MSI (CPE-342)

Project Title: Environment Monitoring System

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Contents

Introduction:

Toxic gases, such as carbon monoxide (CO), can cause illness, loss of consciousness, and even fatalities. Abnormal temperature fluctuations can indicate electrical issues, overheating, or potential fire hazards. Excessive humidity levels can contribute to Mold growth, leading to respiratory problems and property damage. Fires can have devastating consequences, jeopardizing lives, and causing extensive damage to property. They can spread rapidly, leaving occupants with little time to react. Common fire hazards include electrical malfunctions, overheating appliances, and flammable materials. In this project we are going to provide a solution for these life-threatening dangers. The Home Monitoring System for Flame, Gas, Temperature, and Humidity Detection is an advanced solution designed to enhance safety and provide real-time environmental monitoring within a home or indoor environment. This system incorporates multiple sensors and an LCD display to detect and display critical information about potential fire hazards, gas leaks, temperature variations, and humidity levels. By continuously monitoring these parameters, the system aims to ensure the safety and well-being of occupants by alerting them to potential dangers and enabling prompt action to mitigate risks.

Motivation of the project:

Motivation for the Home Monitoring System for Flame, Gas, Temperature, and Humidity Detection project:

1. Safety and Well-being: The primary motivation for this project is to prioritize the safety and well-being of individuals and their living spaces. By implementing a comprehensive monitoring system, you can create a safer environment that helps prevent potential fire hazards, gas leaks, and adverse environmental conditions. This project empowers you to proactively address safety concerns and protect yourself, your family, and your property.

2. Early Detection and Prompt Action: Timely detection of fire hazards, gas leaks, and unfavourable environmental conditions is crucial for minimizing risks and taking prompt action. By incorporating sensors and an LCD display, this project enables you to monitor these parameters in real-time, ensuring that you receive immediate alerts and can respond swiftly. Early detection allows for faster evacuation, activation of safety measures, and seeking professional assistance, thereby reducing the potential for damage and harm.

3. Peace of Mind: Implementing a home monitoring system offers peace of mind by providing constant vigilance and alerts. You can confidently go about your daily activities, knowing that potential dangers are being monitored and that you will be promptly alerted in case of any emergencies. This peace of mind is particularly valuable when you are away from home, allowing you to remotely monitor and address potential risks.

4. Preventing Property Damage: Fires and gas leaks can cause significant damage to property, leading to financial losses and emotional distress. By investing in this monitoring system, you can detect potential risks early on and take immediate action, minimizing the extent of property damage. Additionally, monitoring temperature and humidity levels helps identify issues such as excessive moisture that can lead to mold growth and property deterioration.

5. Environmental Awareness and Comfort: Monitoring temperature and humidity levels in real-time provides insights into the comfort and health of your living environment. By being

aware of temperature fluctuations and humidity levels, you can adjust climate control systems, address ventilation issues, and ensure optimal conditions for comfort and well-being. This project empowers you to create a more pleasant and healthier living space.

6. Learning and Skill Development: Developing and implementing a home monitoring system involves acquiring knowledge and skills in electronics, sensor integration, data interpretation, and programming. Engaging in this project allows you to expand your technical expertise and gain practical experience in building a sophisticated monitoring system. The skills acquired can be applied to other projects and contribute to personal growth and development.

7. In conclusion, the motivation behind the Home Monitoring System for Flame, Gas, Temperature, and Humidity Detection project lies in prioritizing safety, taking prompt action, ensuring peace of mind, preventing property damage, creating a comfortable environment, and acquiring valuable knowledge and skills. By embarking on this project, you contribute to a safer and more secure living environment for yourself and your loved ones.

Aims and Objectives:

The aim of the project is to design and develop a Home Monitoring System for Flame, Gas, Temperature, and Humidity Detection. The project aims to achieve the following objectives:

1. Sensor Integration: Integrate and interface different sensors, including a flame sensor, MQ2 gas sensor, and DHT11 temperature and humidity sensor, into a single monitoring system. Ensure proper connections and compatibility between the sensors and the microcontroller.

2. Real-Time Monitoring: Continuously monitor the parameters of interest, such as flame status, gas concentration, temperature, and humidity levels. Enable real-time data acquisition from the sensors to provide accurate and up-to-date information about the environment.

3. Alert Generation: Implement an alert mechanism that triggers notifications or alarms in case of any potential dangers or abnormal conditions. Develop appropriate thresholds or criteria for generating alerts based on predefined safety levels or user-defined settings.

4. User Interface: Create a user-friendly interface to display the sensor readings and alerts. Utilize an LCD screen or other suitable display technology to present the information in a clear and understandable format. Ensure the interface is intuitive and provides relevant information briefly.

5. Data Interpretation: Process and interpret the raw sensor data to derive meaningful information, such as gas concentration levels, temperature values, and humidity percentages. Implement necessary algorithms or calibration techniques to convert raw data into usable and accurate measurements.

6. System Reliability: Design the system to be reliable and stable, ensuring consistent and accurate monitoring. Implement error handling mechanisms to handle sensor failures or communication issues. Consider factors such as sensor drift, noise, and calibration to maintain the reliability of the system.

7. Safety Enhancement: Enhance the safety of the monitored environment by providing early detection and timely alerts for potential fire hazards and gas leaks. Enable occupants to take

necessary actions, such as evacuating the premises, turning off gas supplies, or contacting emergency services.

8. Expandability and Modularity: Design the system to be expandable and modular, allowing for future additions or modifications. Consider the possibility of integrating additional sensors or connecting to external systems for enhanced functionality or remote monitoring capabilities.
9. Documentation and Reporting: Document the design, implementation, and functionality of the home monitoring system. Prepare a comprehensive report detailing the project's aims, objectives, methodology, findings, and recommendations. Ensure the report provides sufficient information for others to understand and replicate the system.
10. Testing and Validation: Perform thorough testing and validation of the system to ensure its accuracy, reliability, and performance. Verify the functionality of each sensor, the alert mechanism, and the user interface. Conduct real-world scenarios or simulations to evaluate the system's effectiveness in detecting and responding to potential dangers.

By accomplishing these aims and objectives, the project aims to deliver a fully functional and reliable Home Monitoring System for Flame, Gas, Temperature, and Humidity Detection that enhances safety, provides real-time monitoring, and promotes a secure living environment.

Aims and Objectives:

Project Implementation:

The project implementation involves the methodology and technical details of the Home Monitoring System for Flame, Gas, Temperature, and Humidity Detection.

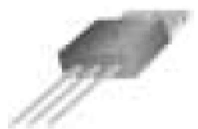
We used the following components for project implementation:

Voltage Regulator:

The MC78XX/LM78XX/MC78XXA series of three terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting,

thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

TO-220



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D-PAK

1

1. Input 2. GND 3. Output

Input Voltage (for V_O = 5V to 18V)
(for V_O = 24V)

35V
40V
Thermal Resistance Junction-Cases (TO-220) $R_{\theta JC}$ 5 ^{o}C/W
Thermal Resistance Junction-Air (TO-220) $R_{\theta JA}$ 65 ^{o}C/W

Operating Temperature Range TOPR 0 ~ +125 oC
Storage Temperature Range TSTG -65 ~ +150 oC

MQ-2 Sensor:

The MQ-2 sensor is a gas sensor that can detect a variety of gases, including but not limited to LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide (CO). It is commonly used in applications such as gas leakage detection, fire detection, and air quality monitoring.

The detection range of the MQ-2 sensor depends on the target gas. It can detect gases in concentrations from a few hundred parts per million (ppm) up to several thousand ppm.

The MQ-2 sensor provides an analog output voltage that corresponds to the gas concentration. The analog voltage can be read by an analog-to-digital converter (ADC) on the Arduino board to obtain a gas concentration value.

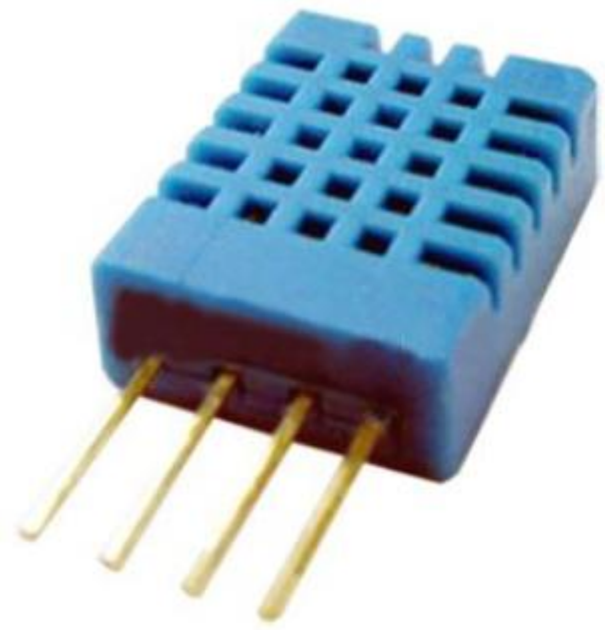
The MQ-2 sensor requires calibration to obtain accurate and consistent readings. Calibration involves exposing the sensor to known concentrations of target gases and adjusting the readings accordingly. Calibration is usually done periodically or when significant changes in environmental conditions occur.

It's important to note that the MQ-2 sensor is a low-cost gas sensor and may not provide highly precise and selective gas measurements. Cross-sensitivity to other gases, response time, and stability can vary. Additionally, the sensor's lifespan may be affected by environmental factors such as humidity and exposure to contaminants.

DHT11:

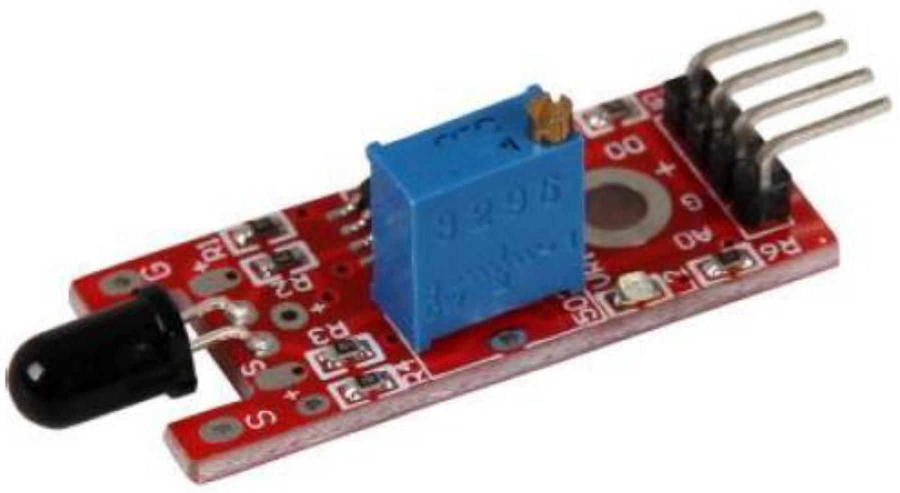
Temperature & Humidity Sensor features a temperature & humidity sensor.
complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition
technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement.
component and an NTC temperature measurement component, and connects to a high-performance
8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

It provides ±5％RH humidity accuracy and ±2℃ temp accuracy.



Flame IR Sensor:

The sensor has 3 main components on its circuit board. First, the sensor unit at the front of the module
which measures the area physically and sends an analog signal to the second unit, the amplifier. The
amplifier amplifies the signal, according to the resistant value of the potentiometer, and sends the signal to
the analog output of the module.
The third component is a comparator which switches the digital out and the LED if the signal falls under a
specific value.
You can control the sensitivity by adjusting the potentiometer.



Working of the Project:

The project involves integrating multiple sensors, including the MQ-2 gas sensor, DHT11 temperature and humidity sensor, and a flame sensor, with an Arduino board to monitor air quality, temperature, humidity, and detect flames. Here's an overview of how the project works:

1. Sensor Connections: The sensors are connected to the Arduino board using appropriate pins. The MQ-2 sensor is connected to an analog input pin (A0) to read the gas concentration, the DHT11 sensor is connected to a digital pin (7) to read temperature and humidity, and the flame sensor is connected to another digital pin (6) to detect flames.

2. LCD Initialization: The project uses a LiquidCrystal library to interface an LCD display with the Arduino. The LCD pins (RS, EN, D4-D7) are connected to specific digital pins on the Arduino. The LCD is initialized with the appropriate settings, such as the number of columns and rows.

3. Setup: In the setup() function, the LCD is initialized, and an initial message is printed on the display. Serial communication is also started to allow data to be printed on the serial monitor for debugging purposes.

4. Loop: The main logic of the project resides in the loop() function, which runs continuously.

- Gas Sensor Reading: The loop starts by reading the analog value from the MQ-2 sensor using the analogRead() function. This value is then mapped to a corresponding air quality level using the map() function. The air quality level is displayed on the LCD and sent to the serial monitor.

- Flame Sensor Detection: The loop checks the status of the flame sensor by reading its digital pin. If the flame is detected (the pin is HIGH), the buzzer is turned on, indicating the presence of a flame. Otherwise, the buzzer remains off.

- Temperature and Humidity Reading: The DHT11 sensor is read using the DHT library. The temperature and humidity values are obtained and displayed on the LCD and sent to the serial monitor.

- Delay: A delay of 2 seconds is added to provide a time interval between sensor readings. This delay ensures that the sensors are not read too frequently, preventing excessive processing and unnecessary power consumption.

5. Sensor Data Display: The air quality level, temperature, and humidity readings are displayed on the LCD screen using the lcd.print() and lcd.setCursor() functions. This allows the user to visually monitor the data in real-time.

The project continuously loops through these steps, updating the sensor readings and displaying them on the LCD screen. The user can observe the air quality level, temperature, and humidity values on the LCD and monitor the data through the serial monitor.

Additionally, if a flame is detected by the flame sensor, the buzzer is activated to provide an audible alert. This can be useful in scenarios where fire detection is required.

It's important to note that the project assumes the sensors are correctly connected and calibrated according to their respective datasheets and operating guidelines. Additionally, appropriate safety precautions should be taken when working with flames or potentially hazardous gases.

Project Analysis with reference to CLO-8 and CLO-9:

CLO-8:

The environmental monitoring system deals with the industrial standards of what is considered toxic gas.

CLO-9:

The designed project, which integrates multiple sensors (MQ-2, DHT11, and flame sensor) with an Arduino board and LCD display, can be justified as significant to society using existing engineering practices. Here's a justification based on engineering principles and practices:

1. Safety and Security: The integration of sensors, such as the MQ-2 sensor for air quality monitoring and the flame sensor for fire detection, enhances safety and security in various environments. By continuously monitoring air quality and detecting the presence of fire, the project can provide early warnings and trigger appropriate actions to prevent potential hazards. This aligns with established engineering practices for safety and risk management.

2. Environmental Monitoring: The inclusion of the MQ-2 sensor in the project enables monitoring of air quality parameters, which is crucial for assessing environmental conditions. By providing real-time information about air quality, the project contributes to environmental awareness and promotes sustainable practices. This aligns with engineering practices related to environmental monitoring and sustainability.

3. Data Acquisition and Analysis: The project incorporates sensors to gather data on air quality, temperature, humidity, and flame detection. This data acquisition capability aligns with engineering practices related to data-driven decision-making and analysis. The collected data can be used for trend analysis, identifying patterns, and making informed decisions regarding environmental conditions and safety measures.

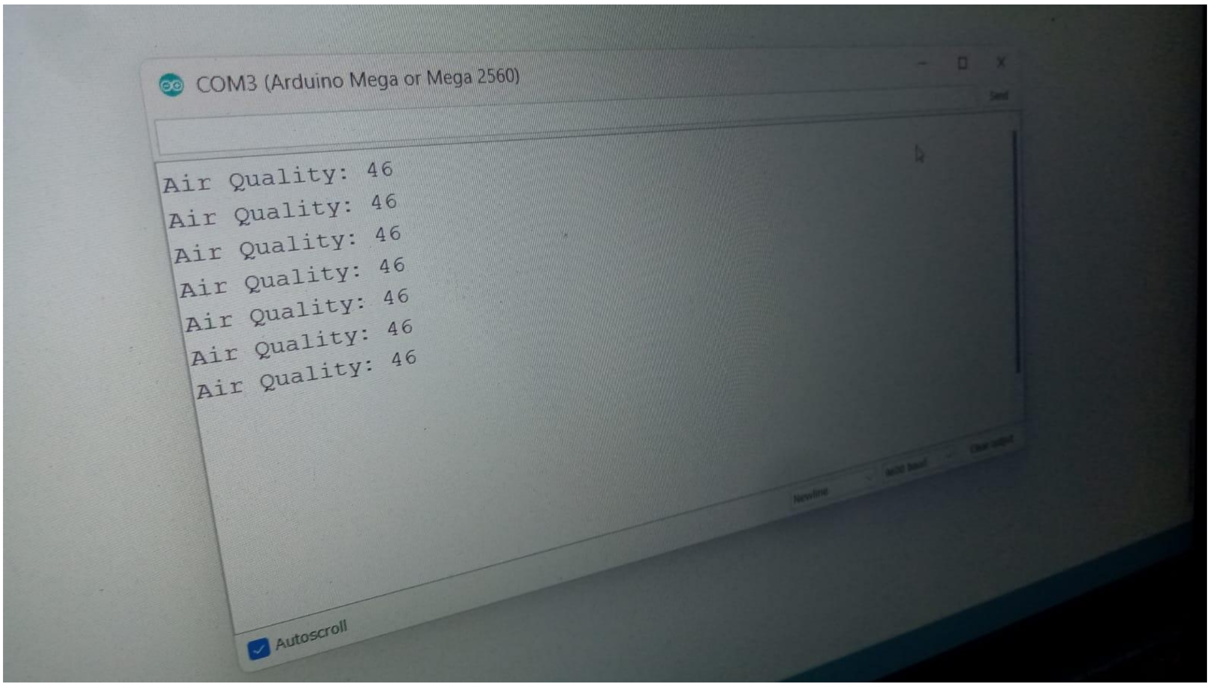
4. Human-Machine Interface: The LCD display serves as a user-friendly interface, providing visual feedback and information about air quality, temperature, humidity, and fire detection. This aligns with engineering practices for designing intuitive and effective human-machine interfaces, enhancing usability and enabling users to interact with the system in a meaningful way.

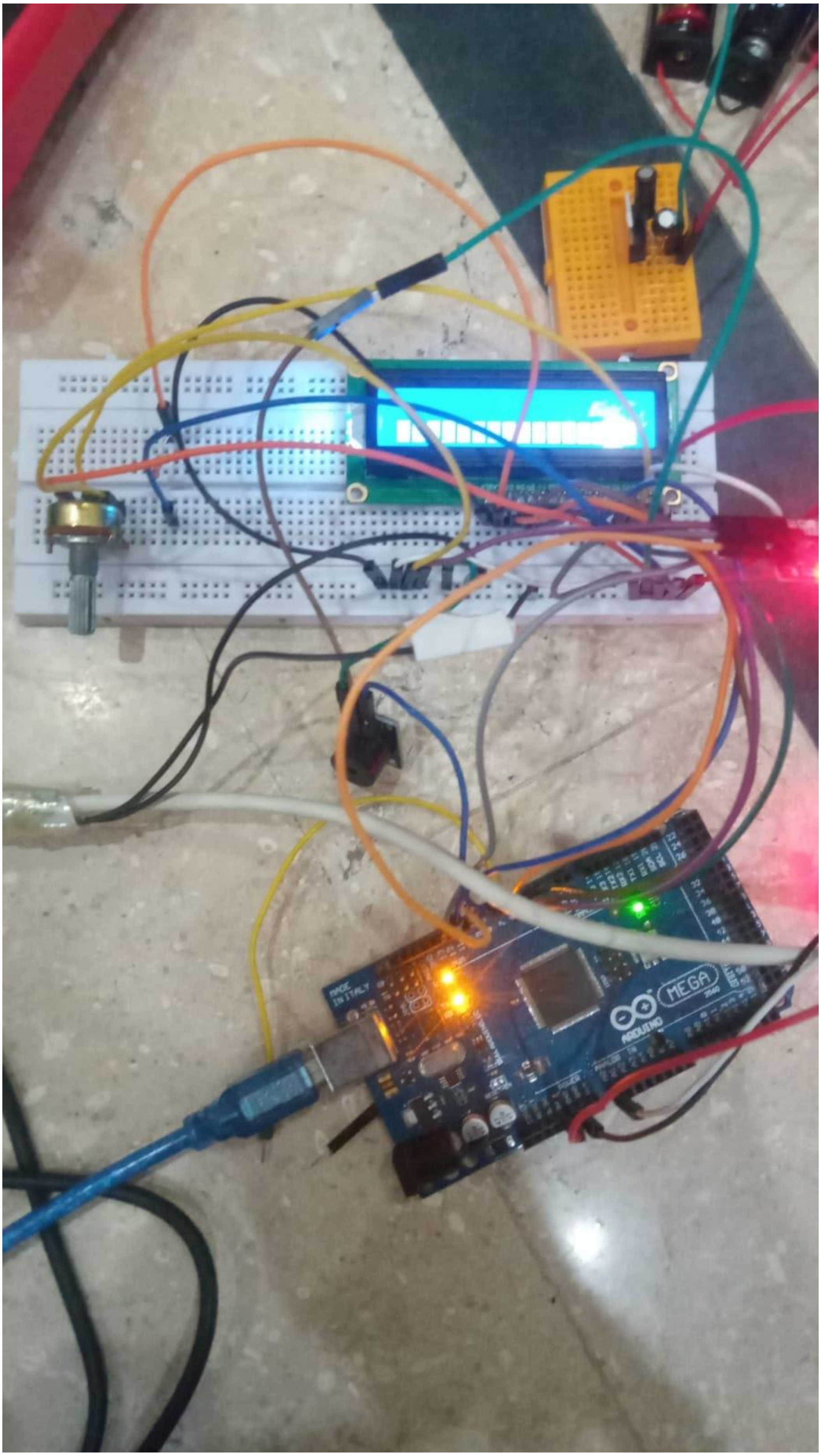
5. System Integration and Interoperability: The project involves integrating multiple sensors, the Arduino board, LCD display, and additional components such as the buzzer. This demonstrates engineering practices related to system integration and interoperability, where different hardware components are seamlessly connected and work together to achieve the desired functionality.

6. Prototyping and Innovation: The project showcases prototyping and innovation, leveraging the flexibility of Arduino and the availability of sensors to create a functional system. This aligns with engineering practices focused on iterative design, experimentation, and continuous improvement.

By demonstrating these engineering practices, the designed project holds significance for society. It promotes safety, environmental awareness, data-driven decision-making, user-friendly interfaces, system integration, and innovation. These aspects contribute to the advancement of engineering practices and address real-world challenges, ultimately benefiting individuals, communities, and various industries.

Results:





Appendix:

```
#include <LiquidCrystal.h>

#include <dht.h>


// Define LCD pin connections

const int LCD_RS = 12;

const int LCD_EN = 11;

const int LCD_D4 = 4;

const int LCD_D5 = 5;

const int LCD_D6 = 6;

const int LCD_D7 = 7;


// Define pin connections for sensors

const int MQ2_PIN = A0;       // MQ-2 sensor pin

const int FLAME_PIN = 9;      // Flame sensor pin

const int BUZZER_PIN = 8;     // Buzzer pin


// Initialize the LCD object

LiquidCrystal lcd(LCD_RS, LCD_EN, LCD_D4, LCD_D5, LCD_D6, LCD_D7);


// Initialize the DHT11 sensor object

dht DHT;


void setup() {

  // Set up the number of columns and rows for the LCD

  lcd.begin(16, 2);


  // Print the initial message on the LCD

  lcd.setCursor(0, 0);

  lcd.print("Temp:   Humidity:");

  lcd.setCursor(0, 1);
```

```
  lcd.print("Flame:  Air Quality:");

  // Set pin modes
  pinMode(FLAME_PIN, INPUT);
  pinMode(BUZZER_PIN, OUTPUT);

  // Start serial communication
  Serial.begin(9600);
}

void loop() {
  /*// Read temperature and humidity from the DHT11 sensor
  int dht11Result = DHT.read11(DHT11_PIN);

  // Check if the DHT11 sensor read was successful
  if (dht11Result == DHTLIB_OK) {
    // Get the temperature and humidity values
    float temperature = DHT.temperature;
    float humidity = DHT.humidity;

    // Check for valid readings
    if (isnan(temperature) || isnan(humidity)) {
      lcd.setCursor(6, 0);
      lcd.print("Error    Error");
      Serial.println("Invalid data");
   // Clear the LCD screen
    lcd.setCursor(6, 0);
    lcd.print("       ");
    lcd.setCursor(6, 1);
    lcd.print("        ");
```

```
// Print temperature and humidity on the LCD
lcd.setCursor(0, 0);
lcd.print(temperature, 1);
lcd.print("C ");
lcd.setCursor(0, 0);
lcd.print(humidity, 1);
lcd.print("%");

// Print temperature and humidity on the serial monitor
Serial.print("Temp: ");
Serial.print(temperature, 1);
Serial.print("C, Humidity: ");
Serial.print(humidity, 1);
Serial.println("%");
}     return;
}

// Clear the LCD screen
lcd.setCursor(6, 0);
lcd.print("       ");
lcd.setCursor(6, 1);
lcd.print("       ");

// Print temperature and humidity on the LCD
lcd.setCursor(0, 0);
lcd.print(temperature, 1);
lcd.print("C ");
lcd.setCursor(0, 0);
lcd.print(humidity, 1);
lcd.print("%");
```

```
    // Print temperature and humidity on the serial monitor
    Serial.print("Temp: ");
    Serial.print(temperature, 1);
    Serial.print("C, Humidity: ");
    Serial.print(humidity, 1);
    Serial.println("%");
  } else{
    // DHT11 sensor read failed, print an error message on the LCD
    lcd.setCursor(0, 0);
    lcd.print("Error    Error");
    Serial.println("DHT11 Read Error");
//  }*/

  // Read the flame sensor value
  int flameValue = digitalRead(FLAME_PIN);

  // Clear the LCD screen
  lcd.setCursor(0, 1);
  lcd.print("      ");



  if (flameValue == HIGH) {
    lcd.print("Detected");
    digitalWrite(BUZZER_PIN, HIGH);  // Turn on the buzzer
  } else {
    lcd.print("None    ");
    digitalWrite(BUZZER_PIN, LOW);   // Turn off the buzzer
  }
```

```
// Read the analog value from the MQ-2 sensor
int sensorValue = analogRead(MQ2_PIN);

// Map the sensor value to a corresponding air quality level
int airQuality = map(sensorValue, 0, 1023, 0, 500);

// Clear the LCD screen
lcd.setCursor(0, 1);
lcd.print("       ");

// Print the air quality level on the LCD
lcd.setCursor(0, 1);
lcd.print(airQuality);

// Categorize air quality based on AQI ranges
lcd.setCursor(0, 1);
if (airQuality <= 50) {
  lcd.print("(Good)");
} else if (airQuality <= 100) {
  lcd.print("(Moderate)");
  delay(1000);
} else if (airQuality <= 150) {
  lcd.print("(Unhealthy)");
} else if (airQuality <= 200) {
  lcd.print("(Very Unhealthy)");
} else {
  lcd.print("(Hazardous)");
}

// Print the air quality level on the serial monitor
Serial.print("Air Quality: ");
```

```
  Serial.print(airQuality);
  Serial.println();

  delay(2000); // Delay between sensor readings
}
```