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FACULTY OF ELECTRICAL AND COMPUTER ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

IOT-BASED AIR QUALITY MONITORING SYSTEM

PROJECT REPORT

MICROPROCESSORS - GROUP 7

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Abstract

This project presents the design and implementation of an IoT-based air quality monitoring system using an Arduino microcontroller. The system integrates an MQ-2 gas sensor to detect air pollutants, a DHT22 sensor for temperature and humidity monitoring, an OLED display for real-time data visualization, and an LED indicator for alerting users about hazardous air conditions. The main objective is to provide an affordable and efficient air quality monitoring solution that can be used for indoor or outdoor applications. The system continuously collects environmental data, displays it on the OLED screen, and provides alerts when gas levels exceed a predefined threshold.

Introduction

Air pollution is a critical global challenge that affects health and the environment. Traditional air quality monitoring solutions are often expensive and not easily accessible for personal use.

Figure 1: Air Pollution

This project aims to develop a cost-effective and real-time monitoring system using an Arduino-based microcontroller to measure gas concentration, temperature, and humidity levels. The implementation of an OLED screen for data visualization and an LED alert system makes it user-friendly and efficient for early detection of harmful pollutants.

Problem Statement

The rise in industrialization and urbanization has significantly contributed to increasing air pollution levels. The lack of affordable air quality monitoring devices limits public awareness and preparedness.

This project addresses the need for a low-cost, real-time air quality monitoring solution that provides timely alerts for hazardous gas concentrations and environmental conditions. By leveraging an MQ-2 sensor, DHT22 sensor, and an OLED display, this system provides continuous monitoring to help users make informed decisions about their surroundings.

Figure 2: DHT22 Sensor

Figure 3: MQ - 2 Sensor

Figure 4: OLED Display

Methodology

The Air Quality Monitoring System operates by utilizing sensors to detect environmental parameters like gas levels, temperature, and humidity. Specifically, analog readings from the gas sensor, connected to an Arduino's analog pin, provide data on the air quality.

These readings are mapped to predefined thresholds, categorizing the air quality as "Good," "Poor," "Bad," or "Toxic." Simultaneously, a DHT22 sensor measures humidity and temperature. The collected data is displayed in real-time on an OLED screen using the Adafruit libraries. By continuously monitoring these parameters, the system offers a snapshot of air quality conditions, enabling users to assess and respond to changes in their environment.

Figure 5: Normal

Figure 6: Poor

Figure 7: Bad

Figure 8: Toxic

The system is designed using a combination of hardware and software components:

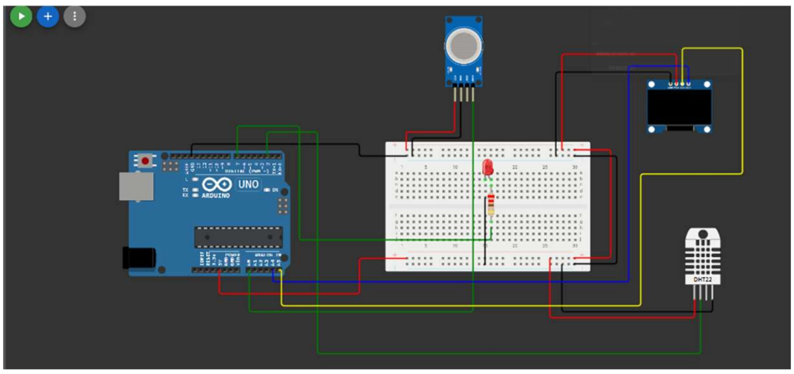

Figure 9: Hardware and Software components

Hardware Components:

- **Arduino Uno:** Acts as the microcontroller unit.
- **MQ-2 Sensor:** Measures gas concentration levels.
- **DHT22 Sensor:** Records temperature and humidity.
- **SSD1306 OLED Display:** Shows real-time data.
- **LED Indicator:** Provides visual alerts for high pollution levels.

Software Implementation:

- **Programming Language:** C++ (Arduino IDE)
- **Libraries Used:** Adafruit GFX, Adafruit SSD1306, DHT Sensor Library.
- **Wokwi Online Simulator**
- **Working Principle:**
  - The system initializes the sensors and OLED display.
  - MQ-2 sensor reads gas levels and DHT22 measures temperature/humidity.
  - Data is processed and displayed on the OLED screen.
  - If gas levels exceed the threshold, the LED blinks as a warning.
  - Serial Monitor logs data for debugging.

System Implementation

The system setup consists of an Arduino Uno connected to the MQ-2 sensor, DHT22 sensor, OLED display, and LED indicator. The MQ-2 sensor outputs an analog signal based on detected gas levels, which is converted to a meaningful air quality reading. The DHT22 sensor provides humidity and temperature data, ensuring a comprehensive environmental analysis. The OLED display is used for real-time visualization, and the LED indicator blinks to warn users when pollution exceeds safe limits.

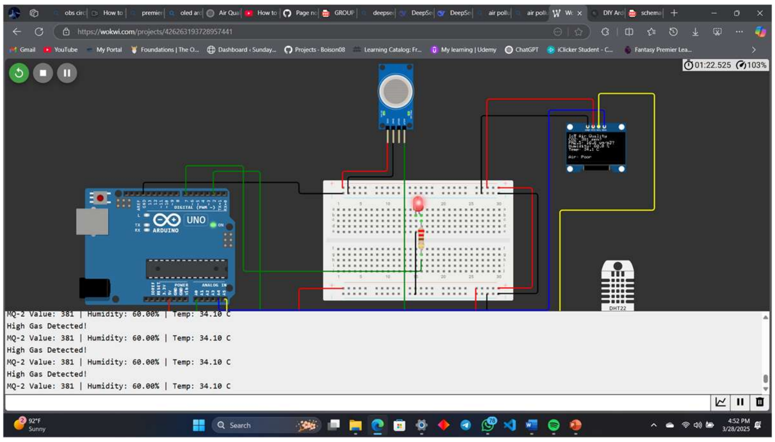

Figure 10: Simulation of System

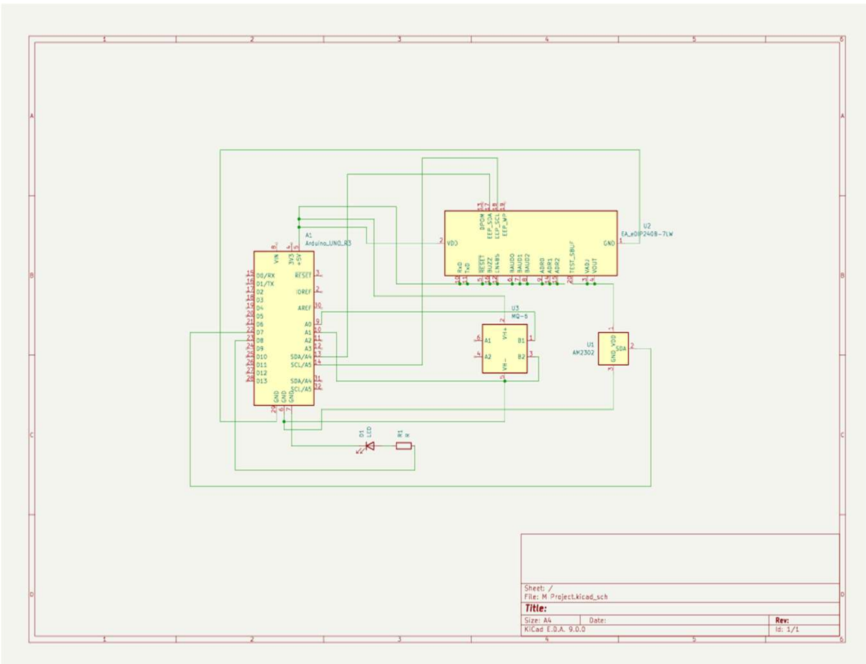

Figure 11: Schematic Drawing of Circuit

SCHEMATIC ARRANGEMENTS

Component	Pin on Component	Connected To (Arduino UNO R3 Pin)
Power Connections	VDD (5V)	5V
	GND	GND
EA eDIP240B-7LW (U2) (I^2C Display)	SDA	A4 (SDA)
	SCL	A5 (SCL)
	VDD	5V
	GND	GND
MQ-6 Gas Sensor (U3)	VH+	5V
	VH-	GND
	B1	A0
	B2	A1
DHT22 Temperature & Humidity Sensor (U1)	VDD	5V
	GND	GND
	DATA	D7
LED (D1)	Anode (+)	Resistor (R1) → D8
	Cathode (-)	GND
Resistor (R1) (Connected to LED)	One side	D8
	Other side	LED Anode (+)

Results and Discussion

The air quality monitoring system was tested in various environments to evaluate its performance.

The MQ-2 sensor successfully detected changes in gas concentration, while the DHT22 sensor accurately measured temperature and humidity.

The OLED display provided clear, real-time feedback, making it easy to interpret data. The LED alert system effectively signaled hazardous air conditions.

However, challenges were encountered, including sensor calibration issues and occasional response delays due to the DHT22 sensor's measurement cycle. Despite these minor setbacks, the system performed reliably in detecting and displaying environmental parameters.

Challenges Encountered

- **MQ-2 Sensor Calibration:** Variability in gas readings required fine-tuning for accurate results.
- **DHT22 Response Delay:** The sensor takes a few seconds to provide temperature and humidity readings, affecting real-time responsiveness.
- **OLED Power Consumption:** Running the OLED display continuously increased power demand, requiring optimized usage strategies.

Future Improvements

To enhance the effectiveness of the air quality monitoring system, several improvements can be implemented:

- **Advanced Sensors:** Replacing the MQ-2 sensor with a more precise CO_2/PM2.5 sensor like MH-Z19 or PMS5003.
- **Cloud Integration:** Implementing Wi-Fi or Bluetooth connectivity for remote data logging and real-time monitoring via a mobile app.
- **Mobile App Interface:** Developing a mobile application to provide remote access to real-time air quality data.
- **Multi-Sensor Integration:** Adding additional sensors to measure other pollutants such as NO_2 and SO_2.

Conclusion

The IoT-based air quality monitoring system successfully demonstrated the ability to detect gas concentration, temperature, and humidity in real-time. The integration of an OLED display and LED alert system enhances usability, making it a practical solution for personal and small-scale environmental monitoring. Despite challenges such as sensor calibration and response delays, the project highlights the feasibility of low-cost, real-time air quality monitoring. Future enhancements such as cloud connectivity, mobile integration, and advanced sensor technology will further improve the system’s accuracy and usability, making it a valuable tool for air pollution awareness and control.

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