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# Design and Development of a Pollution Monitoring System Using Carbon and Oxygen Sensors with Arduino Nano

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**ABSTRACT**

This research project presents the design and development of a low-cost pollution monitoring system using Arduino Uno, carbon dioxide (CO2) and oxygen (O2) sensors, and an LCD display. The system is aimed at real-time monitoring of air quality, especially in urban environments, to promote awareness and enable action against pollution. The prototype gathers data from gas sensors, processes it via Arduino Uno, and displays the results in real-time. This solution provides a foundation for more advanced pollution monitoring systems and can be integrated with IoT for broader applications.

## 1. Introduction

Air pollution is one of the major environmental challenges faced globally. Monitoring key pollutants such as carbon dioxide and oxygen levels in the environment is crucial for health and environmental safety. The objective of this project is to develop a pollution monitoring system that is both affordable and accessible. Using Arduino Uno microcontroller, CO2 and O2 gas sensors, and a display unit, the system detects the gas concentrations and presents real-time data for public or institutional use.

## 2. Literature Review

Previous studies have demonstrated various pollution monitoring systems utilizing microcontrollers and sensor technologies. Work by Sharma et al. (2020) developed a wireless air quality monitor using NodeMCU and MQ sensors. Similarly, Patil et al. (2019) proposed a GPS-enabled air quality monitoring system. Most systems focus on multiple gas sensors and integration with IoT; however, cost and complexity often limit deployment. This project simplifies the design while maintaining essential monitoring functions.

## 3. Methodology

- Identify key pollutants: CO2 and O2.
- Select appropriate sensors: MQ-135 (CO2) and KE-25 (O2).
- Use Arduino Uno for data acquisition and processing.
- Interface a 16x2 LCD display to show real-time values.
- Assemble components on a breadboard or PCB.
- Calibrate sensors and test the system in various environments.

## 4. Design Components

### *4.1. Arduino Uno microcontroller*

Fig.4.1. Arduino Nano

The Arduino Nano is a compact and powerful microcontroller board based on the ATmega328P chip. It is designed for small-scale embedded systems and is ideal for space-constrained projects. It has 14 digital input/output pins, 8 analog inputs, and operates at 5V with a 16 MHz clock speed. It supports USB programming and offers reliable performance for sensor interfacing and data processing. Due to its small size and compatibility with most Arduino IDE libraries, it's widely used in academic, hobbyist, and prototype projects.

### *4.2. MQ-135 Gas Sensor (for CO2)*


Fig.4.2. Carbon Sensor

The MQ-135 is a widely used air quality sensor that can detect a range of harmful gases including carbon dioxide ($CO_2$), ammonia ($NH_3$), benzene, and smoke. It operates on a 5V power supply and provides analog output which varies with the concentration of gases. The sensor has a preheat time and needs calibration in clean air for accurate readings. It is often used in environmental monitoring projects and is known for its affordability and sensitivity. The sensor's response time is fast, making it suitable for real-time monitoring applications.

### *4.3. KE-25 Oxygen Sensor (for O2)*


Fig.4.3. Oxygen Sensor

The KE-25 is a galvanic cell-type oxygen sensor designed to measure the oxygen concentration in the air. It outputs an analog voltage proportional to the oxygen content, typically in the range of 0–25%. The sensor does not require an external power source as it generates voltage itself, and it features long operational life and good linearity. It is widely used in medical, industrial, and environmental applications. The KE-25 is known for its accuracy, compact design, and compatibility with microcontroller-based systems like Arduino.

### *4.4. 16x2 LCD Display*

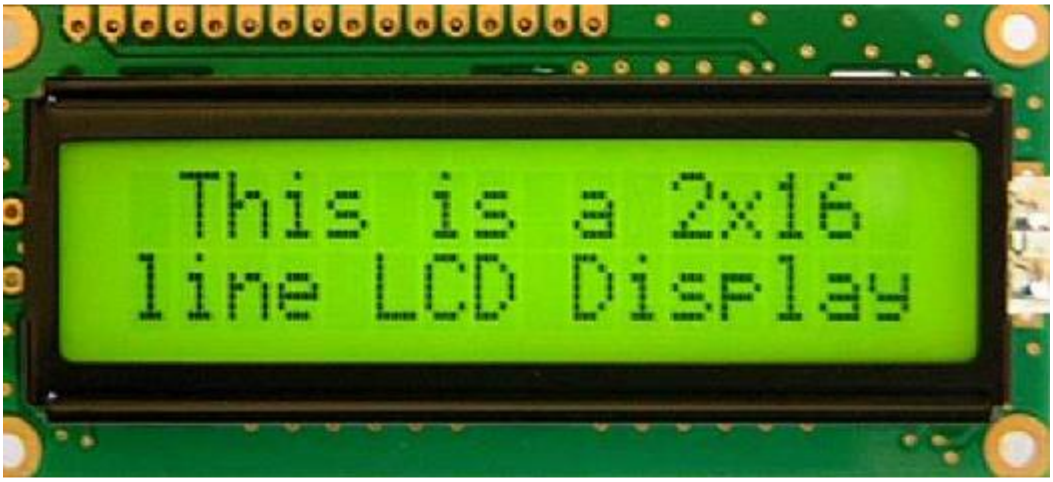


Fig. 4.4.Display

A 16x2 LCD display is a common character display module that can show 16 characters per line across 2 lines. It operates using either 4-bit or 8-bit data modes and can interface directly with microcontrollers like Arduino using parallel communication. These displays are ideal for showing sensor values, status messages, or system notifications. The display typically operates at 5V and uses the HD44780 controller. It may include a backlight for visibility in low-light environments and has customizable contrast through a potentiometer.

### *4.5. Resistors, Breadboard, Jumper Wires*

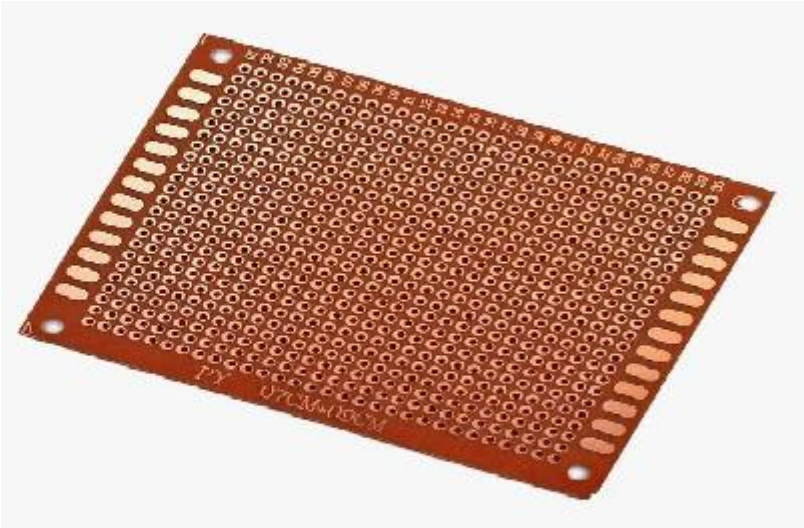

Fig.4.5. PCB

These components serve essential roles in circuit assembly. Resistors are used to limit current, divide voltages, and protect sensitive components. The breadboard offers a solderless platform for prototyping the circuit and allows easy modifications. Jumper wires connect the components and make circuit layout flexible and reconfigurable. These passive components are vital for testing and debugging the prototype before moving on to permanent solutions like PCBs.

### *4.6. Power Supply (Battery or USB)*

Fig.4.6. 12V Adapter

The system requires a steady 5V power supply to function. This can be provided through a USB connection from a computer or external adapter, or through batteries for portable applications. A common setup involves using a 9V battery regulated down to 5V via onboard or external voltage regulators. Reliable power is crucial to ensure sensor accuracy and microcontroller stability during data acquisition and processing.

## 5. Advantages

- Low cost and easy to build
- Real-time monitoring
- Portable and compact
- Expandable to support more gases

## 6. Disadvantages

- Limited to two gases

- Accuracy depends on sensor calibration
- Not suitable for industrial-grade monitoring without enhancement

## 7. Applications

- Urban air quality monitoring
- School or college environmental projects
- Indoor air monitoring (labs, offices)
- Agricultural storage monitoring

## 8. Conclusion

The designed pollution monitoring system provides a simple yet effective solution for real-time CO2 and O2 monitoring using Arduino Uno. While it is not a replacement for industrial systems, it serves as an educational and awareness tool that can be scaled or enhanced further. Future work could integrate data logging, wireless transmission, and support for more gases.

### 9. References


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