AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Engineering

OEL Report

Experiment Title: Implementation of a Fire and Gas Detection System using Arduino: Safety Alerts with LEDs and Buzzer.

Date of Perform:	19 May 2025	**Date of Submission:**	19 May 2025
Course Title:	Microprocessor and Embedded Systems Lab		
Course Code:	EE4103	**Section:**	P
Semester:	Spring 2024-25	**Degree Program:**	BSc in CSE
Course Teacher:	**Prof. Dr. Engr. Muhibul Haque Bhuyan**		

Declaration and Statement of Authorship:

1. I/we hold a copy of this Assignment/Case Study, which can be produced if the original is lost/damaged.
2. This Assignment/Case Study is my/our original work; no part has been copied from any other student's work or any other source except where due acknowledgment is made.
3. No part of this Assignment/Case Study has been written for me/us by any other person except where such collaboration has been authorized. by the concerned teacher and is acknowledged in the assignment.
4. I/we have not previously submitted or am submitting this work for any other course/unit.
5. This work may be reproduced, communicated, compared, and archived to detect plagiarism.
6. I/we permit a copy of my/our marked work to be retained by the Faculty Member for review by any internal/external examiners.
7. I/we understand that Plagiarism is the presentation of the work, idea, or creation of another person as though it is your own. It is a form of cheating and is a very serious academic offense that may lead to expulsion from the University. Plagiarized material can be drawn from, and presented in, written, graphic, and visual forms, including electronic data, and oral presentations. Plagiarism occurs when the origin of the source is not appropriately cited.
8. I/we also understand that enabling plagiarism is the act of assisting or allowing another person to plagiarize or copy my/our work.

** Student(s) must complete all details except the faculty use part.*
** Please submit all assignments to your course teacher or the office of the concerned teacher.

Group # 01

Sl No	Name	ID	PROGRAM	SIGNATURE
1	Md. Saikot Hossain	23-51242-1	BSc in CSE	
2	Md. Mosharof Hossain Khan	23-51259-1	BSc in CSE	
3	Rimal Banik	23-51260-1	BSc in CSE	
4	Md. Rahidul Islam	23-51269-1	BSc in CSE	
5	Rahat Ahmed	21-44911-2	BSc in CSE	

Faculty use only

FACULTY COMMENTS		
	Marks Obtained	
	Total Marks	

Contents

Objectives:

The objectives of this experiment are to-

a) Study the interfacing of analog and digital sensors with an Arduino microcontroller board.
b) Understand the working principles of the MQ-7 gas sensor and flame sensor.
c) Learn how to process sensor data using analog and digital input functions in Arduino.
d) Apply conditional logic to trigger output devices like LEDs and a buzzer.
e) Implement a flame and gas detection system using Arduino to alert hazardous conditions.

Apparatus:

1. Arduino IDE 2.3.5
2. Arduino Microcontroller Board
3. LED Light (Red)
4. 220 Ω Resistors
5. Buzzer
6. MQ-7 Gas Sensor
7. Flame Sensor
8. Jumper Wires
9. Breadboard

Circuit Diagram:

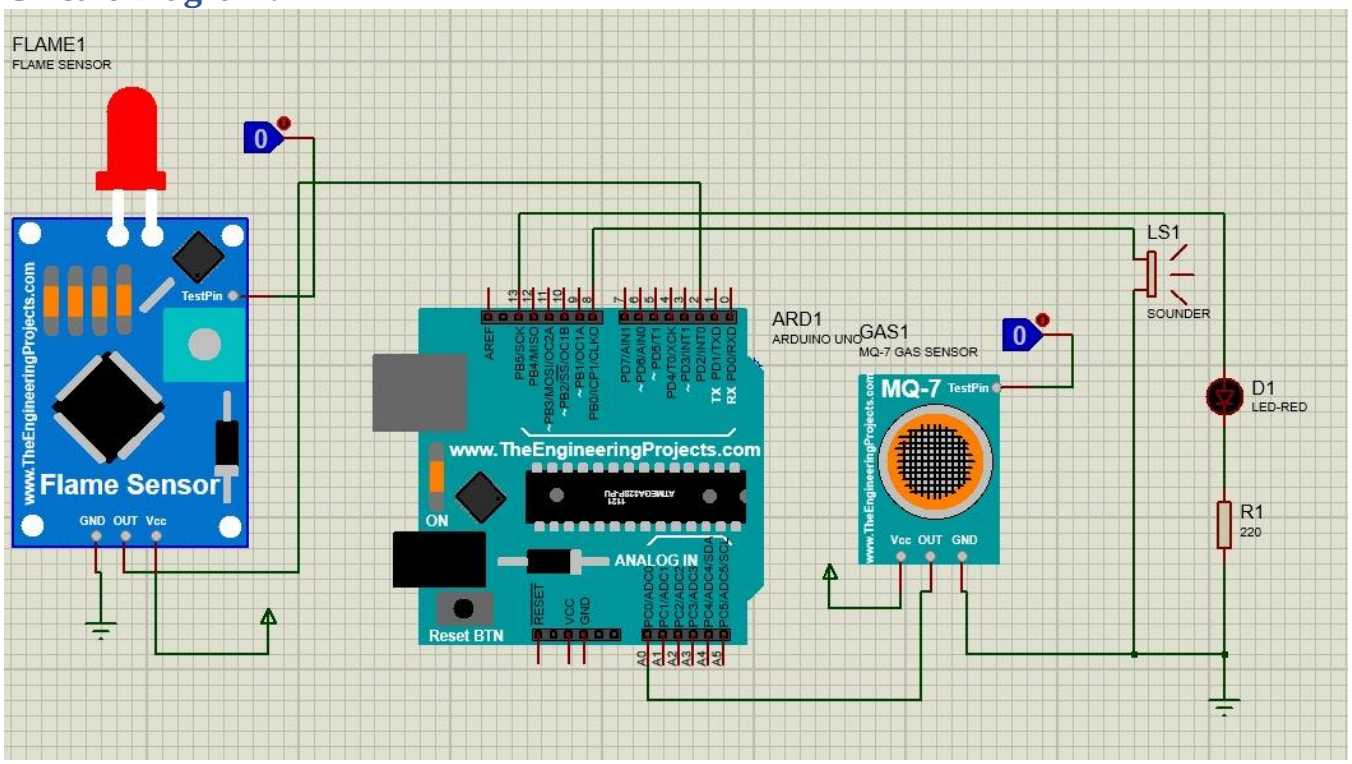

Figure-01: Pin connection for Fire and Gas Detection System using Arduino

Code Explanation:

```
// Define pins
const int mq7Pin =A0;       // Analog pin for MQ-7
const int flamePin = 2;      // Digital pin for Flame sensor
const int buzzerPin = 8;     // Buzzer or alarm
const int ledPin = 13;       // Red LED
const int smokeThreshold = 300; // Define threshold for gas detection
void setup() {
  Serial.begin(9600);
  pinMode(flamePin, INPUT);
  pinMode(buzzerPin, OUTPUT);
  pinMode(ledPin, OUTPUT);
}

void loop() {
  int smokeLevel = analogRead(mq7Pin);       // Read smoke level
  int flameDetected = digitalRead(flamePin); // LOW = flame detected

  Serial.print("Smoke Level: ");
  Serial.println(smokeLevel);
  Serial.print("Flame Detected: ");
  Serial.println(flameDetected == LOW ? "YES" : "NO");

  // Check if smoke or flame is detected
  if (smokeLevel ==smokeThreshold || flameDetected == LOW) {
    digitalWrite(buzzerPin, HIGH);  // Turn on buzzer
    digitalWrite(ledPin, HIGH);     // Turn on red LED
  } else {
    digitalWrite(buzzerPin, LOW);   // Turn off buzzer
    digitalWrite(ledPin, LOW);      // Turn off red LED
  }

  delay(500);
}
```

Explanation: This Arduino program is developed to detect potential fire hazards by monitoring the presence of smoke and flame using two sensors: the MQ-7 gas sensor connected to analog **pin A0** and a flame sensor connected to digital **pin 2**. To alert users of any hazardous conditions, the system also includes a buzzer and a red LED connected to digital pins **8 and 13**, respectively. In the **setup()** function, the input and output pins are properly initialized, and serial communication is started at a baud rate of **9600** to enable real-time monitoring of sensor readings through the Serial Monitor. The core detection logic is implemented in the **loop()** function. The Arduino continuously reads analog data from the MQ-7 sensor to measure the smoke level and checks the digital output from the flame sensor to determine whether a flame is present. If the flame sensor reads LOW (indicating flame is detected) or the smoke level equals 1, the system activates the buzzer and turns on the red LED to signal danger. The corresponding sensor readings and status messages are printed to the Serial Monitor, such as “Smoke Level:” and “Flame Detected: YES” or “NO.” If neither smoke nor flame is detected, the system deactivates the buzzer and red LED, indicating a safe condition. A half-second delay (**delay(500))** is included at the end of the loop to provide stability in sensor readings and prevent excessive output on the Serial Monitor.

Experimental Output Results:

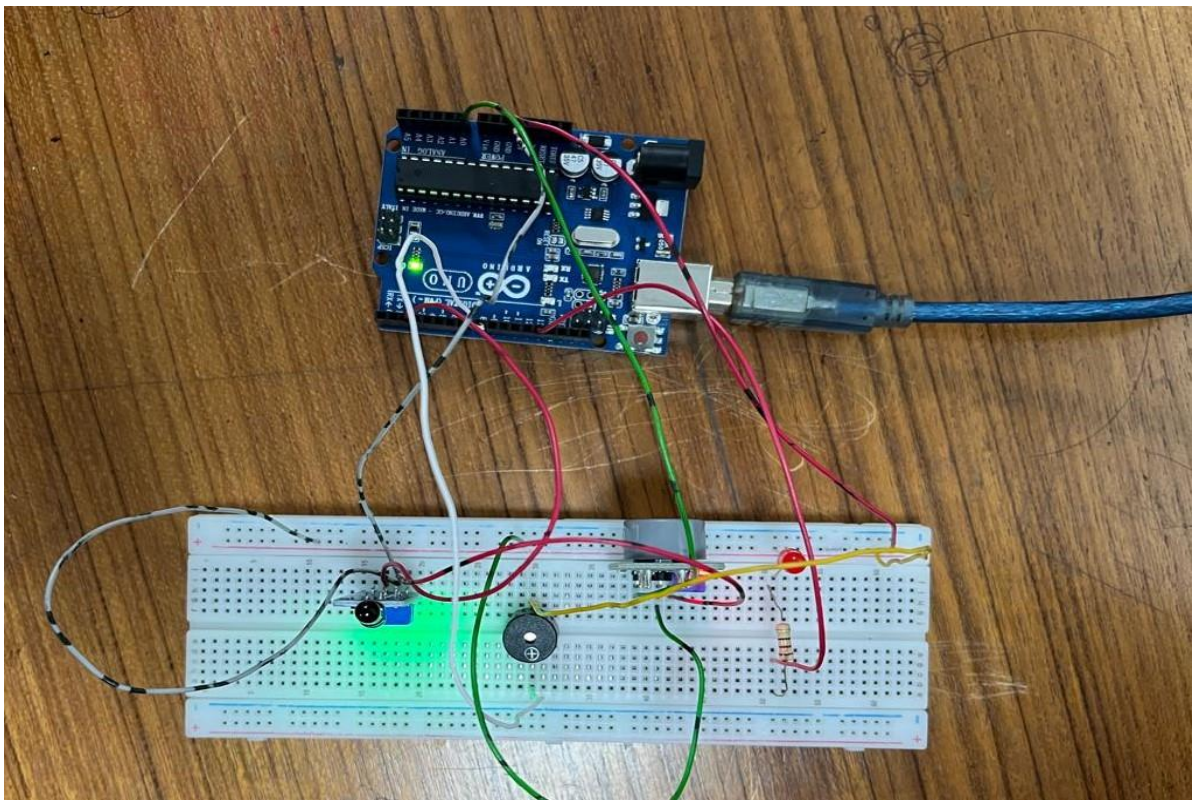

Figure-02: Fire and Gas Detection System(when neither flame nor gas is detected)

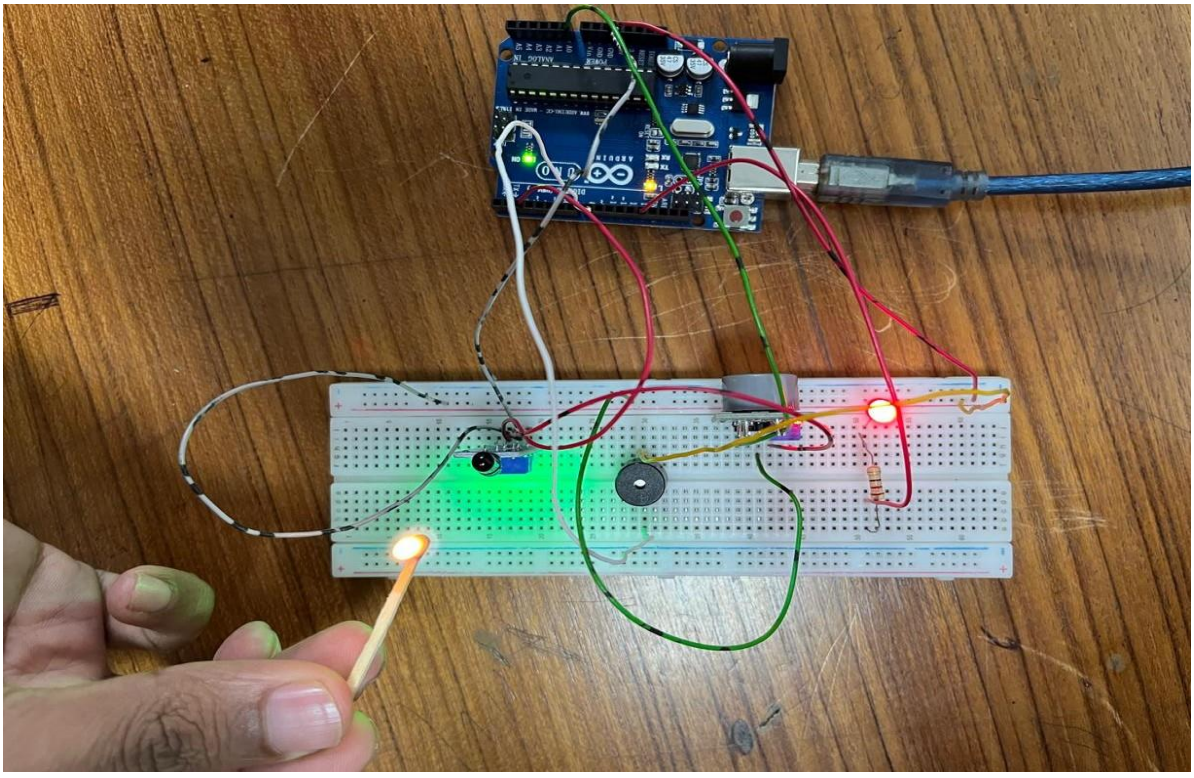

Figure-03: Fire and Gas Detection System(when flame is detected)

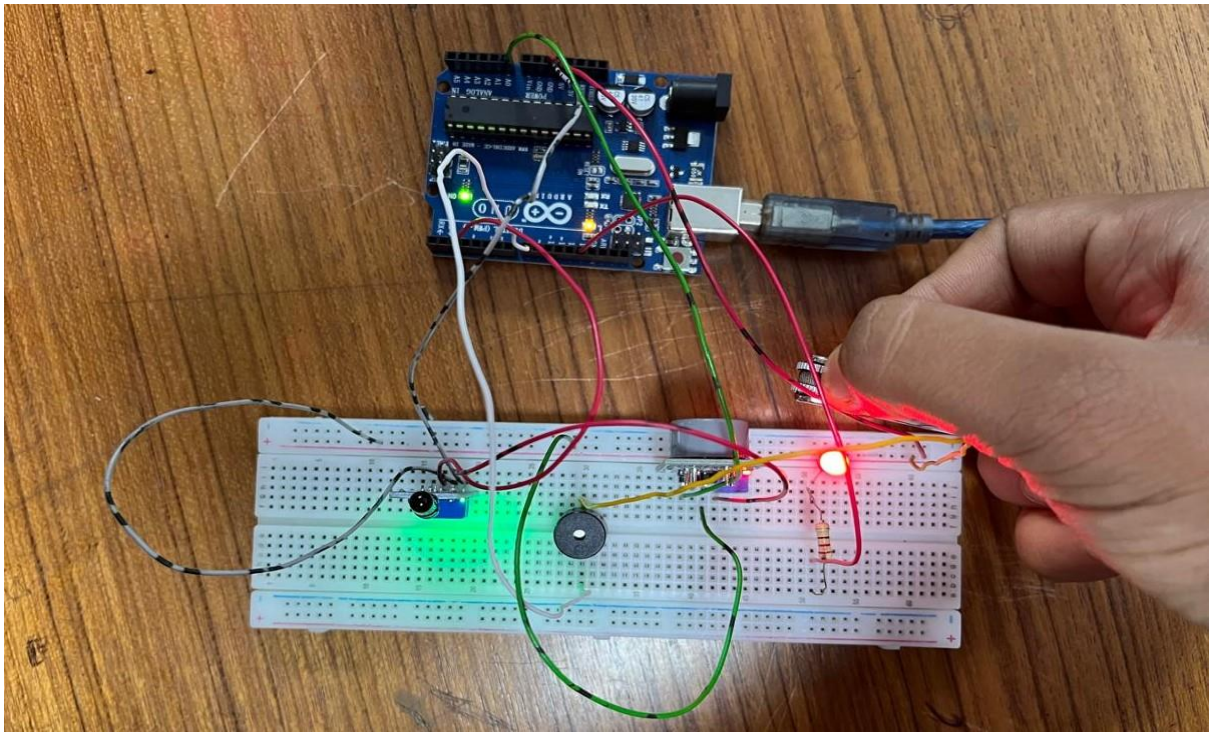

Figure-04: Fire and Gas Detection System(when gas is detected)

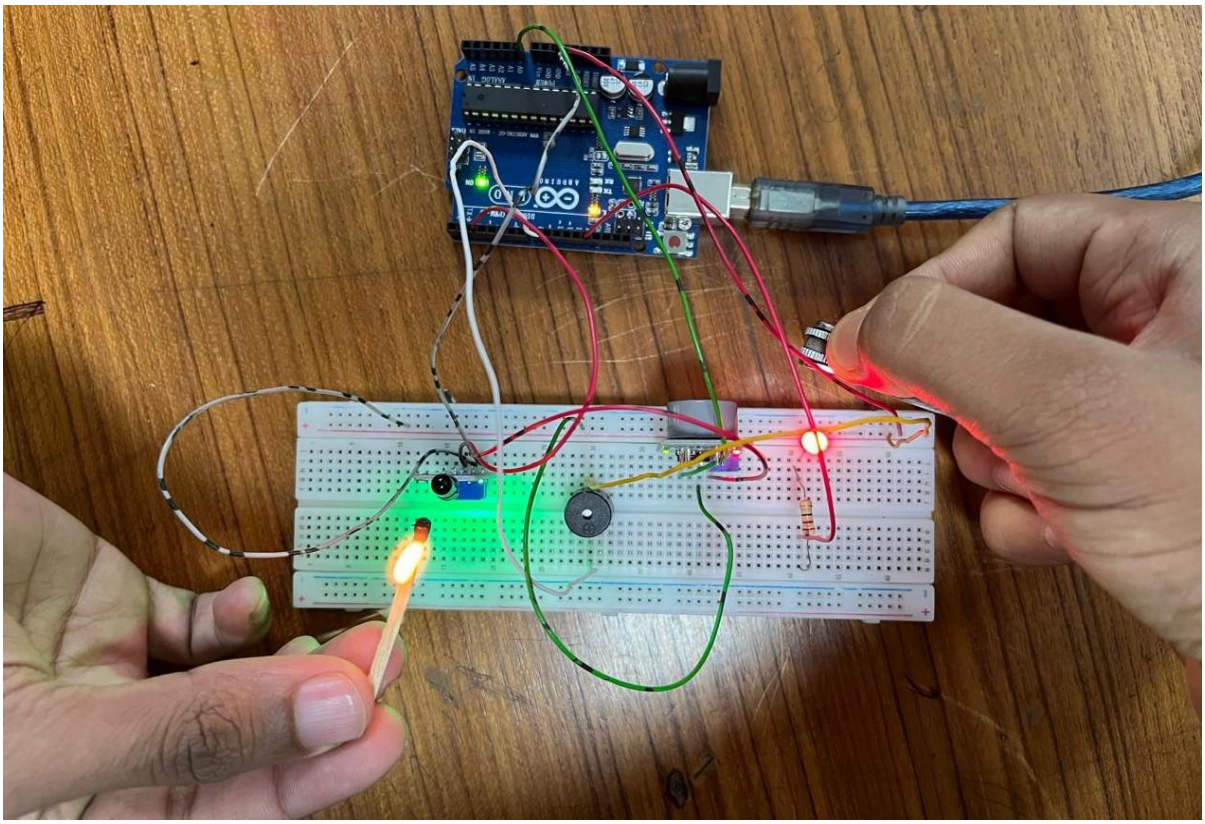

Figure-05: Fire and Gas Detection System(when both are detected)

Explanation: In this setup, a flame sensor and an MQ-7 gas sensor are used in conjunction with an Arduino Uno to create a fire and gas hazard alert system. The MQ-7 gas sensor is connected to the analog pin A0 to detect the presence of carbon monoxide or other combustible gases, while the flame sensor is connected to digital pin 2 to sense infrared radiation from a flame source. A red LED connected to pin 13 to signal danger. A buzzer is connected to pin 8 to produce an audible alert when either gas or flame is detected. Once the components were properly connected and powered, the program was uploaded to the Arduino Uno using the Arduino IDE. The sketch initializes the pin modes in the setup() function and begins serial communication for monitoring sensor outputs. The loop() function continuously reads data from the gas and flame sensors and checks if either or both have detected a hazardous condition. When the system is first powered on, and no flame or gas is present, both sensors remain in their inactive state. Indicating that the environment is safe, and no alert is sounded. As soon as either gas or flame is detected, the corresponding digital or analog reading crosses the defined threshold. The red LED turns ON, the buzzer is activated and signaling a warning. If both gas and flame are detected simultaneously, the system prints "Smoke level=1 and flame detected=Yes" on the serial monitor and activates both visual and audible alerts. If only one hazard is detected, the system appropriately identifies and displays "Smoke level" or "Flame detected" in the serial output.

Simulation Output Results:

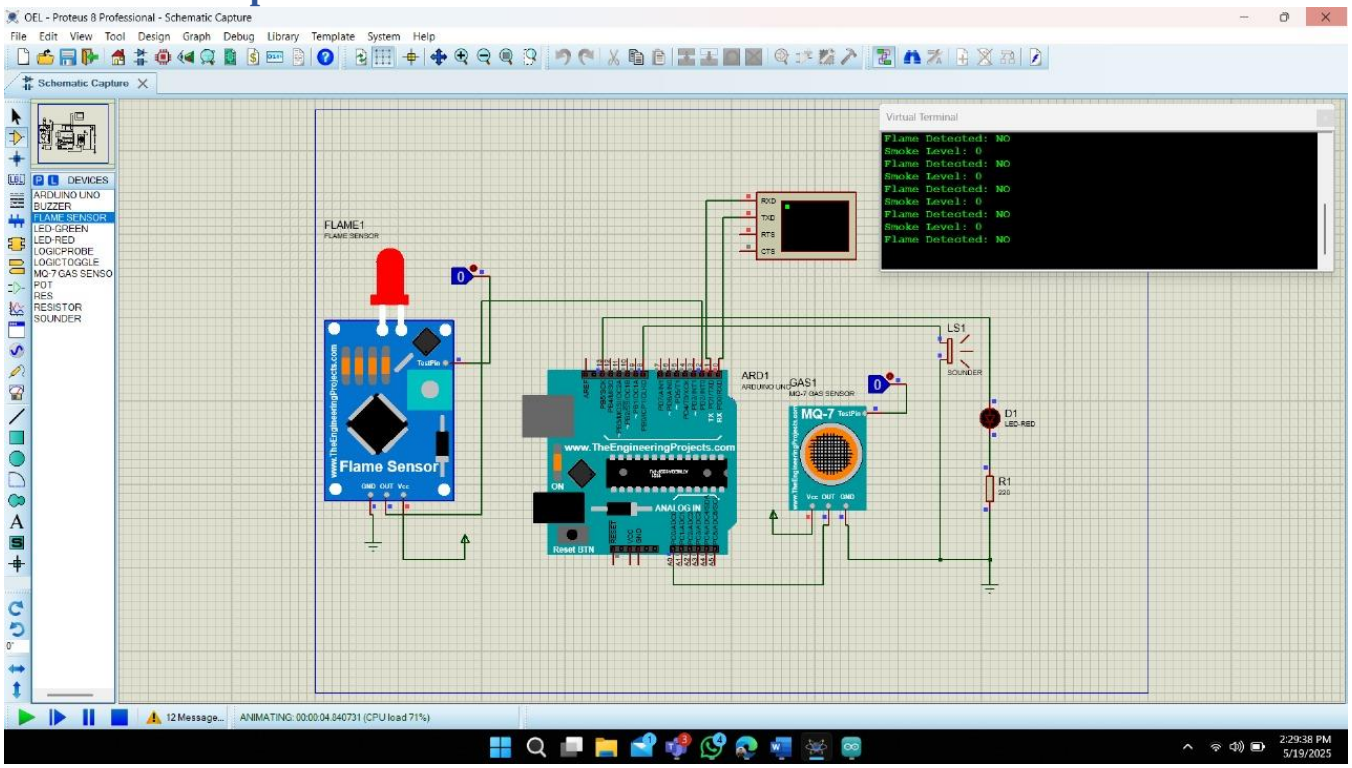

Figure-06:Simulation for Fire and Gas Detection System(when neither flame nor gas is detected)

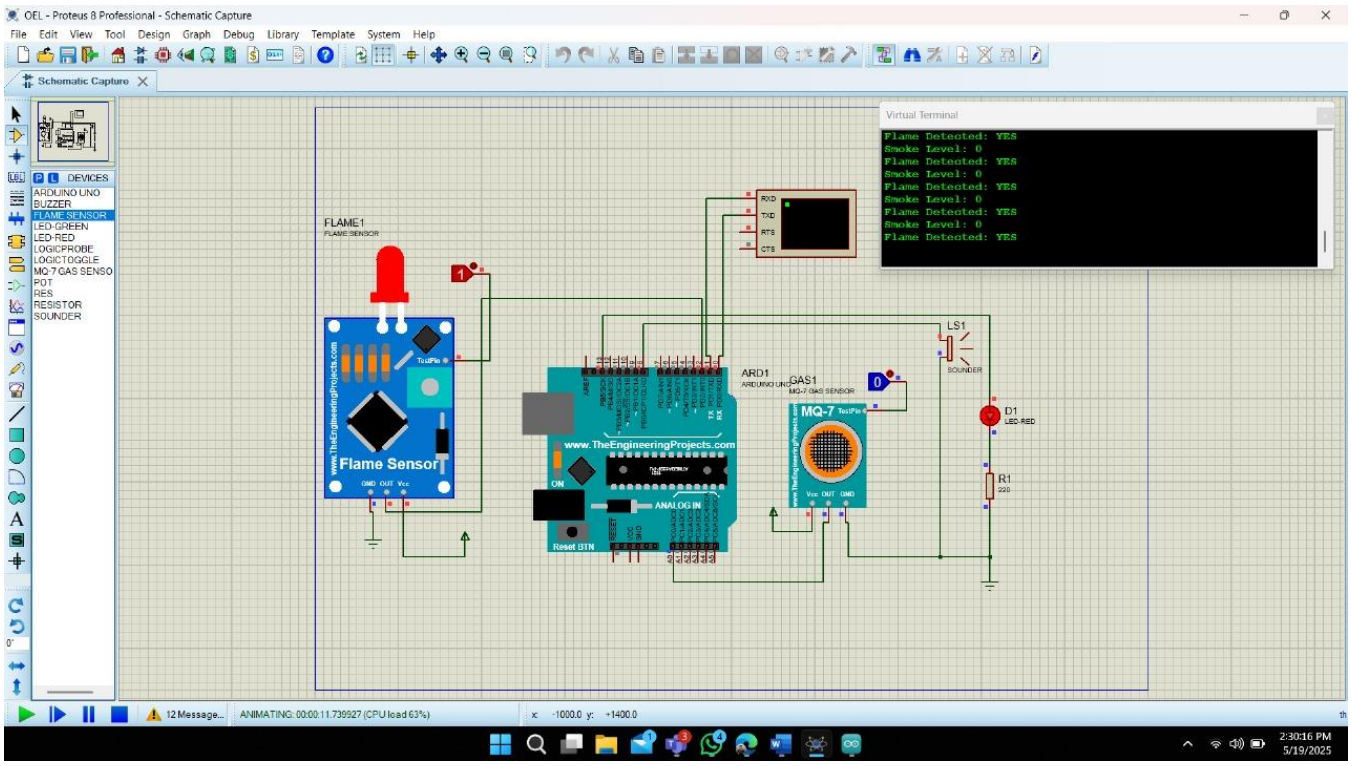

Figure-07: Simulation for Fire and Gas Detection System(when flame is detected)

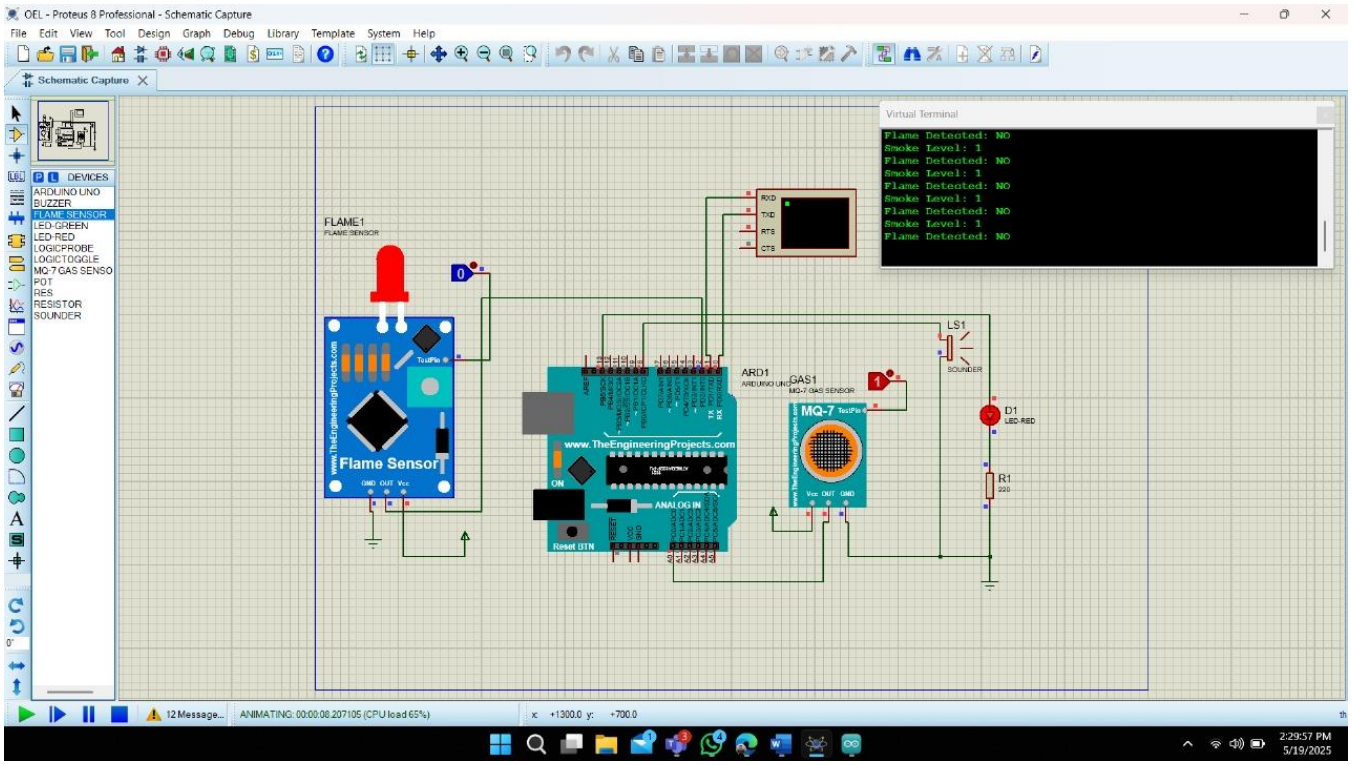

Figure-08:Simulation for Fire and Gas Detection System(when gas is detected)

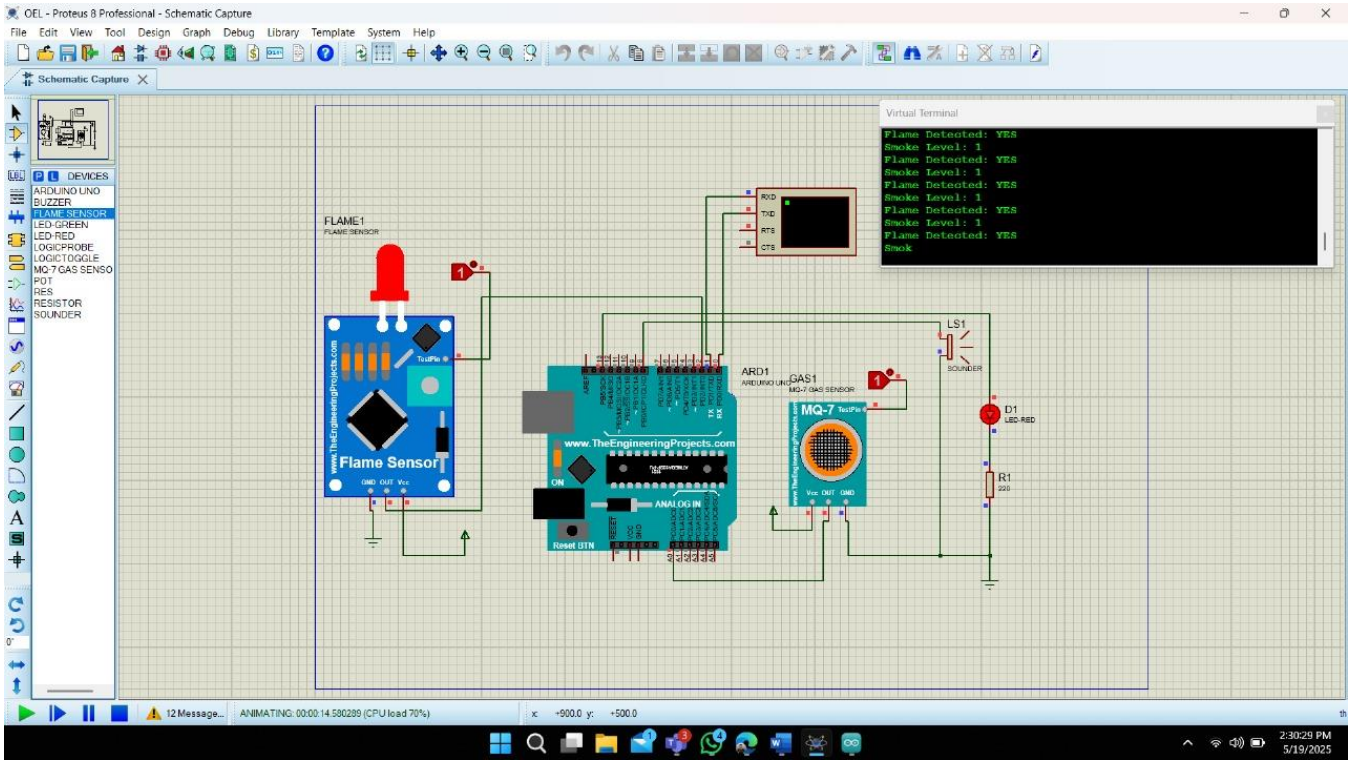

Figure-09: Simulation for Fire and Gas Detection System(when both are detected)

Explanation: In this simulation, a fire and gas detection system was developed using an Arduino Uno, a flame sensor, and an MQ-7 gas sensor. The primary objective was to simulate real-time hazard detection and alert generation based on environmental conditions. The flame sensor was connected to digital pin 2, and the MQ-7 gas sensor was interfaced through analog pin A0. To signal hazardous conditions, a red LED and a buzzer were connected to digital pins 13 and 8, respectively, with suitable resistors to limit current and protect the components. The program was written and verified in Arduino IDE version 2.3.5. After successful compilation, a HEX file was generated, which was imported into Proteus 8 Professional for simulation. Proteus allowed the complete behavior of the circuit to be tested virtually, eliminating the need for physical hardware while still demonstrating realistic performance. During the initial state of the simulation, both sensors were powered on, but no flame or gas was present. In this safe state, the red LED and buzzer remained OFF, indicating normal environmental conditions. When either smoke (high analog value from the MQ-7) or a flame (LOW signal from the flame sensor) was detected, the system immediately activated the red LED and buzzer, providing both visual and audible alerts. Additionally, the virtual terminal displayed real-time sensor data, such as smoke levels and flame detection status, confirming that the logic was functioning as intended.

Discussion:

This experiment focused on understanding how fire and gas detection can be achieved using an Arduino by utilizing digital input signals from sensors and triggering appropriate safety alerts through output devices such as LED and a buzzer. The main objective was to build a real-time hazard alert system that can detect dangerous environmental conditions-specifically the presence of combustible gas and fire-and respond immediately with audio-visual warnings. The system integrated two key sensors: the MQ-7 gas sensor and a flame sensor, which were connected to analog pins A0 and 2 respectively, and operated in digital mode to provide binary signals indicating the presence or absence of danger.

In the hardware setup, digital inputs from the gas and flame sensors were continuously monitored inside the loop() function. Depending on the readings, the Arduino processed the logic to activate the output components: a buzzer and LED (red). If either gas or flame was detected, or both simultaneously, the system activated the buzzer and turned on the red LED to signal danger, which normally indicates a safe state. Serial output was also implemented to display real-time system messages, including "Gas detected," "Flame detected," or "Gas & Flame both detected. Danger!!" Conversely, when no threats were detected, the system printed "Safe," turned off the buzzer and red LED. This created a clear visual and audible distinction between safe and unsafe conditions, suitable for environments where quick reaction to hazardous conditions is critical.

This hands-on implementation demonstrated the role of digital sensors in detecting environmental hazards and how microcontroller-based systems like Arduino can respond in real-time to maintain safety. It also emphasized the importance of using serial monitoring for debugging and validation of sensor behavior. The experiment highlights the practical application of digital input/output control in safety systems and introduces basic automation concepts using simple yet effective hardware components.

Here are some real life scenario and application of this experiment:

1.Smart Home Safety Systems: Fire and gas detection units are common in smart homes to ensure occupant safety.

Example: An Arduino-based smoke and gas detector alerts residents with alarms and messages, and can even trigger ventilation fans.

2.Industrial Safety Monitoring: Factories handling flammable gases use similar systems for early hazard detection.

Example: In chemical plants, continuous monitoring using flame and gas sensors can initiate automatic shutdowns or alarms when a threat is detected.

3.Fire Alarm Panels in Public Buildings: Integrated safety systems in schools, hospitals, and malls use multiple sensors to detect early signs of fire or gas leaks.

Example: A centralized fire panel receives inputs from gas/flame detectors and activates alarms across multiple rooms.

4.Gas Stove and Kitchen Safety: In residential kitchens, gas leakage sensors connected to buzzers can prevent accidents.

Example: A gas sensor near the stove detects leaks and sounds an alarm, possibly cutting off gas supply through a solenoid valve.

5.Vehicle Safety Systems: In automobiles using LPG or CNG, gas leak sensors can alert the driver immediately.

Example: A car using CNG has a sensor that triggers an alert if leakage is detected near the engine bay.

6.Underground Mining Safety Systems: Underground mines are prone to the buildup of toxic and flammable gases such as methane. A fire or gas detection system can be vital for ensuring the safety of miners.
Example: An Arduino-based monitoring device with gas and flame sensors is placed at various mining points to detect early signs of gas accumulation or fire. If detected, alarms are triggered, and ventilation systems are activated automatically.

Conclusion:

This experiment successfully demonstrated the implementation of a fire and gas detection system using digital input processing on an Arduino platform, supported by real-time alert mechanisms such as LEDs and a buzzer. By interfacing flame and gas sensors with the microcontroller, the system could detect hazardous conditions and respond accordingly with visual and audible indicators. The project made effective use of digital logic to distinguish between gas presence, flame presence, or both, and displayed specific messages for each condition via the Serial Monitor. This practical implementation emphasized key embedded system concepts including digital signal processing, sensor integration, and real-time response. Additionally, it provided hands-on experience with condition-based decision making and the design of safety-oriented applications. Overall, this experiment laid a strong foundation for building more advanced safety systems, such as automated emergency alerts or smart surveillance, applicable in both residential and industrial environments.

References:

[1] https://www.arduino.cc/.
[2] https://www.educba.com
[3] https://www.researchgate.net/publication/
[4] https://www.geeksforgeeks.org