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• OPEN ENDED LAB REPORT

Title: **FIRE AND SOMOKE DETECTION WITH ALARM USING ARDUINO UNO**

Contents

1. Abstract

Fire and smoke pose severe threats to life, property, and the environment, making early detection essential. This project presents a cost-effective and automated fire and smoke detection system using Arduino UNO, MQ2 smoke sensor, and flame sensor. The system continuously monitors air quality and flame presence, triggering appropriate responses such as activating a buzzer, exhaust fan, water pump, and displaying real-time status on an LCD. The integration of sensors with relays ensures timely action without human intervention. The proposed system demonstrates reliability, simplicity, and effectiveness, making it ideal for residential, industrial, and educational applications.

2. OBJECTIVE:

To design and implement an Arduino-based fire and smoke detection system that can detect potential hazards and respond with appropriate actions like sounding an alarm, turning on a fan, activating a water pump, and displaying status on an LCD.

3. INTRODUCTION

Fire hazards pose significant risks to life and property. Early detection of fire and smoke is crucial for prompt response and mitigation. This project aims to develop an automated system using an Arduino UNO microcontroller that detects fire and smoke using MQ2 and flame sensors. Upon detection, the system activates an alarm, a water pump, and a fan to control the situation, ensuring safety and minimizing damage.

4. COMPONENTS USED & COMPONENTS OVERVIEW

S.No	Component	Quantity
1.	Arduino UNO	1
2.	MQ2 Smoke Sensor	1
3.	Flame Sensor	1
4.	Relay Module	2
5.	Exhaust Fan	1
6.	Water Pump (Mini)	1
7.	LCD Display (I2C)	1
8.	Buzzer	1
9.	Jumper Wires	As Req.

10.	Breadboard (Mini)	1
11.	Power Source (9V Battery / USB)	

4.1 Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the ATmega328P. It features 14 digital input/output pins, 6 analog inputs, and a USB connection. In this project, it serves as the central processing unit, reading sensor data and controlling actuators like the buzzer, fan, and water pump.

4.2 MQ2 Smoke Sensor(Transducer):

The MQ2 sensor is capable of detecting smoke, LPG, methane, and other combustible gases. It provides an analog output corresponding to the concentration of gases detected. When the gas concentration exceeds a predefined threshold, the sensor signals the Arduino to trigger the alarm and activate safety measures.
Since it converts a physical phenomenon (gas concentration) into an electrical signal, it functions as an **input transducer** in this project.

4.3 Flame Sensor(Transducer)

The flame sensor detects infrared (IR) light emitted by flames. It provides an analog output that decreases as the intensity of the flame increases. When the sensor detects a flame (i.e., the output falls below a certain threshold), it alerts the Arduino to initiate emergency protocols.This sensor also acts as an **input transducer**, converting infrared radiation into an electrical
signal.

4.4 Relay Modules

Relays act as switches that allow the Arduino to control high-power devices like the fan and water pump. When the Arduino sends a signal to the relay module, it closes the circuit, powering the connected device.

4.5 Water Pump (Fluid Actuator):

The water pump is activated to extinguish flames upon detection. Controlled via a relay, it ensures immediate response to fire incidents. Used to spray water on the fire source. It converts the electrical signal into fluid movement.

4.6 Exhaust Fan (Mechanical Actuator):

The fan helps to disperse smoke, improving visibility and reducing inhalation risks. It is also controlled through a relay module. Activated to remove smoke from the affected area. It converts electrical signals into mechanical rotation (airflow).

4.7 LCD Display

A 16x2 LCD display provides real-time feedback on the system's status, such as "System Normal," "Smoke Detected," or "Fire Alert," enhancing user awareness.

4.8 Buzzer (Sound Actuator)

Emits a loud alarm sound to alert nearby individuals. It converts electrical signals from the Arduino into sound energy.

5 CONNECTIONS & CIRCUIT DIAGRAM:

Sensors:

- **MQ2 Sensor**
  - VCC → 5V
  - GND → GND
  - A0 → A0 (Analog)
- **Flame Sensor**
  - VCC → 5V
  - GND → GND
  - A0 → A1 (Analog)

Relay Modules:

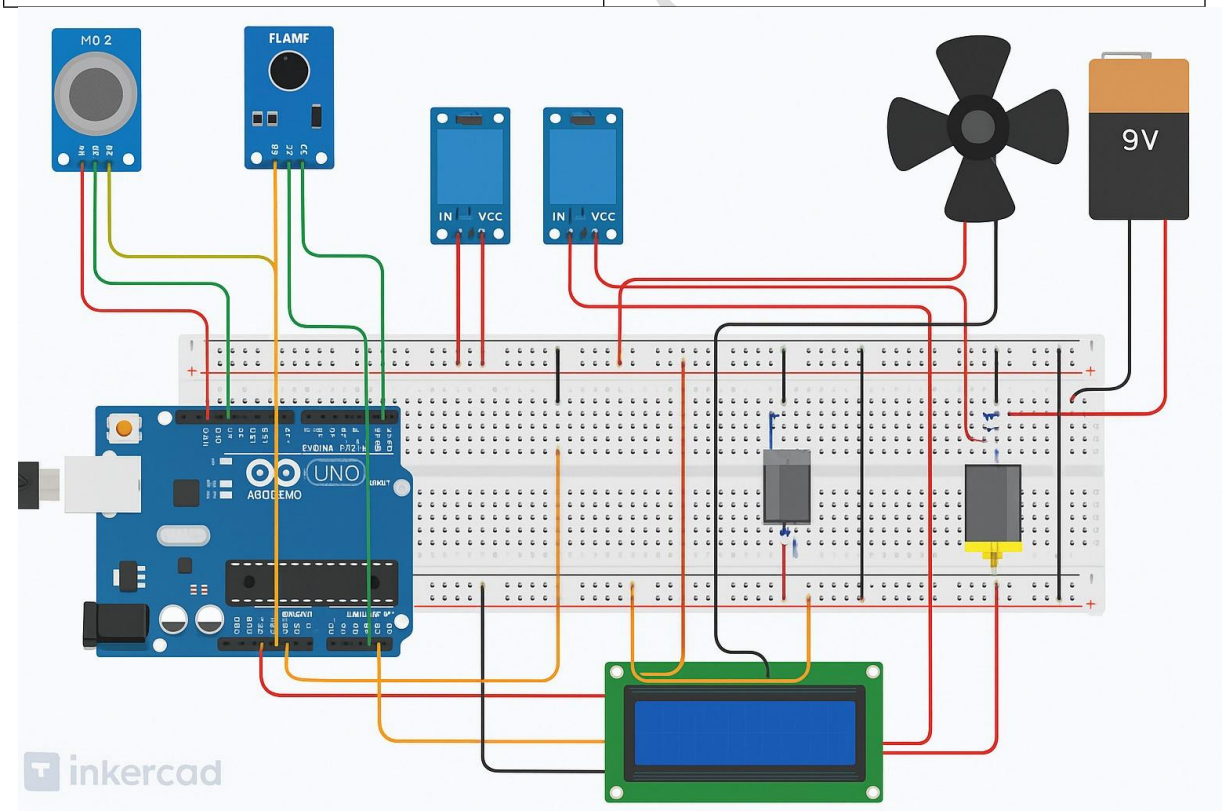
- **Fan Relay**
  - IN → A2
  - VCC → 5V
  - GND → GND
- **Pump Relay**
  - IN → A3
  - VCC → 5V
  - GND → GND

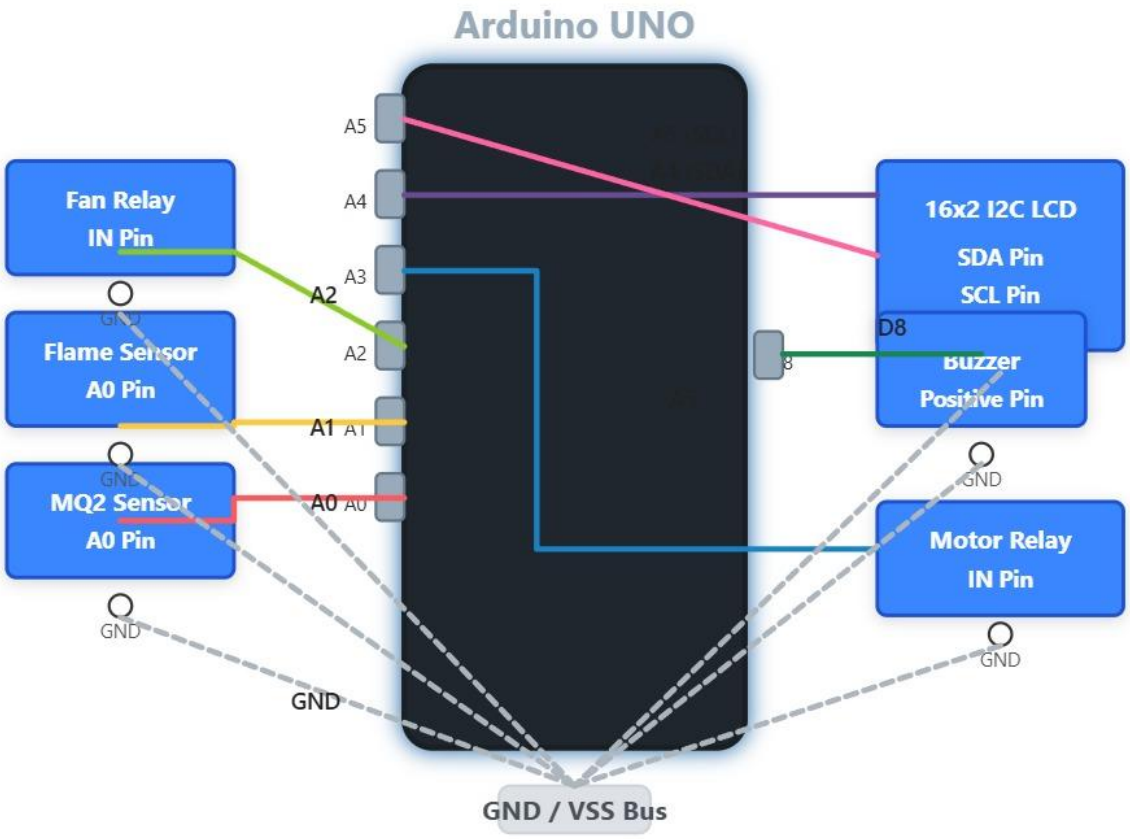
LCD Display (I2C):

- GND → GND
- VCC → 5V
- SDA → A4
- SCL → A5

Buzzer:

- Positive → Pin 8
- Negative → GND





6 WORKING PRINCIPLE

The system continuously monitors the environment using the MQ2 and flame sensors. When the MQ2 sensor detects smoke levels above a certain threshold, or the flame sensor detects the presence of fire, the Arduino UNO processes these signals and activates the buzzer, fan, and water pump accordingly. The LCD display provides real-time updates on the system's status

7 CONTROL MECHANISM

The Arduino microcontroller serves as the system's brain, receiving input signals from the MQ2 and flame sensors. When the gas concentration or flame intensity exceeds predefined threshold values, the Arduino processes this information and triggers the appropriate actuators (buzzer, exhaust fan, and water pump). This automated response ensures a rapid and effective reaction to fire hazards, improving the system's ability to mitigate risks without human intervention.

8 ARDUINO CODE

inm_project_final_code.ino

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Initialize LCD at address 0x27 with 16 columns and 2 rows
LiquidCrystal_I2C lcd(0x27, 16, 2);

const int flameSensorPin = A1;    // Flame sensor analog input pin
const int mq2SensorPin = A0;      // MQ2 sensor analog input pin
const int fanRelayPin = A2;       // Relay to control exhaust fan
const int pumpRelayPin = A3;      // Relay to control water pump
const int buzzerPin = 8;          // Buzzer control pin

// Thresholds
const int smokeThreshold = 300;
const int smokeLowThreshold = 200;
const int flameThreshold = 400;

const int buzzerToneFreq = 1000; // 1kHz buzzer tone

void setup() {
  pinMode(flameSensorPin, INPUT);
  pinMode(mq2SensorPin, INPUT);
  pinMode(fanRelayPin, OUTPUT);
  pinMode(pumpRelayPin, OUTPUT);
  pinMode(buzzerPin, OUTPUT);

  digitalWrite(fanRelayPin, LOW);
  digitalWrite(pumpRelayPin, LOW);
  digitalWrite(buzzerPin, LOW);
```

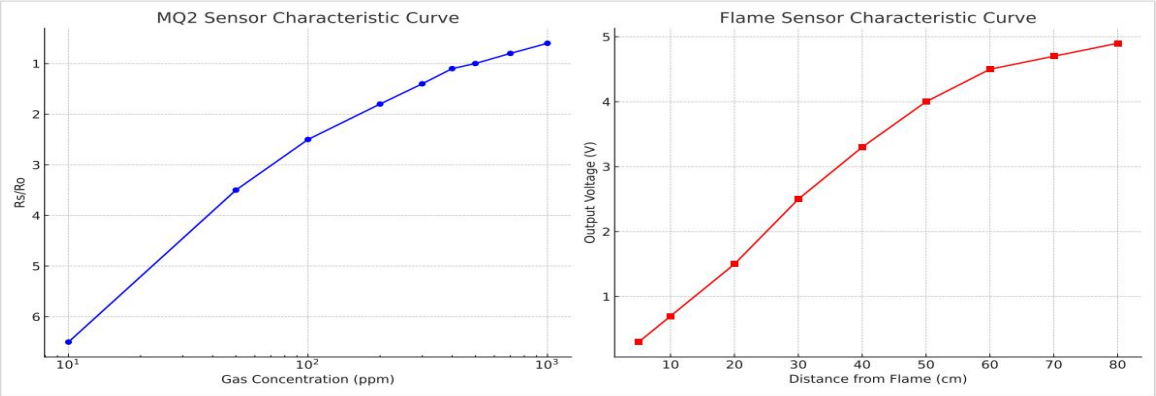
```
30
31    Serial.begin(9600);
32    Serial.println("Smoke and Fire Detector");
33
34    lcd.begin(16, 2);
35    lcd.backlight();
36    lcd.setCursor(0, 0);
37    lcd.print("SMOKE & FIRE");
38    lcd.setCursor(0, 1);
39    lcd.print("DETECTOR READY");
40    delay(10000);
41  }
42
43  void loop() {
44    int flameValue = analogRead(flameSensorPin);
45    int smokeValue = analogRead(mq2SensorPin);
46
47    bool fireDetected = (flameValue < flameThreshold);
48    bool smokeDetected = (smokeValue >= smokeThreshold);
49
50    Serial.print("Flame Sensor: ");
51    Serial.print(flameValue);
52    Serial.print(" | Smoke Sensor: ");
53    Serial.println(smokeValue);
54
55    // Control water pump
56    if (fireDetected) {
57      digitalWrite(pumpRelayPin, HIGH);
58    } else {
59      digitalWrite(pumpRelayPin, LOW);
60    }
61
62    // Control fan with hysteresis
63    static bool fanOn = false;
64    if (smokeDetected && !fanOn) {
65      digitalWrite(fanRelayPin, HIGH);
66      fanOn = true;
67    } else if (!smokeDetected && fanOn && smokeValue < smokeLowThreshold) {
68      digitalWrite(fanRelayPin, LOW);
69      fanOn = false;
70    }
71
72    // Control buzzer
73    if (fireDetected || smokeDetected) {
74      tone(buzzerPin, buzzerToneFreq);
75    } else {
76      noTone(buzzerPin);
77    }
```

```
    noTone(buzzerPin);
  }

  // LCD Display logic
 lcd.clear();
if (fireDetected && smokeDetected) {
  lcd.setCursor(0, 0);
  lcd.print("FIRE ALERT!!!");
  lcd.setCursor(0, 1);
  lcd.print("STAY CALM & EXIT");
} else if (fireDetected) {
  lcd.setCursor(0, 0);
  lcd.print("FIRE ALERT!!!");
  lcd.setCursor(0, 1);
  lcd.print("EVACUATE AREA!");
} else if (smokeDetected) {
  lcd.setCursor(0, 0);
  lcd.print("SMOKE ALERT!!");
  lcd.setCursor(0, 1);
  lcd.print("FAN ON!!");
} else {
  lcd.setCursor(0, 0);
  lcd.print("SYSTEM NORMAL");
  lcd.setCursor(0, 1);
  lcd.print("GROUP D-7");
}

  delay(200);
}
```

9 OBSERVATIONS

- The MQ2 sensor effectively detects varying levels of smoke, triggering the fan and buzzer when thresholds are exceeded.
- The flame sensor promptly identifies the presence of fire, activating the water pump and buzzer.
- The LCD display provides clear, real-time updates on the system's status, enhancing user awareness.
- The system demonstrates reliable performance in detecting and responding to fire and smoke incidents.

10 CHARACTERISTICS CURVE



11 APPLICATIONS

- Residential fire and smoke detection systems.
- Industrial safety monitoring.
- Smart building fire safety integration.
- Educational demonstrations of fire detection systems.

12 ADVANTAGES

- Early detection of fire and smoke, allowing prompt response.
- Automated activation of safety measures reduces reliance on human intervention.
- Cost-effective solution using readily available components.
- Scalable and customizable for various applications.

13 RESULTS

The implemented system successfully detects smoke and fire, activating appropriate safety measures such as alarms, exhaust fans, and water pumps. The real-time feedback provided by the LCD display significantly enhances user awareness, contributing to effective hazard management. During testing, the system was able to detect smoke within a 2-meter radius and trigger alarms and other safety devices within milliseconds of flame detection. This real-time response ensures that immediate actions are taken to mitigate potential hazards, making the system effective for early-stage fire safety.

14 CONCLUSION

The "Fire and Smoke Detection with Alarm Using Arduino UNO" project demonstrates an effective approach to early fire hazard detection and response. By integrating sensors, actuators, and a microcontroller, the system provides a reliable and automated solution for enhancing safety in various environments. Furthermore, the system's low cost and ease of implementation make it an ideal choice for applications in residential, industrial, and commercial settings.In the future, additional features such as wireless communication for remote monitoring or more advanced sensors could be integrated to improve system functionality and extend its range of application.

12 APPENDIX

Here is the Picture of the OEL in Working Condition