ability to accurately identify potential fire incidents and promptly alert occupants for immediate action.

To ensure the system's reliability and effectiveness, extensive testing and simulations are conducted to evaluate its performance in different fire scenarios. The project also includes the development of a user-friendly interface and intuitive controls, making it easy for occupants to interact with the system and evacuate safely during emergencies.

By implementing this advanced fire alarm system, the project aims to significantly reduce the risk of fire-related incidents, minimize property damage, and most importantly, safeguard human lives. The successful implementation of this project will contribute to enhancing fire safety standards and promoting a safer environment for all.

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1. Introduction

The Internet of Things (IoT) describes the network of physical objects— “things”—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. Various technologies like sensors, software, microcontrollers, etc., are integrated and coordinated to develop novel technologies or concepts. This amalgamation of technologies is termed the Internet of Things (IoT). (Oracle, 2023)

We are assigned a task to create something handy using IOT technology. With our group discussion, we define, the project name as “Fire Alarm System with Emergency Water Sprinkler. “In this project, we propose an advanced fire alarm system equipped with emergency water sprinklers based on Arduino technology. The primary components for this project include an Arduino Uno, relays, fire sensors, buzzer, battery and adapter as a power supply and a water sprinkler system. Fire-related incidents pose a serious threat, and the need for effective fire prevention systems is crucial. By integrating a fire alarm with emergency water sprinklers, we aim to enhance safety measures against fires. The project aims to address the urgency of such systems in preventing and decreasing fire disasters.

1.1. Current Scenario

Nepal faced various challenges including issues related to infrastructure, safety concerns, and occasional fire incidents in both urban and rural areas. In Nepal, due to lack of effective fire safety measures, especially in buildings and public spaces, have resulted in devastating losses during fire outbreaks. The swift pace of urban growth, combined with inadequate firefighting resources and infrastructure, has significantly compounded these issues.

1.2. Problem Statement and Project as a Solution

In Nepal, fire incidents occur in urban and rural areas due to inadequate safety measures in building and public places. The lack of effective fire control equipment like fire alarm systems and water sprinklers contributes to disastrous losses during fire outbreaks. This issue is compounded by carelessness, rapid urban growth, and insufficient firefighting resources, posing a severe threat to public safety and property.

Our proposed solution aims to install comprehensive fire alarm systems and emergency water sprinklers in key public spaces, buildings, and urban areas across Nepal. This project will integrate cutting-edge fire detection technology with automated water sprinkler systems to enhance early fire detection and swift suppression capabilities.

1.3. Aims and Objectives

1.3.1. Aims

The aim of developing a fire detection system is to ensure early detection of fires to minimize the risk of property damage, injuries, and loss of life. The primary goal is to enhance fire safety and mitigate the potential devastating effects of fires.

1.3.2. Objectives

a. Early fire Detection: The system aims to detect the presence of smoke, heat, or flames at the earliest stage possible to provide timely alerts and prevent the spread of fire.
b. Cost-Effectiveness: Arduino-based fire detection systems can be a more affordable alternative compared to traditional fire alarm systems, making them accessible to a wider range of users.
c. Customizability: Arduino allows for flexibility and customization in designing the fire detection system, enabling users to tailor it to their specific needs and requirements.
d. Integration with IOT: Arduino can be integrated with Internet of Things (IoT) technology, enabling remote monitoring, data collection, and control of the fire detection system.
e. User-Friendly Interface: The system can be designed with a user-friendly interface that simplifies operation and provides clear notifications to occupants during fire emergencies.
f. Scalability: Arduino-based systems can be easily expanded and scaled up to accommodate larger buildings or additional features as needed.

2. Background

2.1. System Overview

A fire detection device that can send a signal to an alarm circuit. Smoke, flames, heat, or any combination of these can trigger a fire detector. Fundamentally, the diagram usually shows important components such the pump, sensor, buzzer, battery, and breadboard. Fire detectors help to protect the building and its contents from damage by detecting a fire early and alerting the authorities so that they can respond quickly. It is a crucial safety precaution that can lessen the effects of a fire on a company or organization and aid to safeguard assets.

2.2. Design Diagram

2.2.1. System Architecture

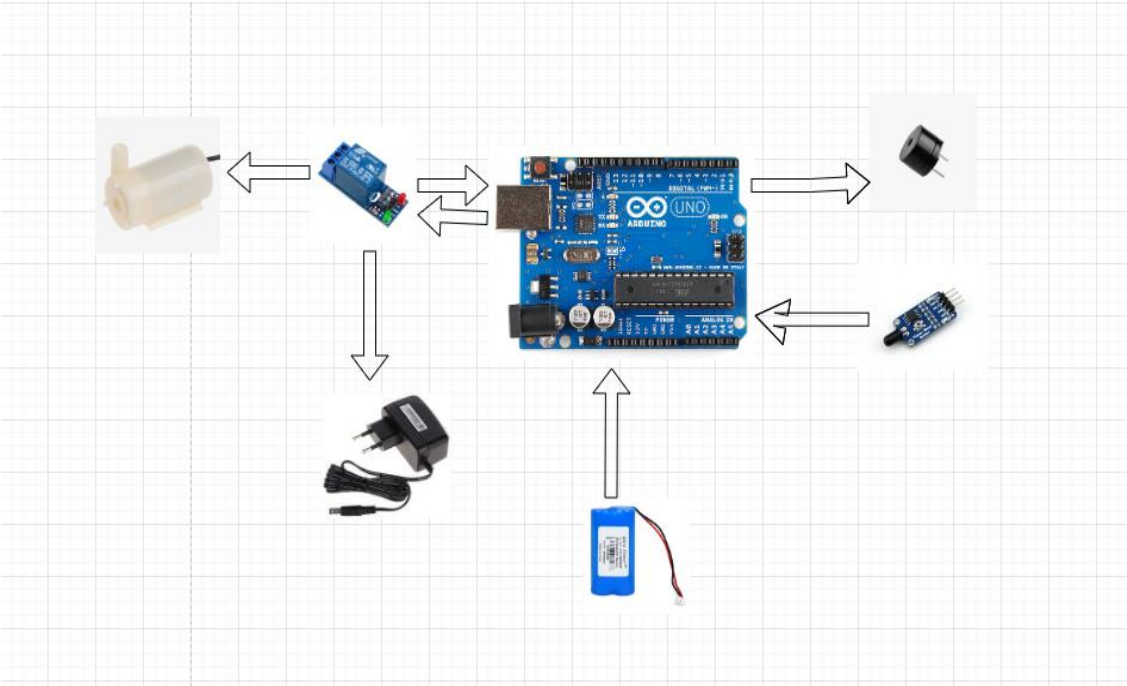

Figure 1 System Architecture

2.2.2. Flowchart

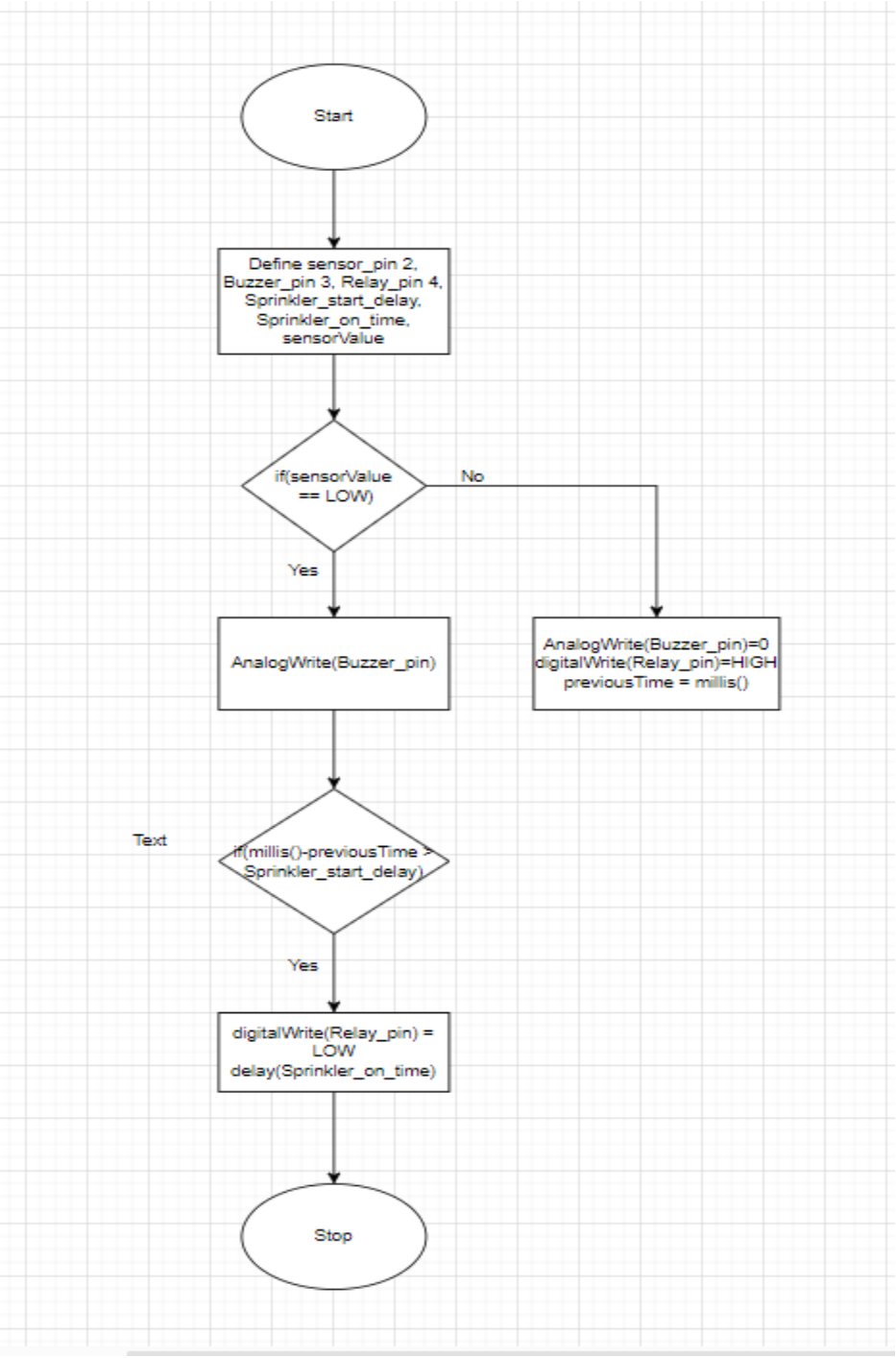

Figure 2 Flowchart

2.2.3. Circuit Diagram

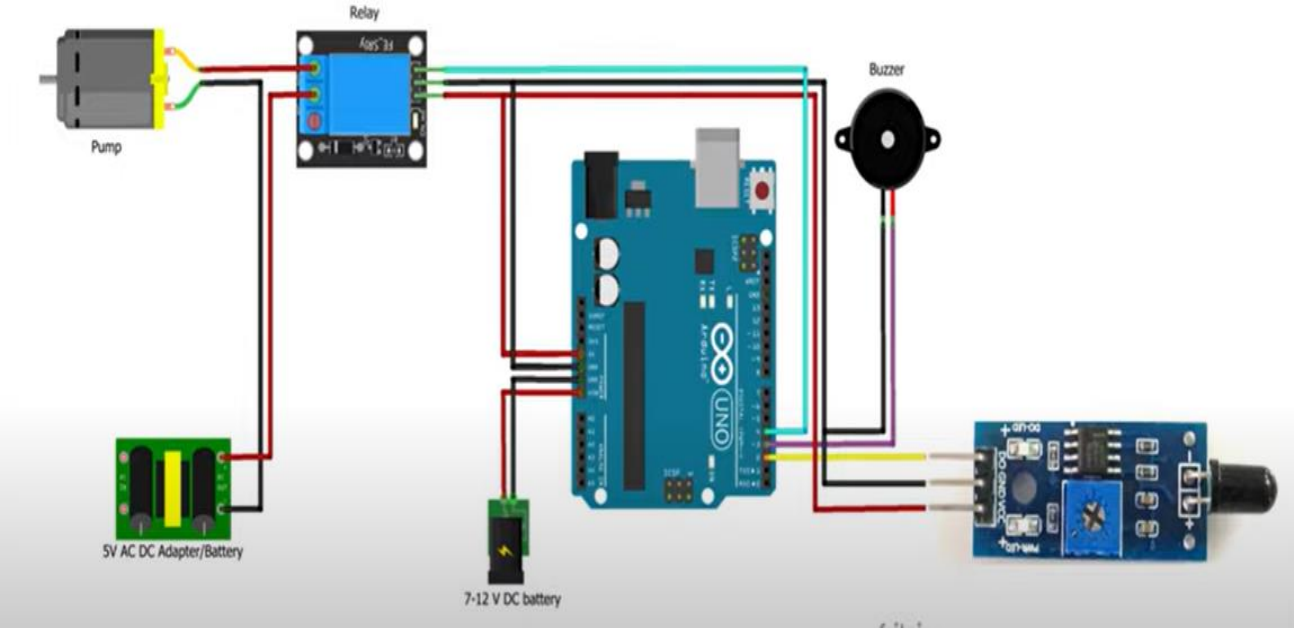

Figure 3 Circuit Diagram

2.2.4. Schematic Diagram

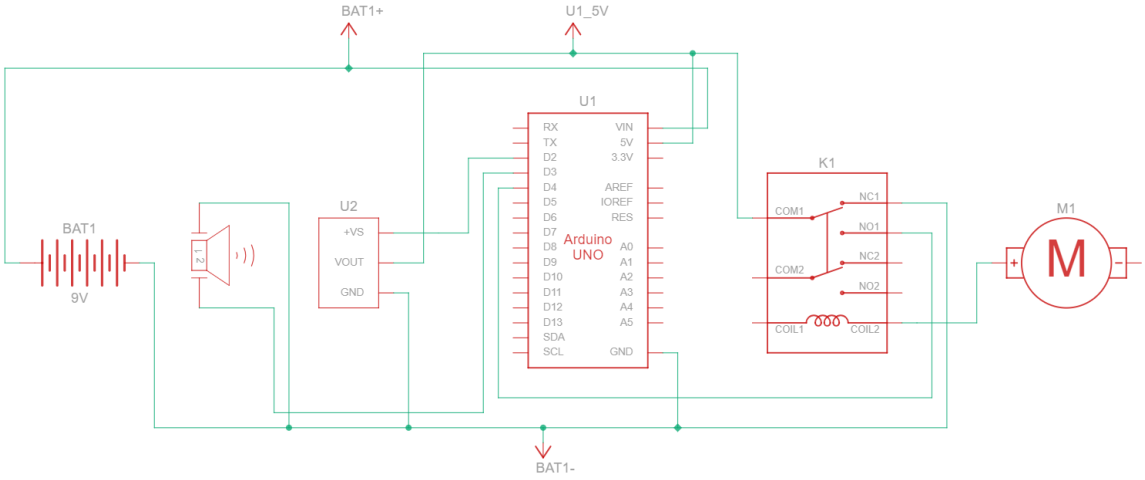

Figure 4 Schematic Diagram

2.3. Requirement Analysis

2.3.1. Hardware Components

1. Arduino uno

A microcontroller board called Arduino Uno is built around the ATmega328P (datasheet). The device is equipped with 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB port, a power jack, an ICSP header, and a reset button. Additionally, it comprises a 16 MHz ceramic resonator. (AUDRINO, 2023)

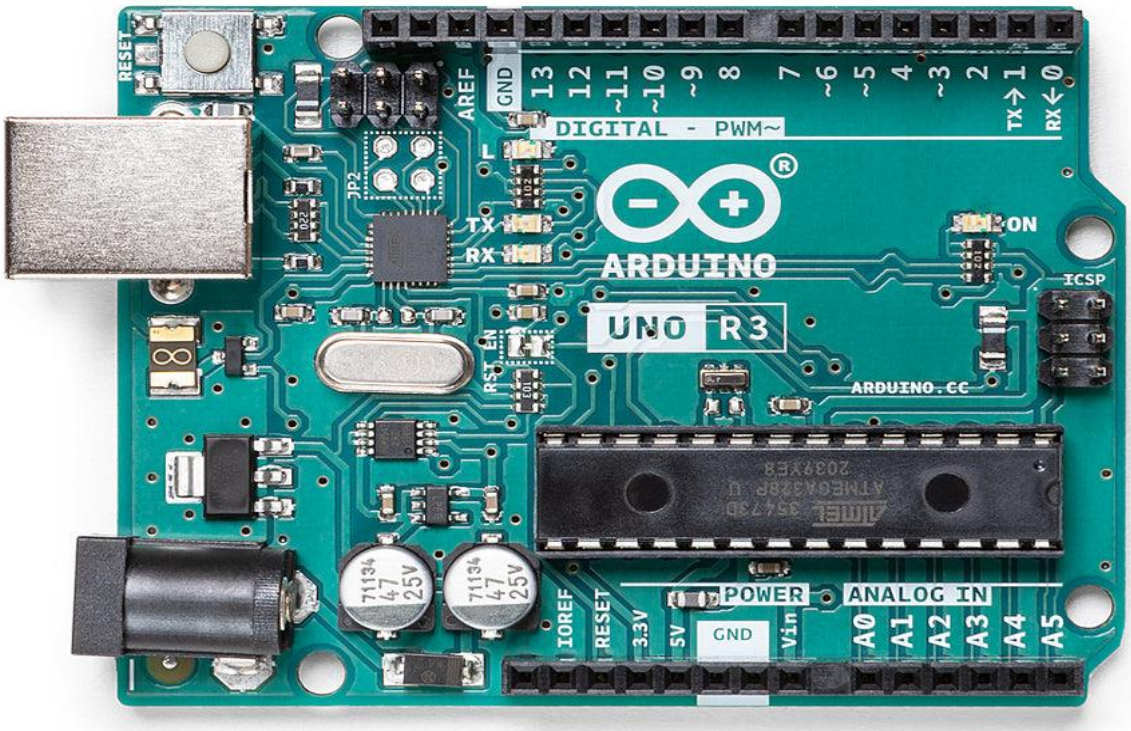

Figure 5: Arduino uno (AUDRINO, 2023)

2. Flame sensor module

A sensor intended to identify and react to the presence of a flame or fire is called a flame detector. Depending on the installation, a detected flame may trigger an alarm, turn off a fuel line (such as a natural gas or propane line), or turn on a fire suppression system. The infrared flame sensor that was utilized for this project is displayed below. (digest, 2023)

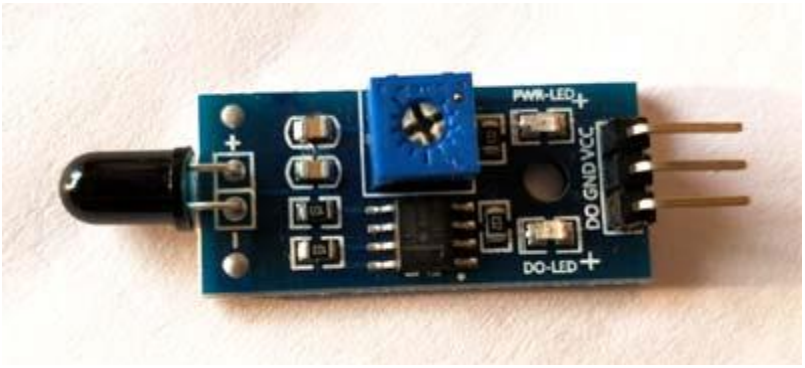

Figure 6: Flame sensor (digest, 2023)

3. 5-volt relay

An automatic switch called a 5-volt relay is frequently used in circuits for automatic control and to regulate high currents using low current signals. The relay signal's input voltage spans from 0 to 5V**.** (elprocus, 2018)

Figure 7: Relay module (Amazon, 2023)

4. 5-volt dc pump

This compact submersible pump motor can run on a 2.5–6V power source and is reasonably priced. Its relatively low 220mA current consumption allows it to hold up to 120 Liters per hour. Simply plug in the tube pipe, attach it to the motor outlet, and submerge it under water. (Hub360, 2020)

Figure 8: Dc pump (Cryton.io, 2023)

5. Buzzer

An auditory signalling device, such as a buzzer or beeper, can be mechanical, electromechanical, or piezoelectric (piezo for short) (Wikipedia, 2023)

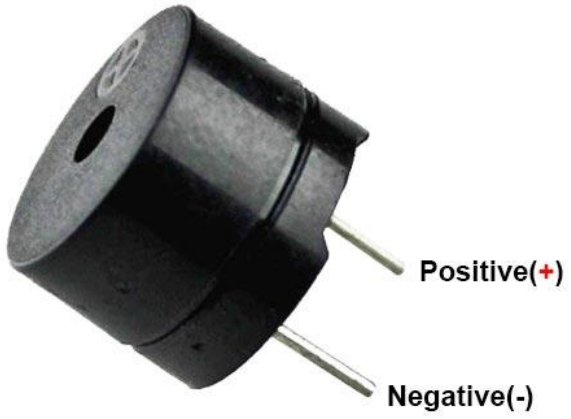

Figure 9: Buzzer (digest, 2023)

6. 5-volt ac/ dc adapter

An electrical power source that transforms alternating current (AC) from a wall outlet into direct current (DC) with a 5-volt output voltage is called a 5-volt AC/DC adapter. These adapters are frequently used to supply power to a variety of electronic devices that need a 5-volt source, including small appliances, and other gadgets.

Figure 10: Adapter (Booster, 2023)

7. 7–12-volt dc battery

The 12-volt potential of the battery is the only characteristic that defines the 12-volt battery. Typically, this higher voltage is found in A23/27 batteries for radio frequency transmission in Bluetooth devices and home security systems. (junction, 2023)

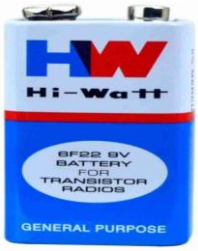

Figure 11: 9-volt dc battery (Flipkart, 2023)

8. Breadboard

When creating makeshift circuits, a breadboard—also known as a plug block—is utilized. Designers may quickly remove and replace components with it, which makes it helpful. For someone who wishes to construct a circuit to show how it works and then utilize the same parts in another circuit, it is helpful. (Direct, 2023)

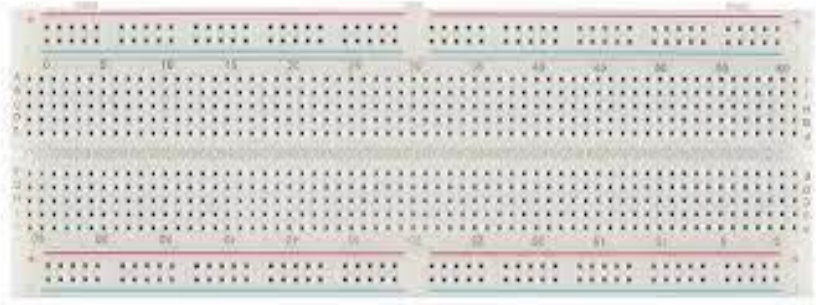

Figure 12: Breadboard (Sciencebuddeis, 2023)

9. Jumper Wires

Any wire with connector pins on both ends can be used as a jumper wire to connect two places without the need for soldering. (Education, 2023)

Figure 13: Jumper wires (Education, 2023)

2.3.2. Software's Used

Arduino IDE 1.8.19

The Arduino IDE is an open-source software which is used to write a program and upload it to the micro-controller. (AUDRINO, 2023).

Draw.io

Draw.io is used to make system architecture and block diagram of the project for the report. (Draw.io, 2023)

Ms Word

It is used to make the report and proposal of the project.

3. Development

Step 1: The design and the planning.

Firstly, we have designed our project in the tinker card software which helped us to build the project virtually. In our project, there were nine major hardware components, they are Arduino UNO, Breadboard, Buzzer, Relay, Flame sensor, Adaptor, Battery, Jumper wire and DC motor. The wire was used to link all the hardware parts in the circuit design once they had been dropped.

We planned to put the 7V rechargeable battery connection to Arduino and distribute the power from Arduino to breadboard and to hardware components that need the power supply like buzzer, relay, and flame sensor. DC motor is being given a power connection from the adapter. We have connected the DC motor to relay module so that the relay module will be able to send the output signal to motor when necessary. But the motor works on the power supplied from adapter not from the battery. By connecting the dots in Tinker Cad, we were able to comprehend the idea behind the project and how it functions. This allowed us to join the connections in a real-world project with ease and comfort and create the project's program.

Step 2: Resource collection.

The Resources to develop this IOT project were collected from the different areas of Asan Bazar. We were unable to use the resources from the IT resource department of the college because most of the resources were out of stock. So we gathered the every resources from some local stores of Asan. The resources that were collected was: Arduino UNO, Breadboard, Buzzer, Relay, Flame sensor, Adaptor, Battery, Jumper wire , DC motor and aluminium foil, cardboard and a box for designing. The above-mentioned resources were collected for the project.

Step 3: System Development.

Phase 1: The method used to construct this project in Tinker Cad is the same as the method used to develop the system. First, we connected the Arduino Uno and bread board by connecting five voltage pins and ground pin to the bread board's positive and negative terminals, respectively.

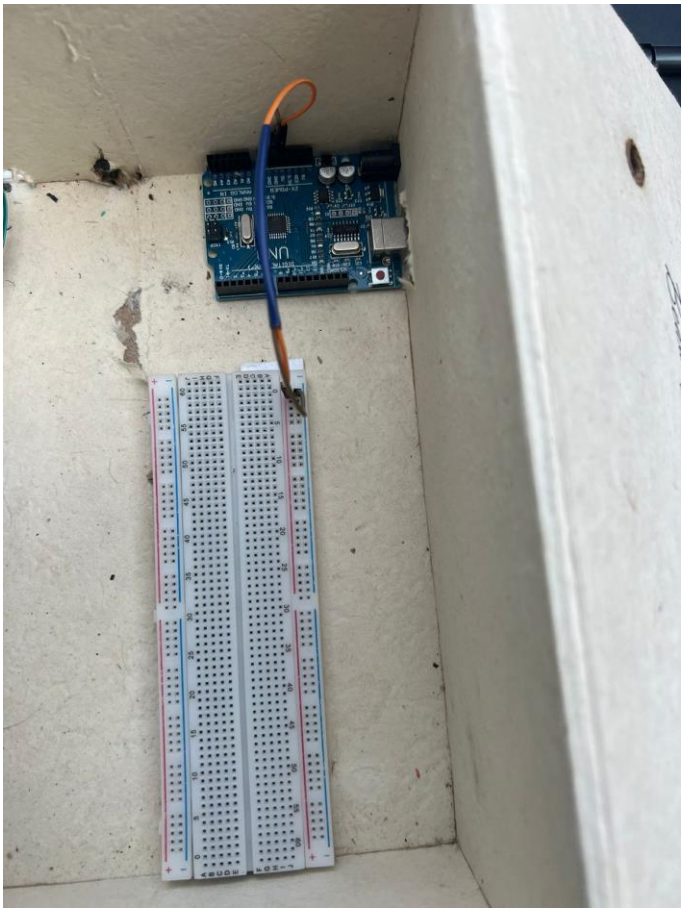

Figure 14 Image of Phase 1 of development

Phase 2: In this phase, the connection of flame sensor is made. The ground pin of flame sensor relates to the negative pin in the breadboard, the vcc pin is connected to positive pin in the breadboard and DO is connected to digital 2 pin in the Arduino.

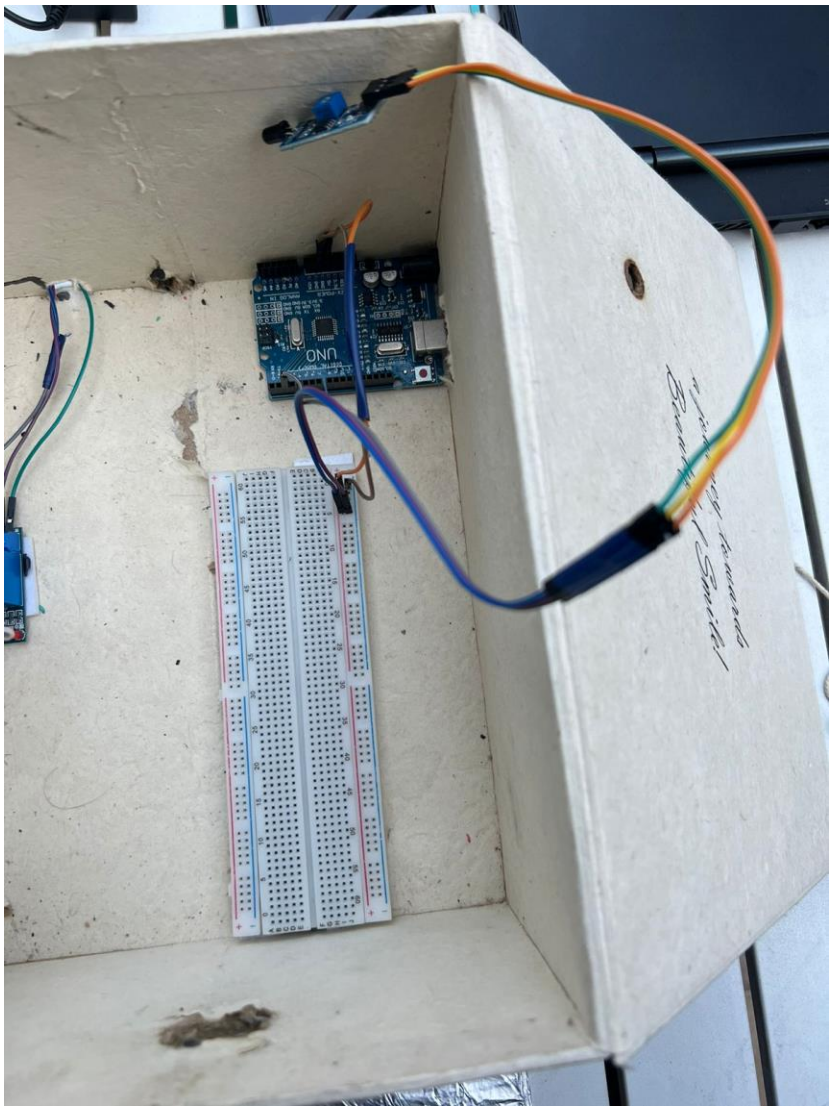

Figure 15 Image of Phase 2 of Development.

Phase 3: Relay module VCC is connected to positive pin, ground is connected to negative pin in the breadboard and IN pin is connected to the Digital 4 pin in the Arduino. The buzzer is connected to breadboard and Arduino. The ground pin is connected to negative of breadboard and positive is connected to the digital 3 pin in the Arduino.

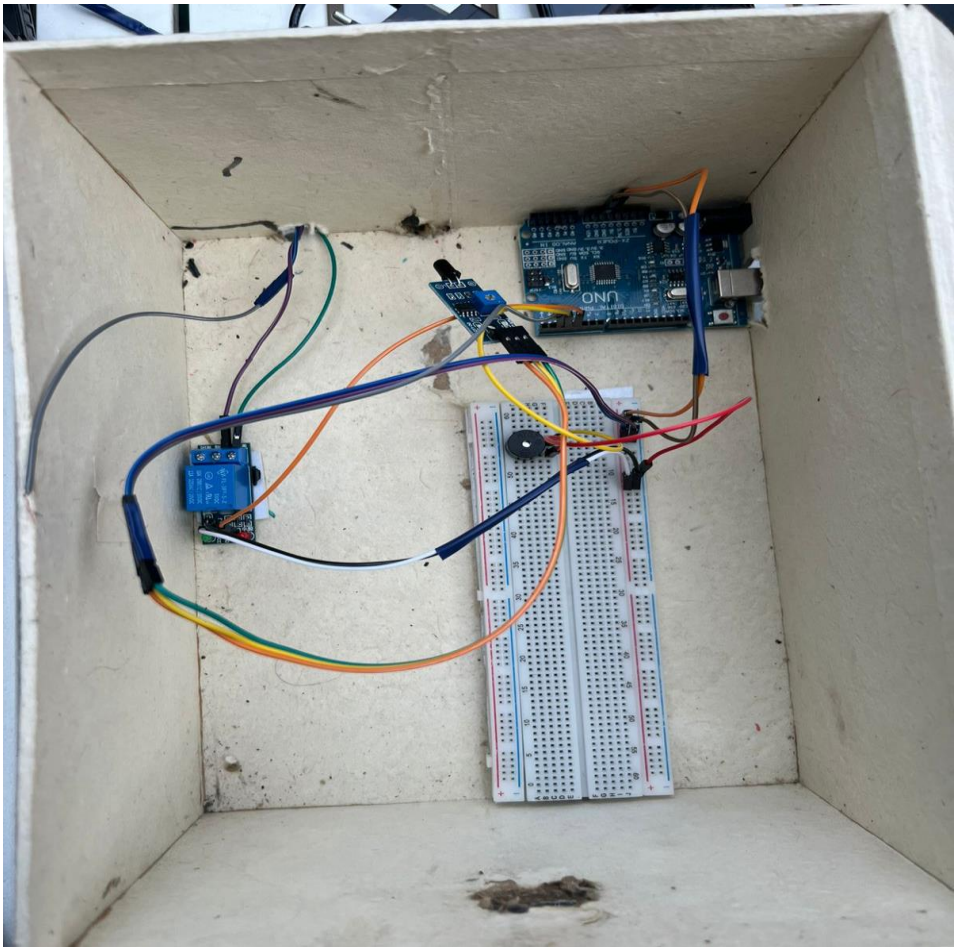

Figure 16 Image of Phase 3 of development.

Phase 4: DC motor is connected to the relay. Motor's negative point is connected to adapter negative point and Positive point is connected to relay. When the relay gives order, the motor does its task taking power from the adapter.

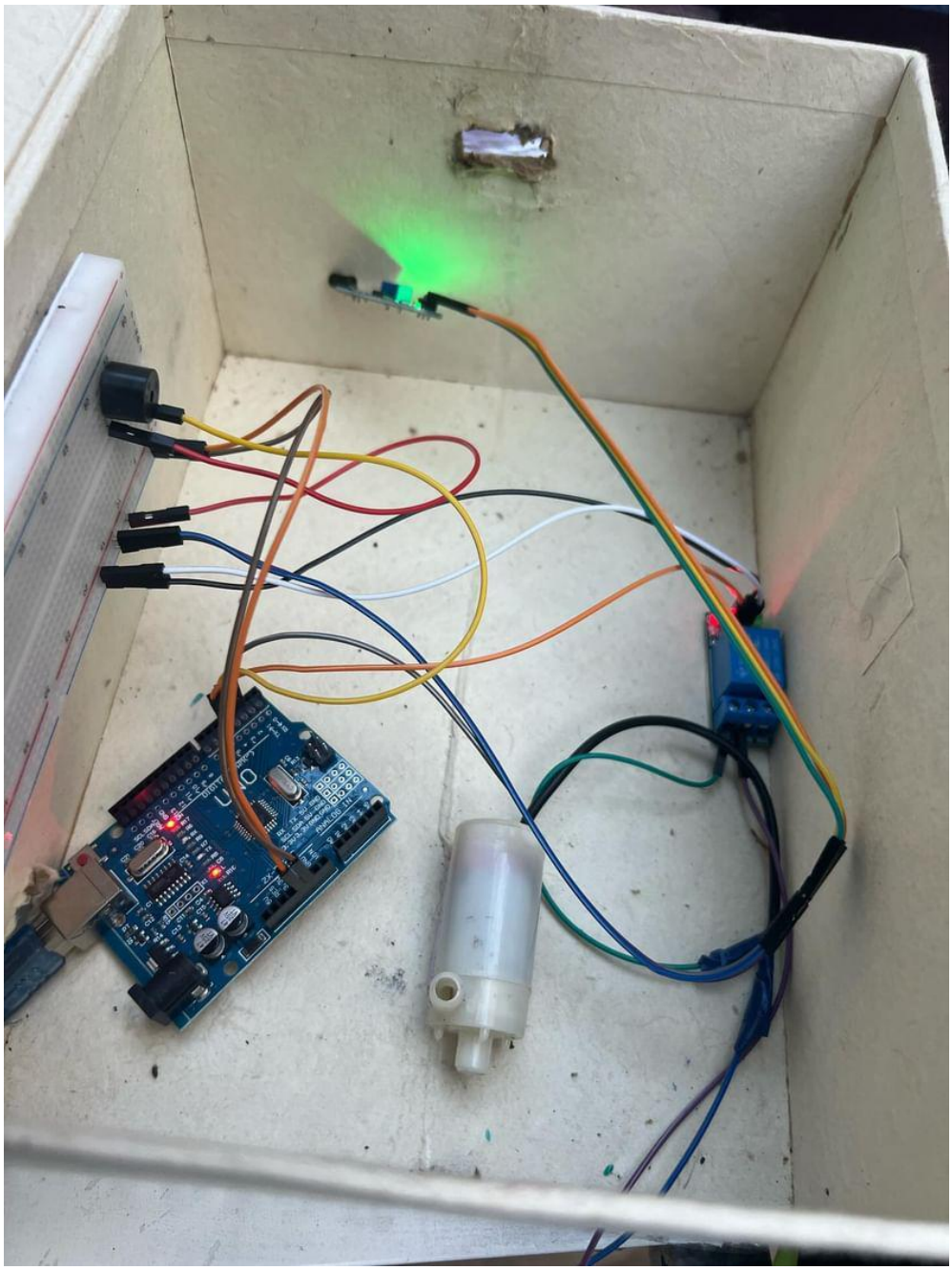

Figure 17 Image of Phase 4 of Development.

Step 4: Pins connection to each other components.

	Connection Pins	Arduino Uno	Breadboard
Flame Sensor	DO GND VCC	Digital 2	 GND 5V
Relay Module	IN GND VCC	Digital 4	 GND 5V
Buzzer	+ve -ve	Digital 3	 GND

Table 1 Pin Connection of the components.

Step 5: Writing the program to run the project.

sketch_dec19a.ino

```
#define FLAME_SENSOR_PIN 2
#define BUZZER_PIN 3
#define RELAYMODULE_PIN 4
#define WATER_SPRINKLER_START_AT 2000  //2 seconds before the pump starts
#define WATER_SPRINKLER_TIME 10000     //10 seconds of run time of water sprinkler

unsigned long previousTime = millis();

void setup()
{
  pinMode(RELAYMODULE_PIN, OUTPUT);
  pinMode(FLAME_SENSOR_PIN, INPUT);
}

void loop()
{
  //If there is fire then the sensor value will be LOW else the value will be HIGH
  int sensorValue = digitalRead(FLAME_SENSOR_PIN);

  //There is fire
  if (sensorValue == LOW)
  {
    analogWrite(BUZZER_PIN, 50);                        //Turns on the buzzer

    if (millis() - previousTime > WATER_SPRINKLER_START_AT)  //the pump will wait for few seconds before sprinkler can be started once fire is detected.
    {
      digitalWrite(RELAYMODULE_PIN, LOW);                    //Relay is low level triggered relay so we need to write LOW to switch on the light
      delay(WATER_SPRINKLER_TIME);                          //this will keep the sprinkler on for the given time.
    }
  }
  else
  {
    analogWrite(BUZZER_PIN, 0);
    digitalWrite(RELAYMODULE_PIN, HIGH);
    previousTime = millis();
  }
```

Figure 18 Writing the program to run the project.

4. Results and Findings

After the project is completed and development process is finished, the project is now fully functional. The system detects fire and when the fire is detected, the pump is activated to sprinkle water over the fire. The code is done where if the sensor detects fire, the sensor value is set at low, and the buzzer is activated to alarm people, else, the sensor value is set at high. The pump start time is set at 4 seconds where if the sensor detects for 4 seconds or more, the pump is turned on through relay module and water is released onto the fire and the runtime of the pump is set at 4 seconds. The design of the project is given the shape of a room to give real life demonstration where the sensor detects fire in the room and the water is released to the room from the pipe which is connected to the pump from the ceiling of the room which helps in full distribution of the water to the surface. The pump and buzzer are only activated when the sensor detects fire and value is set to low. The whole system's power is provided through 7.4-volt dc battery as well as 5-volt dc adapter.

Testing

Test 1- Test to see if the sensor detects fire.

Test	1
Objectives	To test if the flame sensor detects fire after the power is given
Activity	1. Connect the Arduino to the laptop. 2. Enter, compile, and run the code. 3. Connect the sensor the to the Arduino and the breadboard. 4. Provide the power to the Arduino and the sensor. 5. Put fire in front of the sensor to detect it.
Expected Result	The flame sensor should detect the fire and the led light on the sensor should be turned on.
Actual Result	The sensor detected the fire and the led light turned on indicating fire detection
Conclusion	The test is successful.

Table 2 Table of Test-1.

Image Evidence of the Test:

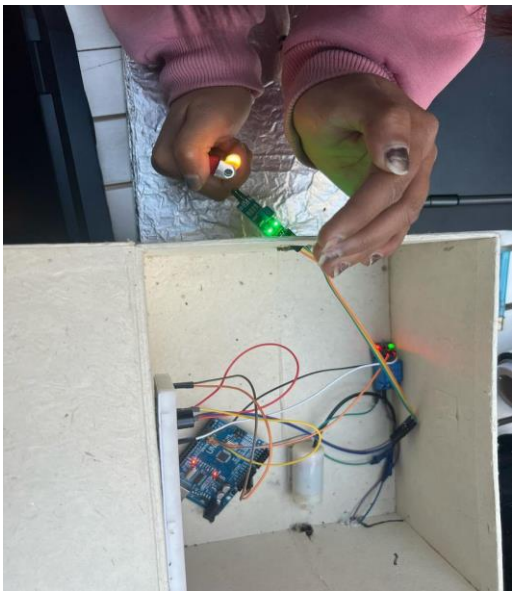

Figure 19 Image of Test 1.

Test 2- Test to see if the pump is activated when fire is detected.

Test	**2**
Objectives	To test if the pump is activated after giving the power and the fire is detected.
Activity	1. Connect the Arduino to the laptop. 2. Enter, compile, and run the code. 3. Connect the negative of the wire to the dc adapter and the positive side to the relay module. 4. Connect the adapter to provide power. 5. Put fire in front of the sensor for it to be detected. 6. Wait for the pump to activate after the fire is detected
Expected Result	The pump to be activated and supply water when the fire is detected.
Actual Result	The pump activated and supplied water to put out the fire when the fire is detected.
Conclusion	The test is successful.

Table 3 Table of Test-2.

Image Evidence of the Test:

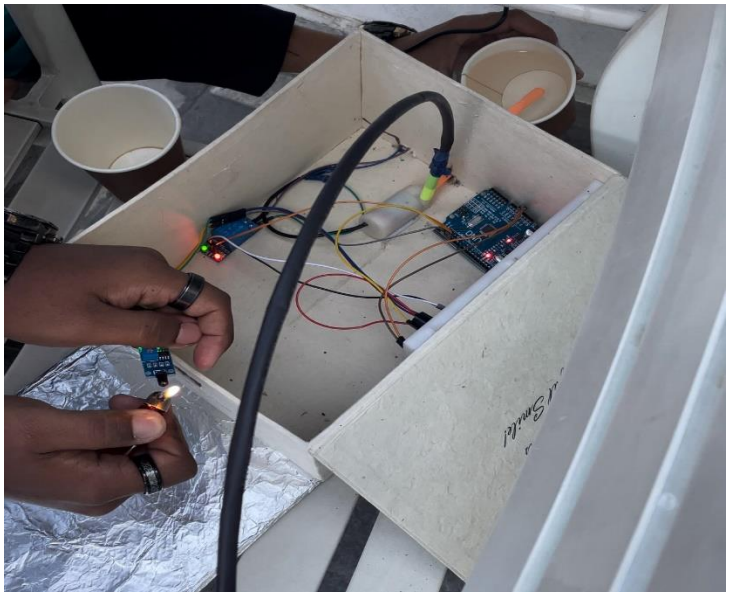

Figure 20 Image of Test 2.

5. Future Works

This fire alarm system with water sprinkler is currently functional, but there is more room for enhancement to ensure increased safety, efficiency, and ease of use. In future iterations, incorporating a display system could provide clearer notifications to building occupants about the nature and location of the fire emergency. This feature would contribute to a quicker and more organized evacuation process. Furthermore, integrating a GSM module into the system can be a valuable addition. This module would enable the system to send immediate alerts and updates to emergency services, building management, and even the occupants' designated contacts. This real-time communication ensures a rapid response, potentially minimizing damage, and casualties.

This sophisticated fire alarm system can be seamlessly integrated into buildings, with sensors strategically placed to provide comprehensive coverage. Upon detection of a potential fire hazard, the system would trigger the water sprinklers, effectively suppressing the fire and minimizing its spread. To further improve accuracy and responsiveness, additional sensors could be integrated throughout the building to detect not only smoke but other indicators of fire, such as elevated temperature level.

6. Conclusion

The project has tested our skills and ability to work together as a team. We understood about various terms and got familiar to different hardware devices while creating the IoT project. The project we decided to create was done with a motive to solve the problem of causing death by fire. It does not fully solve the problem, but it prevents the damage and hazard to occur. The device was created to prevent the loss of life which is caused by fire. For this main purpose, we had decided to create Fire alarm system that has automatic activated water sprinklers that will help to put out the fire once the sensors detect the fire.

To sum up the whole project, we have created a project to solve a major problem while co-operating with each other while also learning and gaining different knowledge about various terms and devices throughout this fun yet difficult process.

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8. Appendix

8.1. Source Code

```
#define FLAME_SENSOR_PIN 2

#define BUZZER_PIN 3

#define RELAYMODULE_PIN 4

#define WATER_SPRINKLER_START_AT 2000  //2 seconds before the pump starts

#define WATER_SPRINKLER_TIME 10000      //10 seconds of run time of water sprinkler


unsigned long previousTime = millis();


void setup()

{

  pinMode(RELAYMODULE_PIN, OUTPUT);

  pinMode(FLAME_SENSOR_PIN, INPUT);

}


void loop()

{

  //If there is fire then the sensor value will be LOW else the value will be HIGH

  int sensorValue = digitalRead(FLAME_SENSOR_PIN);


  //There is fire

  if (sensorValue == LOW)

  {

    analogWrite(BUZZER_PIN, 50);                    //Turns on the buzzer
```

```
    if (millis() - previousTime > WATER_SPRINKLER_START_AT)  //the pump will wait for few seconds before sprinkler can be started once fire is detected.
    {
      digitalWrite(RELAYMODULE_PIN, LOW);                    //Relay is low level triggered relay so we need to write LOW to switch on the light
      delay(WATER_SPRINKLER_TIME);                           //this will keep the sprinkler on for the given time.
    }
  }
  else
  {
    analogWrite(BUZZER_PIN, 0);
    digitalWrite(RELAYMODULE_PIN, HIGH);
    previousTime = millis();
  }
}
```

8.2. Block Diagram

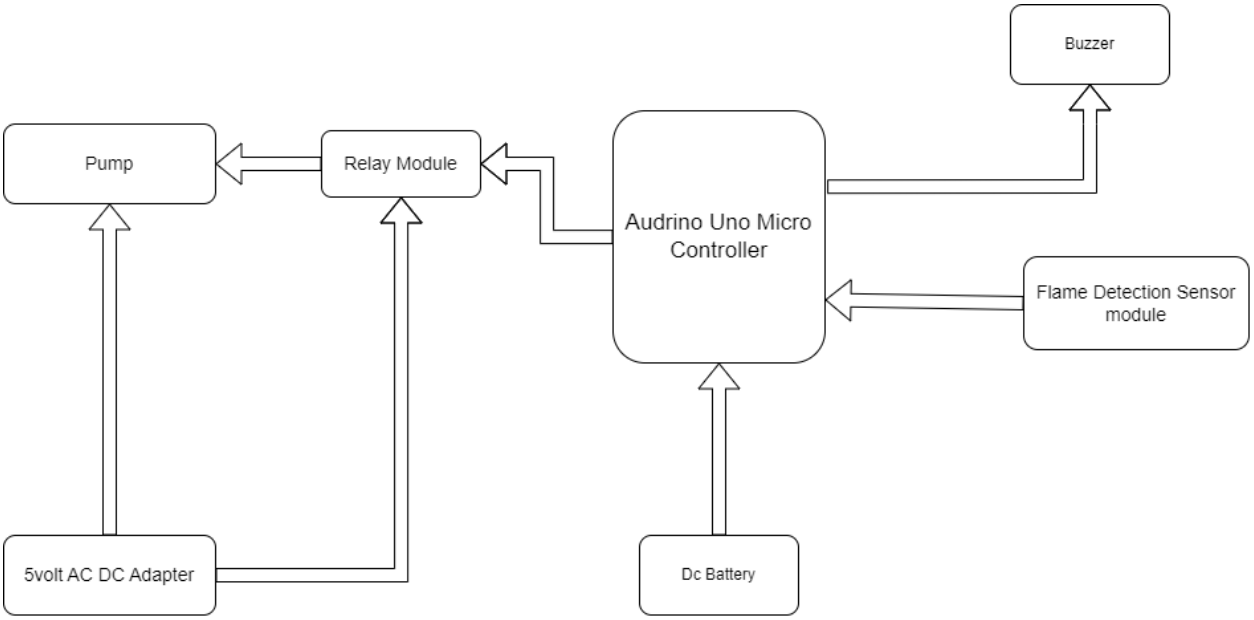

Figure 21 Block Diagram of the project

8.3. Individual Contribution

We have a team of four that are doing this project.

Student Name	Role	Contribution
Rounak Joshi	**Proposal:** Acknowledgement, Individual Contribution plan, Conclusion, Block diagram of fire alarm, appendix. **System Development Report:** Acknowledgement, Results and findings, Appendix, Block Diagram. **Application Implementation:** making connections between different connections, Reviewing the code, and improving it, design of the project. **Presentation:** Working mechanism of the project.	25%
Pragati Kunwar Chhetri	**Proposal:** Expected outcomes and deliverables, Requirement analysis. System architecture. **System Development Report:** Background, Requirement analysis, design diagram, circuit diagram, system architecture, **Application Implementation:** Setting up Arduino IDE and making connections between different connections, design of the project. **Presentation:** Purpose of the project	25%

Binaya Kharel	**Proposal:** Introduction, current scenario, Problem Statement and Project as a solution. **System Development Report:** Development, future works, conclusion. **Application Implementation:** Code to execute the connections between different connections. **Presentation:** Working mechanism of the code	25%
Darshan Mainali	**Proposal:** Abstract, Aims and objectives. **System Development Report:** Introduction, aims and objectives. **Application Implementation:** Setting up Arduino IDE and making connections between different connections. **Presentation:** use and exceptions of the project	25%

Table 4 Individual Contribution Plan