SSN COLLEGE OF ENGINEERING
DEPARTMENT OF INFORMATION TECHNOLOGY

UIT2412 Digital Systems and Microprocessor Laboratory

MINI PROJECT

Title: SMOKE ALARM USING MQ2 GAS SENSOR

PROJECT REPORT

Done by

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ABSTRACT:

- This project presents the design and implementation of an Arduino-based smoke alarm system utilizing the MQ-2 gas sensor. The primary objective is to create a cost-effective, reliable, and responsive smoke detection system suitable for residential and commercial environments. The MQ-2 gas sensor can detect smoke, methane, butane, and other combustible gases, making it an ideal choice for a comprehensive safety device.
- The system's core is an Arduino microcontroller that continuously monitors the gas concentration levels detected by the MQ-2 sensor. When the sensor's readings exceed predefined threshold values, indicating the presence of smoke or hazardous gas levels, the Arduino triggers an LED indicator for visual alert.
- This project emphasizes simplicity, affordability, and ease of installation, making it accessible for a wide range of users. The integration of the MQ-2 gas sensor with the Arduino platform demonstrates an effective approach to enhancing safety measures against fire hazards and gas leaks, contributing to safer living, and working environments. The smoke alarm system's performance and reliability are validated through a series of tests, confirming its capability to promptly and accurately detect smoke and gas concentrations.

INTRODUCTION:

- Fire safety is a critical concern in both residential and commercial settings, necessitating the development of reliable and efficient smoke detection systems. Traditional smoke alarms, while effective, often come with limitations in terms of detection range, response time, and the ability to detect various types of hazardous gases. To address these challenges, this project explores the development of a sophisticated smoke alarm system using an Arduino microcontroller and an MQ-2 gas sensor.
- The MQ-2 gas sensor is renowned for its ability to detect a wide range of gases, including smoke, methane, butane, and other combustible gases. This versatility makes it an excellent choice for enhancing fire detection capabilities. By integrating the MQ-2 sensor with an Arduino, this project aims to create a responsive and cost-effective smoke alarm system that not only detects smoke but also identifies the presence of other dangerous gases, providing a comprehensive safety solution.
- The Arduino serves as the system's processing unit, continuously monitoring the output from the MQ-2 sensor. When the sensor detects gas concentrations above a predefined threshold, the Arduino activates an alarm system comprising a buzzer and an LED indicator to alert occupants immediately. This immediate response is crucial for preventing potential fire hazards and ensuring the safety of individuals within the monitored area.
- In summary, this project aims to develop a versatile, reliable, and affordable smoke alarm system using an Arduino and an MQ-2 gas sensor. By addressing the limitations of traditional smoke alarms and incorporating advanced notification features, the proposed system offers a significant improvement in fire safety measures for homes and businesses alike.

MOTIVATION:

The motivation for this project stems from the critical need for enhanced fire safety measures in both residential and commercial environments. The development of a more versatile and responsive smoke detection system is hence essential for improving safety and reducing the risk of fire-related incidents.

Key motivations for this project include:

1. **Enhanced Detection Capabilities:** Traditional smoke alarms are primarily designed to detect smoke from fires, but many dangerous situations involve the presence of other gases such as methane, butane, and propane. The MQ-2 gas sensor's ability to detect multiple types of gases provides a more comprehensive safety solution.
2. **Improved Response Time:** Early detection of smoke and gas leaks is crucial for preventing fires and minimizing damage. By utilizing the Arduino's real-time monitoring capabilities, this project aims to ensure faster detection and response, giving occupants more time to evacuate and take necessary actions.
3. **Affordability and Accessibility:** High-quality smoke detection systems can be expensive, limiting their accessibility to many households and small businesses. This project focuses on creating a cost-effective solution using readily available components, making advanced fire safety technology accessible to a broader audience.
4. **Educational Value:** This project serves as an excellent educational tool for those interested in electronics, programming, and safety systems. It demonstrates the practical application of microcontroller technology and sensors in solving real-world problems, inspiring innovation, and learning.
5. **Reducing Fire-Related Incidents:** Fire-related incidents cause significant loss of life and property each year. By developing a more effective smoke alarm system, this project aims to contribute to reducing the occurrence and impact of these incidents, ultimately saving lives, and protecting property.

OBJECTIVE:

Design and Development: To design and develop a smoke alarm system using an Arduino microcontroller and an MQ-2 gas sensor capable of detecting smoke, methane, butane, and other combustible gases.

Real-Time Monitoring: To implement continuous real-time monitoring of gas concentrations using the MQ-2 sensor, ensuring prompt detection of hazardous conditions.

Alarm System Integration: To integrate an audible alarm (buzzer) and visual indicator (LED) that are triggered when gas levels exceed predefined safety thresholds, providing immediate alerts to occupants.

Threshold Calibration: To calibrate the MQ-2 sensor for accurate detection and set appropriate threshold levels for various gases to minimize false alarms while ensuring sensitivity to real hazards.

User Interface: To develop a simple and user-friendly interface for system setup, including options to adjust sensitivity levels and set up mobile alerts.

Power Efficiency: To design the system with power efficiency in mind, ensuring it can operate effectively over long periods with minimal power consumption.

Cost-Effectiveness: To create a cost-effective solution using readily available and affordable components, making the system accessible to a wide range of users.

Reliability and Robustness: To ensure the system is reliable and robust, capable of functioning accurately in various environmental conditions and over extended periods.

Testing and Validati: To conduct comprehensive testing and validation of the system's performance, ensuring it accurately detects smoke and gas concentrations and responds appropriately.

PROBLEM STATEMENT:

Current smoke alarms are limited in their ability to detect only smoke and not other hazardous gases like methane, butane, and propane. They often provide inadequate response times and alert mechanisms, leaving households and businesses vulnerable to fire-related incidents. There is a pressing need for an affordable, versatile, and reliable smoke alarm system that can detect a wider range of dangerous gases and offer timely alerts, including remote notifications. This project aims to develop an Arduino-based smoke alarm using the MQ-2 gas sensor, providing comprehensive detection and immediate alerts to enhance fire safety and protect lives and property.

DESIGN AND DEVELOPMENT OF THE SOLUTION:

Components Needed:

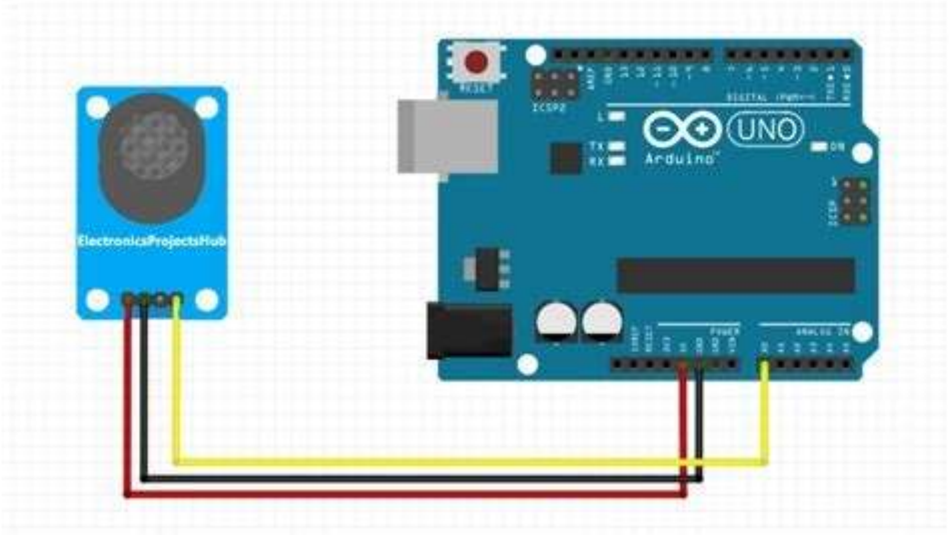
1. **Arduino Uno**: The microcontroller board to process data from the sensor and control the LED.
2. **MQ-2 Gas Sensor**: A sensor capable of detecting smoke, methane, butane, and other combustible gases.
3. **LED**: A visual indicator that lights up when gas levels are high.
4. **Resistors**: Specifically, a 220-ohm resistor for the LED.
5. **Connecting Wires**: For making the necessary electrical connections.
6. **Breadboard**: For prototyping the circuit.

Circuit Diagram and Connections: 1. MQ-2 Gas Sensor:

- **VCC** to 5V on Arduino.
- **GND** to GND on Arduino.
- **AO (Analog Output)** to A0 on Arduino.

2. **LED**:
   - Anode (longer leg) to Digital Pin 7 on Arduino (with a 220-ohm resistor in series).
   - Cathode (shorter leg) to GND on Arduino.

CIRCUIT DIAGRAM:



ARDUINO CODE:

```
#define sensorPin A0

#define ledPin 13

float R0 = 10.0;

float cleanAirFactor = 9.83;

float thresholdPPM = 60.0;

void setup() {

  pinMode(sensorPin, INPUT);

  pinMode(ledPin, OUTPUT);

  Serial.begin(9600);

  // Calibrate the sensor

  Serial.println("Calibrating...");
  R0 = calibrateSensor();
  Serial.print("Calibration complete. R0: ");
  Serial.println(R0);
}
void loop() {
  float rs = readSensor();
  float ratio = rs / R0;
  float ppm = getPPM(ratio);
  Serial.print("Gas concentration: ");
  Serial.print(ppm);
  Serial.println(" ppm");
  if (ppm > thresholdPPM) {
    digitalWrite(ledPin, HIGH);
  } else {
    digitalWrite(ledPin, LOW);
  }
  delay(1000);
}
float calibrateSensor() {
  int sensorValue = 0;
  long sensorSum = 0;
  for (int i = 0; i < 50; i++) {
    sensorValue = analogRead(sensorPin);
    sensorSum += sensorValue;
    delay(100);
  }
  float avgSensorValue = sensorSum / 50.0;
  float rsAir = (1023.0 / avgSensorValue) - 1.0;
  rsAir = 5.0 / rsAir;
  return rsAir / cleanAirFactor;
}
float readSensor() {
  int sensorValue = analogRead(sensorPin);
  float rs = (1023.0 / sensorValue) - 1.0;
  rs = 5.0 / rs;
  return rs;
}
float getPPM(float ratio) {
  // Parameters for the log-log plot equation
  float m = -0.47;  // Slope (derived from the datasheet)
  float b = 1.9;    // Intercept (derived from the datasheet)
  float ppmLog = (log10(ratio) - b) / m;
  return pow(10, ppmLog);
}
```

GAP ANALYSIS

Current State:

1. **Basic Functionality Implemented**: The project has been designed and developed to detect gas concentrations using the MQ-2 sensor and provide a visual alert through an LED when the gas concentration exceeds a predefined threshold.
2. **Calibration Implemented**: The sensor calibration process is included in the code to ensure accurate readings.
3. **Serial Communication for Debugging**: Serial communication is utilized for debugging purposes, providing insights into sensor readings and system behavior.

Desired State:

1. **Enhanced Sensor Calibration**: The calibration process can be refined to improve accuracy and reliability, ensuring consistent performance across different environmental conditions.
2. **Threshold Adjustment Mechanism**: Implement a mechanism to adjust the threshold PPM value dynamically based on environmental factors or user preferences.
3. **Real-Time Data Logging**: Incorporate functionality to log sensor data in real-time, enabling users to analyze historical trends and detect anomalies.
4. **Advanced Alerting Mechanisms**: Integrate additional alerting mechanisms such as email notifications or mobile app notifications for remote monitoring and enhanced user awareness.
5. **Power Efficiency Optimization**: Optimize the power consumption of the system to prolong battery life in portable applications or reduce energy costs in continuous operation scenarios.
6. **Fault Detection and Diagnostics**: Implement fault detection algorithms to identify sensor malfunctions or connectivity issues, providing proactive maintenance alerts to users.

7. **Integration with Home Automation Systems**: Enable integration with existing home automation systems or IoT platforms for seamless integration into smart home environments.

Identified Gaps:

1. **Limited Threshold Adjustment**: The current implementation lacks flexibility in adjusting the threshold PPM value, potentially leading to false alarms or missed detections in varying conditions.
2. **Lack of Advanced Alerting**: The absence of advanced alerting mechanisms limits the system's capability to notify users promptly and effectively, especially in remote monitoring scenarios.
3. **Missing Real-Time Data Logging**: The absence of real-time data logging prevents users from accessing historical sensor data for analysis or troubleshooting purposes.
4. **Potential Reliability Issues**: Limited fault detection and diagnostics capabilities may result in undetected sensor failures or erroneous readings, compromising the system's reliability.
5. **Integration Challenges**: The lack of integration with home automation systems restricts the system's interoperability and compatibility with other smart devices or platforms.

By addressing these identified gaps and implementing the recommended enhancements, the smoke alarm project can achieve greater functionality, reliability, and user satisfaction, thereby enhancing fire safety measures in residential and commercial environments.

CONCLUSION AND FUTURE WORK:

In summary, the smoke alarm project utilizing Arduino and the MQ-2 gas sensor has laid the foundation for enhancing fire safety in residential and commercial environments. The project successfully detects smoke and combustible gases, providing a visual alert through an LED. However, there are opportunities for further improvement identified through gap analysis.

Future work includes implementing dynamic threshold adjustment, advanced alerting mechanisms, real-time data logging, enhanced fault detection, integration with home automation systems, and user interface enhancements. These enhancements will elevate the system's effectiveness, reliability, and user experience, ensuring prompt notification of potential hazards and facilitating seamless integration into smart home environments.

Ultimately, by addressing these areas for improvement, the smoke alarm project can evolve into a sophisticated, reliable, and user-friendly safety solution, contributing to improved fire safety and peace of mind for users.

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