iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VI **Month of publication:** June 2025

DOI: https://doi.org/10.22214/ijraset.2025.72739

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VI June 2025- Available at www.ijraset.com

Air Quality Monitoring and Alert System

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Abstract: Air pollution is a pressing environmental challenge with significant implications for public health and ecosystems. Air quality monitoring system presents a cost-effective air quality monitoring advantage using Arduino Uno and MQ-135 gas sensor. The system is designed to detect and measure the concentration of harmful gases, including CO2, NH3, benzene, and smoke, in real-time.
Data is displayed on an I2C-compatible LCD screen, offering various air quality levels.
When pollution levels exceed a predefined threshold, the system activates an alert mechanism using a buzzer to indicate hazardous conditions. The proposed system is versatile and can be deployed in various settings, including homes, schools, and offices, providing a practical solution for environmental monitoring.
Future enhancements include the integration of wireless communication modules such as ESP8266 to enable remote monitoring through mobile applications or web platforms. This project underscores the importance of air quality awareness and offers a scalable, user-friendly tool for promoting environmental sustainability and healthier living standards.
Keywords: Air Quality Monitoring, Arduino Uno, MQ-135, Gas Sensor, LCD Display, Pollution Detection, Environmental Sustainability, Alert System.

I. INTRODUCTION

1) Overview: The Air Quality Monitoring and Alert System is a cost-effective, real-time system designed to measure air quality and notify users when pollution levels are hazardous. By employing the MQ-135 gas sensor, the system detects the concentration of air pollutants and uses an Arduino microcontroller to process sensor data and generate alerts. This research explores the development of such a system, integrating Arduino technology with the MQ-135 sensor, as a means to provide an efficient, affordable, and accurate solution for air quality monitoring. The study posits that this integration can facilitate timely alerts to mitigate health risks associated with poor air conditions.

2) Background: Air pollution is a significant environmental and public health concern, contributing to millions of premature deaths annually. The World Health Organization (WHO) has established guidelines for acceptable air quality levels, but many urban areas around the globe regularly exceed these standards, exposing their populations to serious health risks. To address this issue, there is a pressing need for low-cost, real-time air quality monitoring systems capable of alerting users to poor air conditions, especially in resource-constrained environments.

3) Objective: The primary objective of this research is to design and implement a low-cost air quality monitoring and alert system that employs the MQ-135 gas sensor and Arduino microcontroller. The system aims to:

- This system measures real-time air pollutant concentrations.
- This system provides an alert system when air quality is poor.
- This system provides a LCD display for visualizing air quality data.

Technical Stack:

- Hardware: The system comprises an Arduino Uno, MQ-135 gas sensor, buzzer, 16×2 LCD display, resistors, a breadboard, jumper wires, and an I2C module.
- Software: The software stack includes the Arduino Integrated Development Environment (IDE) for programming in C++, along with libraries for interfacing the MQ-135 sensor and the LCD display.

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II. METHODOLY

The proposed system will use IoT bias connected in series with each road light through one line communication.
This device will cover the status of air and descry air quality.
Step1: Connect 16 * 2 LCD with I2C module
At first, we added I2C module with 16 legs of 16 * 2 TV. And I2C module has four anchorages GND, Vcc, SDA, SCL independently.
Step2: Connect 16 * 2 LCD(I2C Module) with Arduino uno
GND of I2C TV is connected to the GND of Arduino uno via jumper wires. Similarly Vcc of I2C TV is connected to the 5V od the Arduino uno. Analog 4(A4) is connected to SD of LCD and analog 5(A5) is connected to SCL of LCD.
Step3: Connect MQ- 135 gas detector with Arduino and Breadboard
Vcc of the MQ- 135 gas detector is connected to 5V power force of Arduino uno. GND of MQ-135 detector is connected to the ground (GND) of the Breadboard. A0 leg of the MQ-135 is connected with the A0 leg of Arduino uno.
Step4: Connection of Buzzer and LED with Arduino uno
Pin number 8 and 9 of Arduino is connected to Buzzer and LED independently. And the other side of buzzer and LED is connected to the GND of breadboard.
Step5: Software perpetration
The software law is written in Arduino IDE, combining detector readings, data processing, and stoner cautions. The program reads the analog affair from the MQ- 135 detector, converts the readings to a corresponding attention position, and displays the data on the LCD.The buzzer is touched off when the air quality crossed the predefined thershold limits.

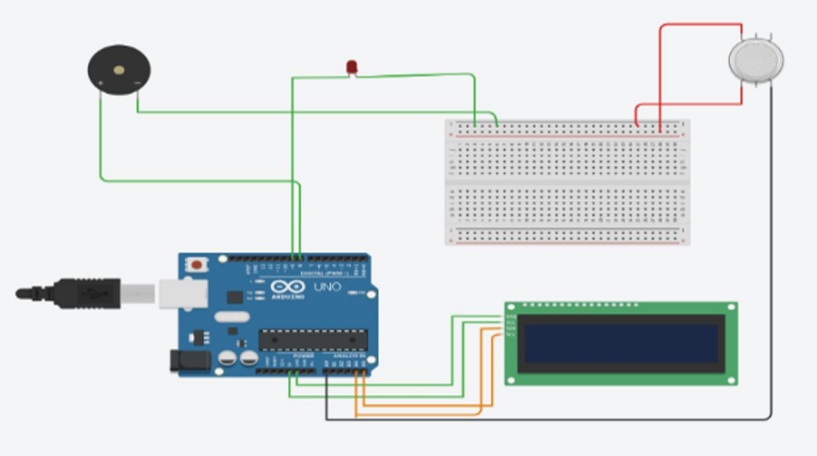

Fig1 -Circuit diagram

III. APPLICATIONS

1) Indoor and Outdoor Air Quality Monitoring:Monitoring air quality bothin homes,offices, and other indoor spaces to ensure a healthy environment and in outdoor spaces, like parks, streets, and industrial areas, to track pollution levels.
2) Monitoring Air Qualityin Industrial Field: Air quality monitoring in industrial settings, like factories and warehouses, to ensure worker safety and compliance with regulations.
3) Mnitoring Low Cost Air Quality: Developing low-cost air quality monitoring systems using MQ135 and Arduino to monitor air quality within lowest cost for urban and rural areas.
4) RealTime Air Quality Detect: Development of a real-time air quality monitoring system utilizing the MQ-135 gas sensor and Arduino to deliver instantaneous feedback on air quality levels.
5) Smart Cities and IoT: Integrating air quality monitoring systems with smart city infrastructure and IoT devices to create a more sustainable, efficient, and livable urban environment.
6) Air Quality Monitoring for Research and Development:Implementation of an air quality monitoring system using the MQ-135 gas sensor and Arduino for advancing research and development in environmental science and public health.

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IV. OVERVIEW OF COMPONENTS

A. MQ-135 Sensor

The MQ-135 sensor is a air quality sensor which detects and monitors various gases like Ammonia (NH_3), Alcohol, Benzene, smoke, and carbon dioxide (CO_2) etc. This sensor operates on a supply voltage of 2.5–5.0 V with a typical power consumption of 150 mA. To achieve accurate results, the sensor requires a preheating period of approximately 20 seconds before operation.

This sensor provides both analog and digital outputs, making it versatile for use in different applications, such as air quality control systems and environmental monitoring equipment. Key technical specifications of the MQ-135 sensor include:

Key Features:

- Operating Voltage: 2.5–5.0 V
- Typical Operating Voltage: 5.0 V
- Power Consumption: 150 mA
- Detectable Gases: NH_3, CO_2, Alcohol, Benzene, Smoke
- Digital Output Range : 0–5 V

Fig2: MQ-135 Sensor

B. Buzzer

A buzzer is an electromechanical or mechanical audio signaling device used to convert electrical signals into sound. It is widely utilized in applications such as timers, alarms, printers, and computers due to its ability to produce a variety of sound outputs, including alarms, music, sirens, and bells.

Typically powered by DC voltage, the buzzer features two terminals:

- Positive (+ve): Marked with a '+' symbol or represented by a longer terminal, typically powered by 6V.
- Negative (-ve): Represented by a shorter terminal, connected to ground (GND).
  Key Features : Color: Black
- Frequency Range: 3–300 Hz
- Operating Temperature: -20°C to +60°C
- Operating Voltage: 3V to 24V DC
- Sound Pressure Level: 85 dBA at 10 cm
- Supply Current: <15 mA

Fig3: Buzzer

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C. Ardiuno UNO

The Arduino Uno is a highly popular microcontroller board that bridges the gap between hardware and software, ideal for prototyping and educational applications. As an open-source platform, it encourages innovation and accessibility, making it a favorite choice among hobbyists and developers. The Arduino Uno R3 utilizes the ATmega328P microcontroller and has undergone three major revisions to enhance its functionality and design.

The board is equipped with 14 digital input/output pins, six of which support Pulse Width Modulation (PWM), enabling its use in diverse projects. It features a USB-B port for programming and communication, a power jack for external power supply, six analog input pins, a reset button, and 32 KB of flash memory for code storage.

Programming the Arduino Uno is facilitated by the Arduino Integrated Development Environment (IDE), which simplifies code development and uploading to the board.

Key Specifications :

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage: 7–12V (recommended), 6–20V (limits)
- Digital I/O Pins: 14 (6 with PWM capability)
- Analog Input Pins: 6
- Maximum Current per I/O Pin: 40 mA
- Maximum Current for 3.3V Pin: 50 mA

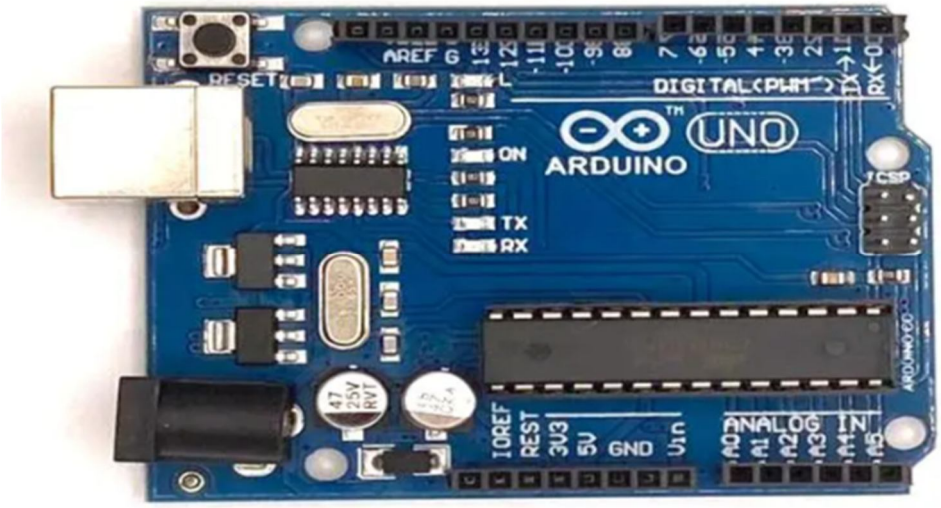

Fig4-Ardiuno uno

D. Resisitor

A resistor is a passive electrical component designed to impede the flow of electric current by introducing resistance into a circuit. It is an essential element in nearly all electrical networks and electronic systems. The resistance of a resistor is quantified in ohms (Ω), where one ohm corresponds to the resistance that allows a current of one ampere (A) to flow when one volt (V) is applied to its terminals. This relationship is defined by Ohm's Law:V=IR or R=V/I

Numerous applications of resistors in electrical and electronic systems are:

- Limiting the flow of electric current
- Dividing voltage within a circuit
- Generating heat as a byproduct of resistance
- Matching and loading circuits for optimal performance
- Controlling gain in amplifier circuits
- Establishing time constants in RC (resistor-capacitor) circuits
- Acting as electric brakes in specific industrial and automotive application

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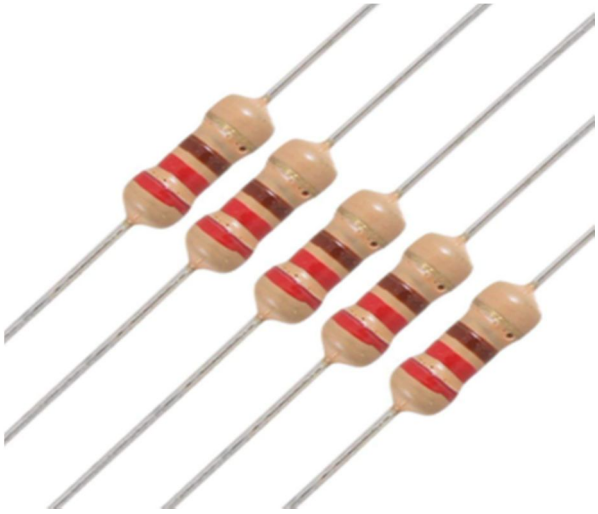

Fig5- Resistors

E. LED

A Light-Emitting Diode (LED) is a semiconductor device that emits light when an electric current flows through it. This emission occurs due to the recombination of electrons and holes within the semiconductor material, releasing energy in the form of photons. LEDs are designed to allow current to flow inthe forward direction while blocking current in the reverse direction, making them highly efficient and reliable light sources.

Key Characteristics:

Fig6- LED

- Emits light in a specific wavelength range, depending on the material composition.
- Operates at low voltages and currents, resulting in energy efficiency.
- Long lifespan compared to traditional light sources.

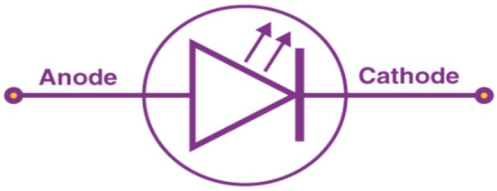

Fig7-LED

F. Breadboard

A breadboard is a reusable platform used to build and test electronic circuits.

Key Features:

1. Grid Pattern: A breadboard has a grid pattern of holes, typically with a spacing of 0.1 inches (2.54 mm).
2. Rows and Columns: The grid is divided into rows and columns, with each row and column connected by a metal strip.
3. Power Rails: Most breadboards have two power rails, one for positive voltage (VCC) and one for ground (GND).
4. Jumper Wires: Breadboards use jumper wires to connect components and create circuits.

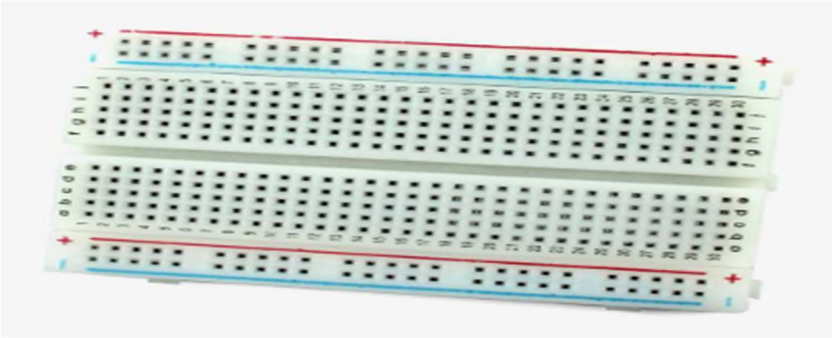

Fig8- Breadboar

*G. 16*2 LCD*

A 16x2 LCD (Liquid Crystal Display) is a type of display screen that can show 2 rows of text, with each row containing up to 16 characters.It is Commonly used in embedded systems, such as robots, automation systems, and IoT devices and often used to display status information, such as temperature, humidity, or sensor readings.

Key Features:

1. Display Size: 16 characters x 2 rows
2. Display Type: LCD (Liquid Crystal Display)
3. Interface: Typically uses a 4-bit or 8-bit parallel interface
4. Backlight: Usually has a built-in backlight for visibility
5. Power Consumption: Typically low power consumption, around 2-5V

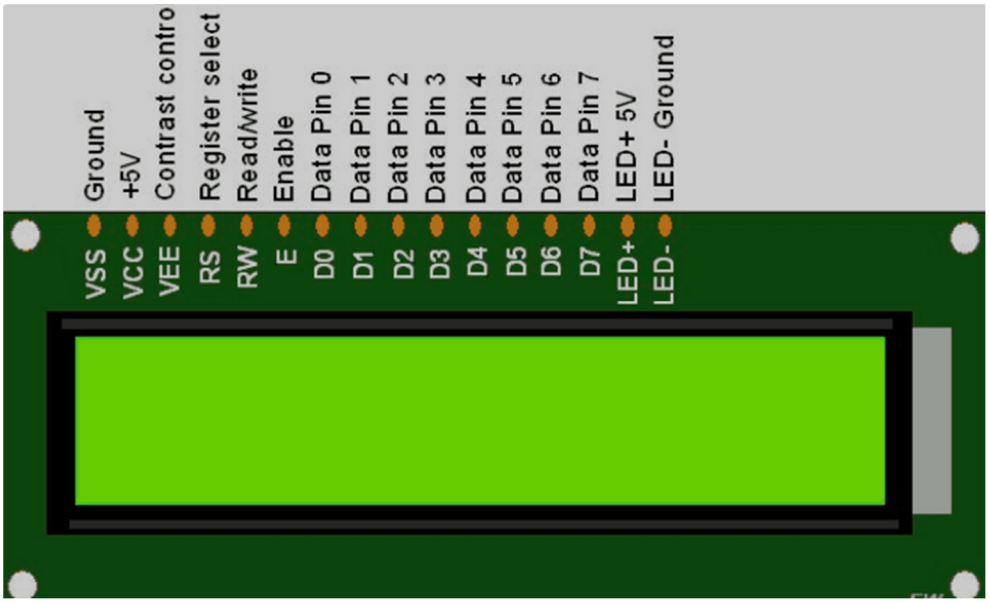

Fig9- 16*2 LCD

H. I2C Module

An I2C (Inter-Integrated Circuit) module isa smallelectronicmodule thatallowsmultipledevices to communicate with each other using theI2Cprotocol.

Key Features:

1. I2C Protocol: Uses the I2C protocol for communication
2. Two-Wire Interface: Uses only two wires (SCL and SDA) for communication
3. Multi-Device Support: Allows multiple devices to be connected to the same bus
4. Low Speed: Typically operates at a low speed of 100 kHz or 400 kHz
5. Short Distance: Designed for short-distance communication, typically up to 1 meter .

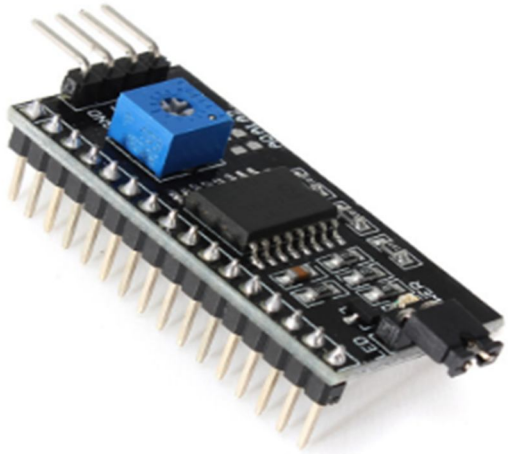

Fig10- I2C Module

I. Jumper Wires

Jumper wires, also known as jumpers, jumper cables, or simply cables, are electrical wires or groups of wires often terminated with connectors, pins, or "tinned" bare ends. These wires are primarily used to interconnect components in breadboards, prototype circuits, or test setups without the need for soldering. Jumper wires facilitate rapid assembly and modification of circuits during the prototyping and testing phases.

Jumper wires come in various types based on the connectors at their ends:

- Male-to-Male: For connecting components with female headers.
- Female-to-Female: For linking male pins or headers.
- Male-to-Female: For versatile connections between male and female terminals.

Fig11- Jumper wires

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V. CIRCUIT DIAGRAM

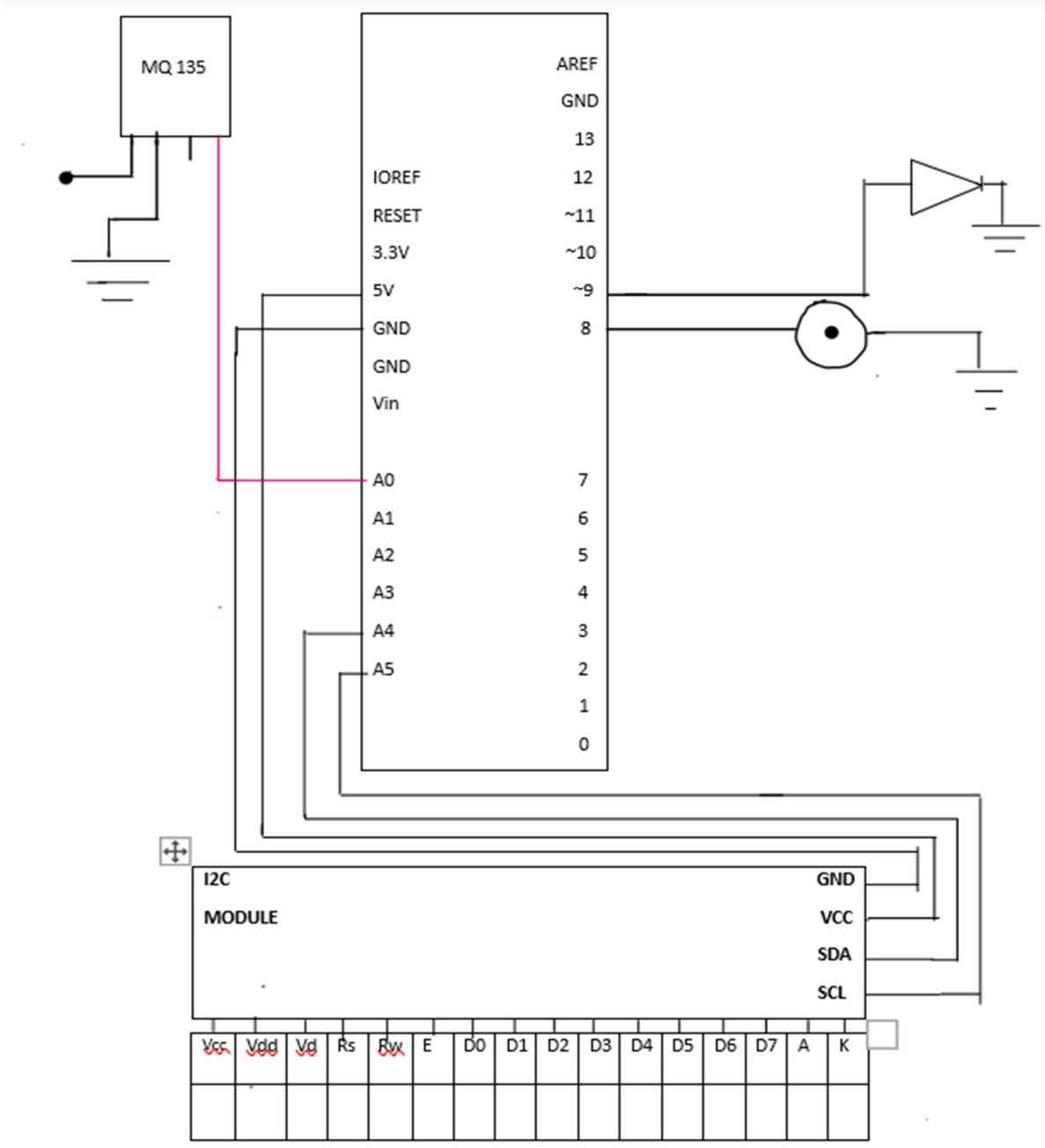


Fig12- Circuit Diagram

VI. SYSTEM BENEFIT

A. Environmental Benefits

1) Improved Air Quality: Real-time monitoring of air quality helps identify pollution sources and takes corrective action to improve air quality.

2) Reduced Pollution: By monitoring air quality, industries and governments can take steps to reduce pollution, resulting in a cleaner environment.

3) Protection of Ecosystems: Air quality monitoring helps protect ecosystems, including forests, water bodies, and wildlife habitats.

B. Health Benefits

1) Improved Public Health: Air quality monitoring helps to identifyareas with poor air quality, enabling authorities to take action to protect public health.

2) Reduced Respiratory Problems: By monitoring air quality, people can take precautions to avoid exposure to poor air quality, reducing respiratory problems.

3) Early Warning Systems: Air quality monitoring systems can provide early warnings for poor air quality, enabling people to take necessary precautions.

C. Economic Benefits

1) Cost Savings: Air quality monitoring can help industries reduce costs by optimizing processes and reducing energy consumption.

2) Increased Productivity: By monitoring air quality, industries can take steps to improve indoor air quality, leading to increased productivity and employee well-being.

3) Compliance with Regulations: Air quality monitoring helps industries comply with environmental regulations, reducing the risk of fines and penalties.

D. Technological Benefits

1) Real-Time Data: Air quality monitoring provides real-time data, enabling quick decision-making and action.

2) Data Analysis: Air quality monitoring systems can analyze data, providing insights into air quality trends and patterns.

VII. RESULT AND DISCUSSION

1) System Performance: The air quality monitoring system will display real-time data on the LCD, including gas concentration levels. Thisdevice was tested under various conditions – both indoors and outdoors. The readings from the MQ-135 varied with environmental changes, providing clear indications of air quality.

2) Alert Mechanism: This alert device effectively notified users when pollutant levels exceeded set limits. For example, the alarm was triggered when ppm>threshold, where threshold<=250ppm.

```
AQ Level HIGH
Air Quality: 250
AQ Level Good
Air Quality: 240
AQ Level Good
```

Month- May Weeks	Air Quality	Concentration
Week 1	350	High
Week 2	290	High
Week 3	240	Good
Week 4	260	High

VIII. CONCLUSION

The Air Quality Monitoring and Alert System utilizing Arduino and the MQ-135 sensor offers a reliable and economical approach to real-time air quality analysis. This device is adaptable for both personal and industrial purposes, empowering individuals and organizations to monitor environmental conditions and make informed decisions.

Future advancements could include the integration of IoT-enabled devices for remote monitoring and real-time data logging, further enhancing the system's capabilities and user interaction.

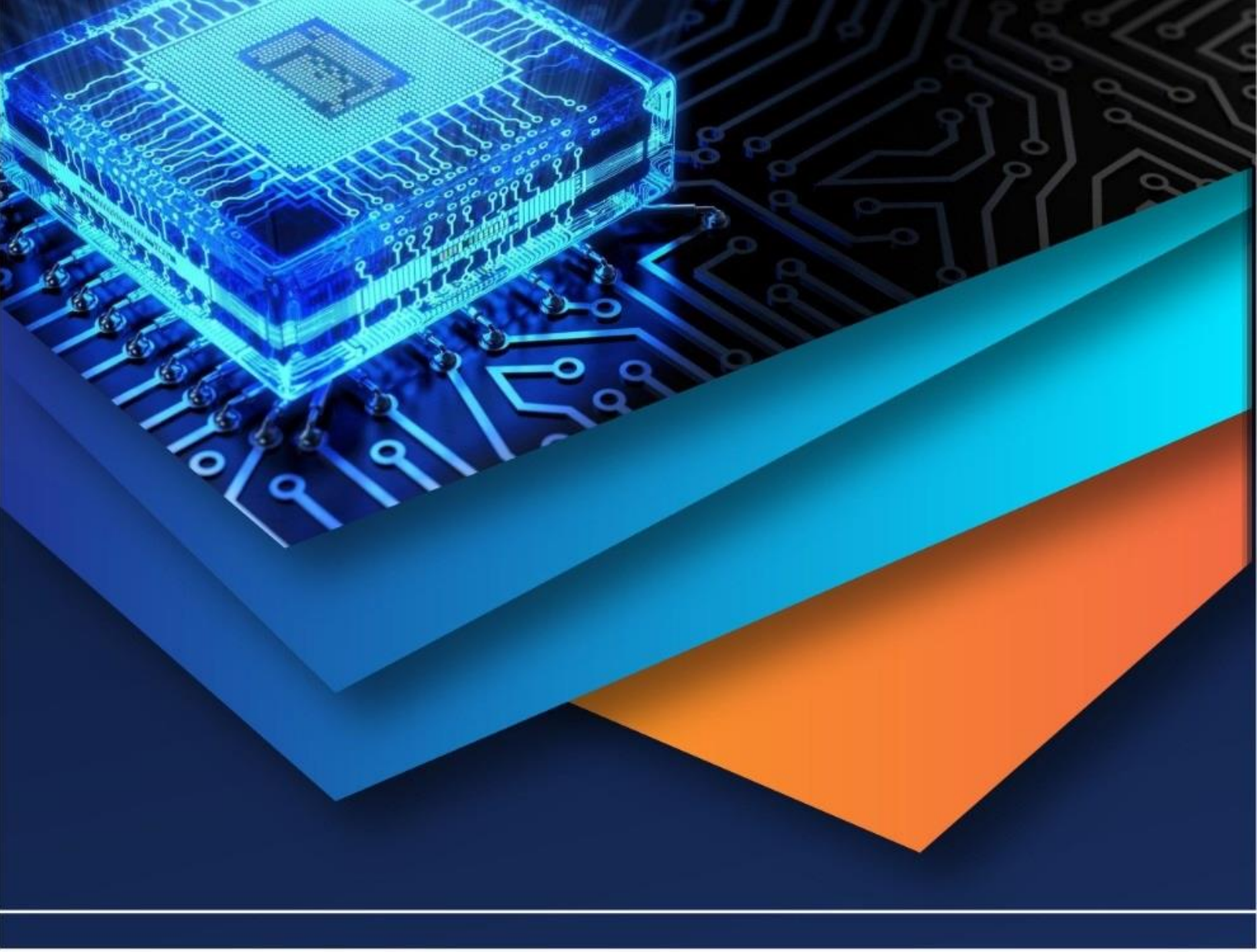
REFERENCES

Here are some scientific sources and references related to Air Quality Monitoring System devices:

[1] Kumar & Saha, S. K. (2020). "Air quality monitoring and management: Challenges and opportunities." Environmental Pollution. This paper discusses various air quality monitoring systems, their design, and the challenges faced in implementing efficient air quality management. It includes technical insights on sensors, data collection, and the integration of these devices in urban and industrial areas.

[2] Kalagotla Chenchireddy, D Sandhya, M Praveen, G Karthik & G maruthi (2021). "Air Quality Monitoring and Alert System Using MQ135 Gas Sensor with Arduino Controller. This paper discuss about gas sensors and their features, gives a brief information about Arduino board. And a potential circuit diagram of Air Quality monitoring system using MQ135 gas sensor with Arduino controller.

[3] Deepshikha, Vikram, Ganesh, Deva Kalyan. "Real Time Air Quality Monitoring System". This report work focus on the development of a low-cost device for real-time monitoring of air pollutants such as particulate matter (PM2.5), nitrogen dioxide (NO2), and carbon dioxide (CO2).



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