AIR QUALITY MONITORING SYSTEM USING ARDUINO

MINI PROJECT REPORT

Submitted by

AKALYA.S - 962222106009

ALBINA SHERLIN.J-962222106014

DHARSHINI.R-962222106054

St.Xavier's Catholic College of Engineering

Department of Electronic and Communication Engineering

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AKALYA.S -962222106009

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Signature of HOD	**Signature of Supervisor**
Dr.S.CAROLINE	**Dr.S.Mary Vasanthi**
Associate Professor and Head,	**Associate Professor,**
Department of ECE,	**Department of ECE,**
St. Xavier's Catholic	**St. Xavier's Catholic**
College of Engineering,	**College of Engineering,**
Chunkankadai-629003	**Chunkankadai-629003**

Reviewed on_____ **Coordinator**

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OBJECTIVE

The goal of this project is to develop a reliable and low-cost air quality monitoring system. It detects harmful gases using the MQ-135 sensor, processes data through Arduino Uno and provides real-time alerts when gas levels exceed safe limits. The system aims to raise awareness and support timely action for a healthier and safer environment.

ABSTRACT

The air quality monitoring system is designed using an Arduino Uno and an MQ- 135 gas sensor to detect harmful gases in the environment. The system processes data from the sensor to determine if the air quality is safe or polluted. A green LED lights up when the air quality is safe, while a red LED and a buzzer activate when harmful gas levels exceed a set threshold. Real-time data on air quality is displayed on an I2C LCD screen. The system is powered by a 12V adapter and connected using jumper wires and resistors. This monitoring system offers an effective solution for maintaining air quality in various environments such as homes, offices and industries, ensuring a safer living and working space.

INTRODUCTION

Air pollution has become a major concern in recent years due to the rapid growth of industries, urban development and the rising number of vehicles on the road. As a result, harmful gases such as carbon monoxide (CO), ammonia (NH_3), nitrogen oxides (NOx) and smoke are released into the atmosphere, significantly affecting the quality of the air we breathe. Prolonged exposure to polluted air can lead to various health problems including asthma, bronchitis, lung infections and even heart disease.

Despite its serious impact, air pollution is often invisible and people may not even realize when the air around them is unsafe. This is why it is important to have systems that can monitor air quality in real time, allowing people to be more aware of their surroundings and take necessary precautions.

Most professional air quality monitoring stations are large, expensive, and fixed in location. They are not easily accessible to the general public, especially in smaller towns or remote areas. To overcome this limitation, compact and affordable systems based on microcontrollers like Arduino are gaining popularity. These systems make it possible to monitor air pollution on a smaller scale, whether it's inside a house, school, office or any public place.

This project focuses on creating a simple and cost-effective Air Quality Monitoring System using Arduino. It uses sensors such as the MQ-135, which is capable of detecting multiple gases including ammonia, smoke and carbon dioxide. The gas concentration values are displayed on an LCD screen, helping users identify whether the air is clean or polluted. The entire setup is small, lightweight and easy to use.

This kind of system is useful not only for everyday monitoring but also for educational purposes, where students can learn about electronics, sensors and environmental science through a hands-on project. It can also be upgraded in the future with wireless modules to send data to smartphones or cloud platforms for remote access and data analysis.

LITERATURE SURVEY

1. Anabi Hilary Kelechi et al. developed a low-cost air quality monitoring system using Arduino with MQ-135 and MQ-7 sensors to detect harmful gases like carbon monoxide. The system sends real-time data to ThingSpeak and generates alerts when pollution levels exceed limits, helping increase public awareness and safety.

2. Poonam Pal et al. Designed an IoT-based system using Arduino UNO, ESP8266 and MQ-135 sensor to monitor gases like CO and smoke. Data is displayed in PPM on a web server and LCD. When pollution crosses the limit, it triggers an alarm and displays alerts on the website. The system can also work in non-IoT settings.
3. Ramya et al. proposed a gas leakage detection and alert system, which consists of two key modules: gas detection and broadcast module and a user registration module. This system monitors gas usage and provides real-time alerts when gas leaks are detected, helping to ensure safety in both residential and industrial settings.

4. Okokpujie et al**.** created a system that tracks air quality using Arduino and MQ135 sensors. It logs real-time data and sends it to a cloud server for global access. This system promotes public awareness of pollution levels, offering efficient monitoring and reducing health risks.

5. Landge and Harne proposed an IoT-based air quality monitoring system using Arduino, tracking pollutants like PM2.5 and AQI. The system sends data to a cloud server, generating real-time alerts for high pollution levels. It aims to improve public health management through continuous monitoring.

6. Buelvas et al. focused on data quality challenges in IoT-based air quality systems. The study highlights sensor calibration issues, data reliability and

environmental impacts on accuracy. Strong quality control mechanisms are recommended to ensure reliable real-time data for effective environmental decision-making.

7. Múnera et al. reviewed 55 IoT-based air quality systems, analyzing components like sensor tech, data protocols and cloud visualization. They identified scalability and accuracy issues and emphasized the need for adaptive system designs for smart city environments.

8. Husain et al. developed an Arduino-based system to monitor harmful gases like CO and SO2, using Bluetooth to transfer data to Android or PC for analysis. It's useful in environments like industrial sites, hospitals and schools to monitor air quality for safety.

9. Saad SM et al. developed Indoor air quality monitoring system using wireless sensor network (WSN) with web interface talks about a system that checks the quality of air inside buildings. It uses different sensors to measure harmful gases, dust, temperature, and humidity, which can affect people's health and comfort. These sensors are connected through a wireless network and send the data to a computer that works as a base station. This computer has a special program that lets users see the air quality data through a website. The main aim of this system is to help people monitor indoor air in real time and improve the environment inside buildings.

10. S. Listyarini et al. developed a low-cost air quality monitoring system using Arduino Uno and multiple sensors like MQ-7, MQ-2, MQ-131, and GP2Y1010AU0F to detect pollutants like CO, smoke, ozone, and dust. The system displays real-time data on an LCD, making it ideal for offline use without internet connectivity.

COMPONENTS

The components used in this project are listed below:

1 Arduino UNO

2 MQ-135 Gas Sensor

3 Resistors

4 I2C LCD display

5 Red LED

6 Green LED

7 Buzzer

8 12V Adapter

9 Connecting Wires

ARDUINO UNO

The Arduino Uno is the main controller of the air quality monitoring system. It reads the analog signals from the MQ-135 gas sensor, processes the data and controls other components such as LEDs and the LCD display. It makes decisions based on the sensor values, like when to turn on the green or red LED or display warning messages. Figure 1 shows the Arduino Uno board.

Fig 1: Arduino UNO

It is based on the ATmega328P microcontroller, which offers stable performance and efficient data handling. With multiple digital and analog I/O pins, it can interface easily with air quality sensors like the MQ-135. The board supports USB connectivity, making it simple to upload code and view serial data on a computer. It can be powered through USB or an external adapter, offering flexibility for different setups. Its ease of use, open-source nature and strong community support make it ideal for embedded and IoT projects.

MQ-135 GAS SENSOR

The MQ135 gas sensor as shown in Figure 2 is used to check air quality by detecting harmful gases like carbon dioxide, ammonia, smoke and benzene. It gives an analog signal to the Arduino based on the amount of gas in the air. The sensor is very sensitive and helps in measuring pollution levels. It needs to be calibrated for better accuracy. The sensor works by changing its resistance when it senses gas. It is commonly used in projects that monitor air pollution or gas leaks.

Fig 2: MQ-135 Gas Sensor

RESISTORS

Resistors are essential components in an air quality monitoring system, helping to control the flow of electrical current and protect sensitive components like sensors and microcontrollers. Resistors are important in the circuit to control the flow of electrical current and protect sensitive components. In this project, they are used with the MQ-135 gas sensor and LEDs to ensure proper voltage levels and stable operation. They help in creating voltage divider circuits, ensuring the sensor readings are accurate and safe for the Arduino to process. Figure 3 shows the resistors with varying values.

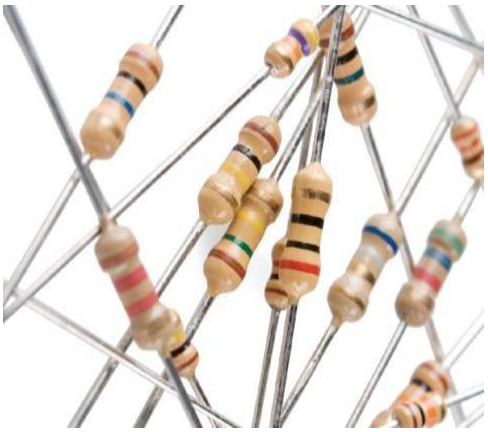

Fig 3: Resistors

I2C LCD DISPLAY

The LCD display in an air quality monitoring system is used to show real-time data from the gas sensor, such as the current gas level or sensor value. When connected to a microcontroller like an Arduino, the LCD can display helpful messages like "Air Quality: Safe" or "Warning: High Gas Level" based on the readings from the MQ- 135 gas sensor. It can also show the exact sensor value, which helps users understand how the gas level is changing over time. It is shown in Figure 4.

Fig 4: I2C LCD Display

The most commonly used display is a 16x2 LCD, which shows two lines of text and is easy to connect using an I2C module to reduce wiring. By adding an LCD display to the system, users can easily monitor the air quality without needing to check a computer or phone, making the system more user-friendly and informative.

RED LED

The red LED in an air quality monitoring system using the MQ-135 gas sensor serves as a warning signal when the air becomes polluted. When the sensor detects high levels of harmful gases like carbon dioxide, ammonia or smoke, the Arduino Uno reads the sensor data and turns on the red LED to alert users that the air quality is poor. This provides a clear visual indication that the environment may be unsafe for breathing. Figure 5 shows Red LED.

Fig 5: Red LED

The red LED is activated only when the gas concentration crosses a certain threshold, which helps in quickly identifying the presence of pollutants. It works alongside the green LED, which indicates safe air, allowing the system to easily communicate the current air quality status in a simple and effective way.

GREEN LED

The green LED in an air quality monitoring system using the MQ-135 gas sensor is used as an indicator of clean and safe air. When the sensor detects low levels of harmful gases such as carbon dioxide, ammonia or smoke, the Arduino Uno processes this information and turns on the green LED to signal that the air quality is good. This provides a simple and clear visual indication that the environment is safe to breathe. The green LED stays on as long as the gas concentration remains below a set threshold. If the air becomes polluted and the gas level rises above that threshold, the green LED turns off and another alert, such as a red LED or buzzer, can be activated. This makes the system user-friendly by allowing people to quickly understand the air quality at a glance. Figure 6 shows the green LED.

Fig 6: Green LED

BUZZER

A buzzer as shown in Figure 7 is an audio signaling device used in the system to alert users when gas levels exceed a safe threshold. It produces a beeping sound when activated by the Arduino based on sensor readings. The buzzer serves as a simple but effective way to warn users of potential danger. It is compact, low-power and easy to interface with microcontrollers. Its immediate audio feedback is crucial in critical monitoring systems. Buzzers can be either active or passive, depending on the use case.

Fig 7: Buzzer

12V ADAPTER

A 12V adapter is commonly used to power the components in an air quality monitoring system, including the Arduino Uno, MQ-135 gas sensor, LCD display and other components. The adapter provides a stable 12V output, which can be connected to the power jack of the Arduino Uno to supply the required power for the system. While the Arduino Uno operates at 5V, it has an onboard voltage regulator that converts the 12V input down to the necessary 5V. This ensures that the microcontroller and other components receive the proper voltage to function correctly. Additionally, using a 12V adapter can provide enough power for other connected devices like sensors, LEDs and the display, making it a reliable power source for the entire system. It is shown in Figure 8.

Fig 8: 12V Adapter

CONNECTING WIRES

Connecting wires are essential components used in electrical and electronic circuits to provide a path for electrical current to flow between two or more points. They are made of a conductive material, usually copper or aluminium, that has low resistance and high conductivity.

Jumper wires are a type of connecting wire used to make temporary or permanent connections in electronic circuits. They are typically made of thin, flexible, insulated wire with a male or female connector at each end. Jumper wires are commonly used to make quick and easy connections between components on a breadboard or prototype board during the design and testing phase of electronic circuits.

Jumper wires can be purchased in pre-cut lengths or in spools that can be cut to the desired length. They are available in different colors to help with organisation and identification of connections. Some jumper wires are also labelled with their wire gauge or AWG (American Wire Gauge) size, which refers to the diameter of the wire. It is shown in Figure 9.

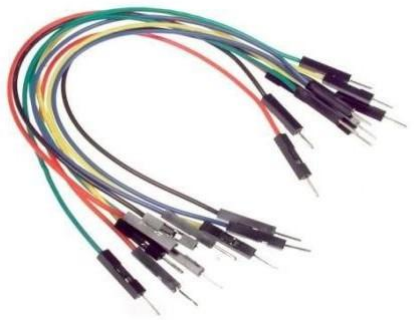

Fig 9 : Connecting wires

Jumper wires are an essential tool for prototyping and testing electronic circuits, as they allow for easy changes and adjustments to the circuit design without the need for soldering or permanent connections. They are also useful in troubleshooting and debugging circuits by allowing for easy signal tracing and isolation of problem areas.

BLOCK DIAGRAM

Figure 10 shows the block diagram of the proposed project. The MQ135 gas sensor is used to measure air quality by detecting harmful gases like ammonia, nitrogen oxides, alcohol, benzene, smoke, and carbon dioxide. It's perfect for an Air Pollution Monitoring System because it can detect a wide range of gases.

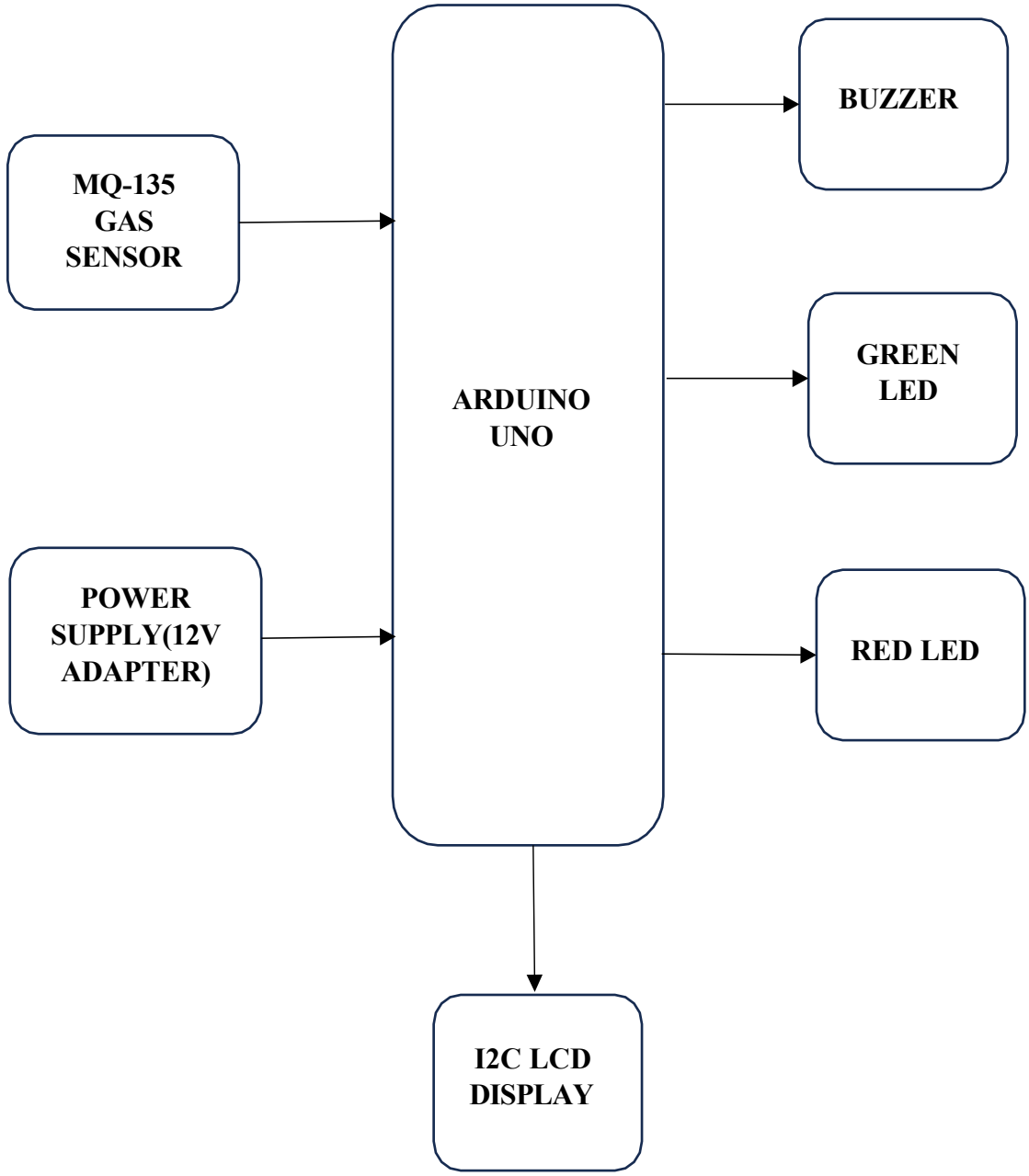

Fig.10: Block diagram of the proposed system.

The sensor is connected to an Arduino UNO, which continuously checks the air and shows the pollution level in PPM (parts per million).The sensor sends an analog voltage output, which is turned into PPM using the MQ135 library in the Arduino code.

The Arduino reads the gas concentration from the sensor and controls the system components, including a buzzer, LCD display, virtual terminal, Red LED and Green LED.

When the PPM value is below the set threshold, the air quality is good. In this case, the LCD screen shows "AQ Level Good," the Green LED lights up, the Red LED stays off and the buzzer doesn't sound.If the PPM value is above the threshold, it means the air quality is poor. The LCD will display "AQ Level High," the Red LED will turn on for a visual alert and the buzzer will sound to alert you. The Green LED will turn off. The virtual terminal also shows the PPM readings and status messages in real time.

MERITS AND LIMITATIONS

MERITS:

- **Cost-effective:** Built with affordable and easily available components.
- **Real-time Updates:** Provides continuous monitoring of air quality.
- **User-friendly Interface:** Displays gas levels clearly using an LCD.
- **Modular Design:** Easy to expand with more sensors or wireless features.
- **Educational Value:** Enhances learning of embedded systems and sensor interfacing.

LIMITATIONS:

- **Sensor Accuracy:** Less precise than commercial or industrial monitoring tools.
- **No Remote Monitoring:** Data is not sent wirelessly unless upgraded with IoT modules.
- **Environmental Sensitivity:** Sensor readings can be affected by temperature and humidity.
- **Calibration Needed:** Requires calibration for reliable and consistent output.
- **Limited Power Options:** Operates mainly on wired power; not optimized for battery use.

COMPLETED RESULTS

The Air Quality Monitoring System using Arduino UNO was successfully implemented using an Arduino UNO, an air quality sensor , 16x2 LCD display, and a set of LEDs and a buzzer. Upon powering the system, the sensor actively monitored the air quality by detecting the concentration of pollutants, converting them into analog values and displaying the data on the LCD. The hardware of the proposed project is shown in Figure 11.

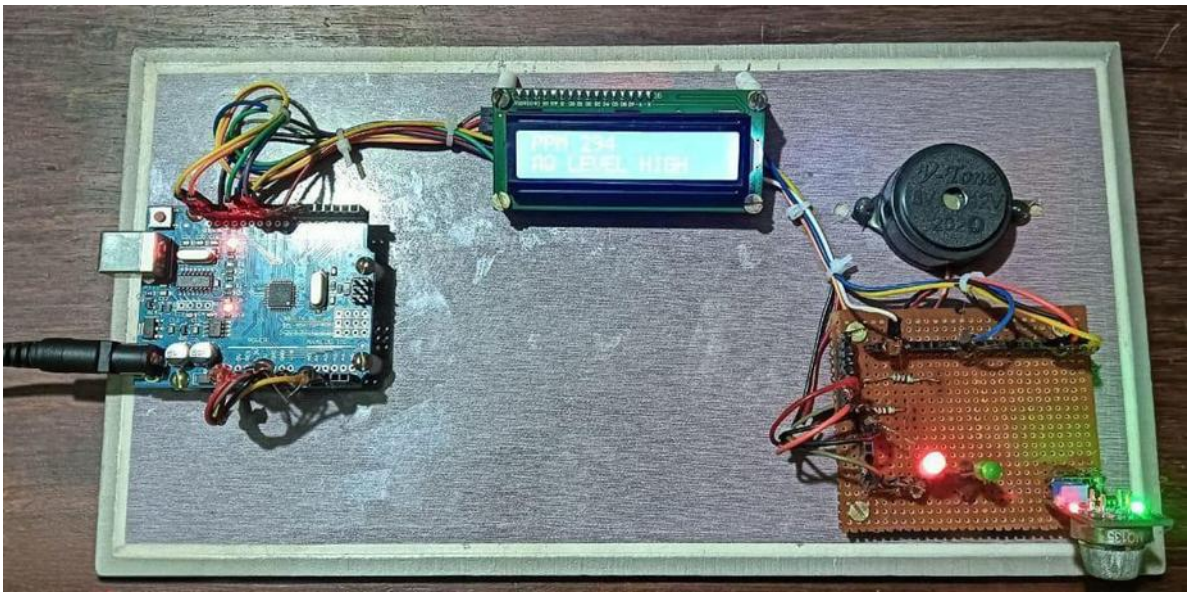

Fig 11: Hardware setup for the proposed project work.

The system displayed real-time air quality data, showing the PPM (Parts Per Million) value on the LCD along with a corresponding message. If the air quality was good (below the threshold value of 250), the system displayed "AQ LEVEL GOOD," and the green LED lit up. If the air quality was poor (above the threshold), the display showed "AQ LEVEL HIGH," and the red LED blinked while the buzzer sounded, alerting the user to take necessary precautions.

The system was tested in different environments and the results demonstrated the system's capability to accurately reflect air quality levels in response to changes in the surrounding environment, such as increased levels of particulate matter. The real-time feedback mechanism, with both visual (LED) and audible (buzzer) alerts, proved effective in conveying air quality status.

The project confirmed that an affordable and simple setup could effectively monitor environmental conditions, providing immediate feedback on air quality, making it a reliable solution for basic pollution detection and awareness.

CONCLUSION

The Air Quality Monitoring System developed in this mini project effectively detects harmful gases in the environment and provides real-time feedback. Despite being a basic prototype, it proves that low-cost embedded systems can play a vital role in addressing environmental issues.

This system can be enhanced further by integrating IoT modules for remote access, mobile alerts, and even solar-based operation for deployment in remote areas. Overall, the project showcases a practical application of electronics for environmental sustainability.

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