PROJECT REPORT

Air Quality Monitoring System

Submitted by

Arjunsingh Gautam (22070123043)

Ashish Balsure (22070123030)

Bhoumik Sundaram (22070123034)

Aadesh Yadav (22070123014)

Under the Guidance of

Dr. Shilpa Hudnurkar/ Dr. Priti Shahane

Department of E&TC Engineering

SYMBIOSIS INSTITUTE OF TECHNOLOGY, PUNE

DECLARATION

I hereby declare that the project work entitled Air Quality Monitoring System is an authentic record ofour own work carried out as requirement of Mini project for the course of Hardware Interfacing and Sensor Integration of S.Y B.Tech Electronics & Telecommunication Engineering, SymbiosisInstitute of Technology, Pune, under the guidance of Prof. Shilpa Hudnurkar, during Jan–June2024.

Arjunsingh Gautam (22070123043)
Ashish Balsure (22070123030)
Bhoumik Sundaram (22070123034)
Aadesh Yadav (22070123014)

Date: 31 March 2024

Certified that the above statement made by the student is correct to the best of our knowledge and belief.

Dr. Priti Shahane/Dr. Shilpa Hudnurkar

Assistant Professor,

E&TC Dept, SIT, Pune

INDEX

Abstract

Air pollution poses significant health and environmental challenges worldwide. To address this concern, we present a sophisticated yet accessible solution: a Real-Time Air Quality Monitoring System leveraging Arduino technology in conjunction with an MQ135 sensor. Our objective is to empower individuals and communities with the means to monitor and respond to air pollution hazards effectively.

The system comprises essential components including an Arduino Uno board, an MQ135 Gas Sensor, a 2x16 LCD Display, a potentiometer, a buzzer, and connecting wires. The Arduino Uno serves as the central processing unit, interfacing with the MQ135 sensor to detect a range of harmful gases. Real-time air quality data is displayed on the LCD screen, providing users with immediate feedback. A potentiometer allows for easy adjustment of display contrast for optimal readability. Moreover, a buzzer acts as an alert mechanism, notifying users when air quality surpasses predefined thresholds.

Implementation involves sensor setup, calibration, and software development. The Arduino is programmed to read sensor data, calculate the Air Quality Index (AQI), display results, and trigger alerts as necessary. Rigorous testing ensures the system's accuracy, reliability, and responsiveness across diverse environmental conditions.

Expected outcomes include the development of a fully functional air quality monitoring system that is both accurate and user-friendly. By increasing awareness of environmental pollution levels, we aim to promote healthier living environments. Furthermore, the system's scalability and adaptability facilitate potential modifications for different sensors or expanded functionalities.

In conclusion, our project addresses the critical issue of air pollution through the creation of an accessible monitoring system. By harnessing the capabilities of Arduino and MQ135 sensor technology, we offer a practical solution to enhance environmental awareness and foster healthier communities. Through collaboration and innovation, we aspire to mitigate the impact of air pollution and create a more sustainable future for all.

Introduction

Air pollution stands as a formidable challenge of our time, with far-reaching implications for public health and environmental sustainability. As urbanization and industrialization accelerate, so does the release of harmful pollutants into the atmosphere, necessitating innovative solutions to monitor and mitigate their impact. In response to this pressing need, we introduce a Real-Time Air Quality Monitoring System developed using Arduino technology and MQ135 sensor capabilities.

The urgency of addressing air pollution cannot be overstated. Exposure to pollutants such as ammonia, nitrogen oxides, benzene, smoke, and carbon dioxide has been linked to respiratory diseases, cardiovascular complications, and even premature mortality. Furthermore, the ecological repercussions of air pollution extend to biodiversity loss, ecosystem degradation, and climate change exacerbation.

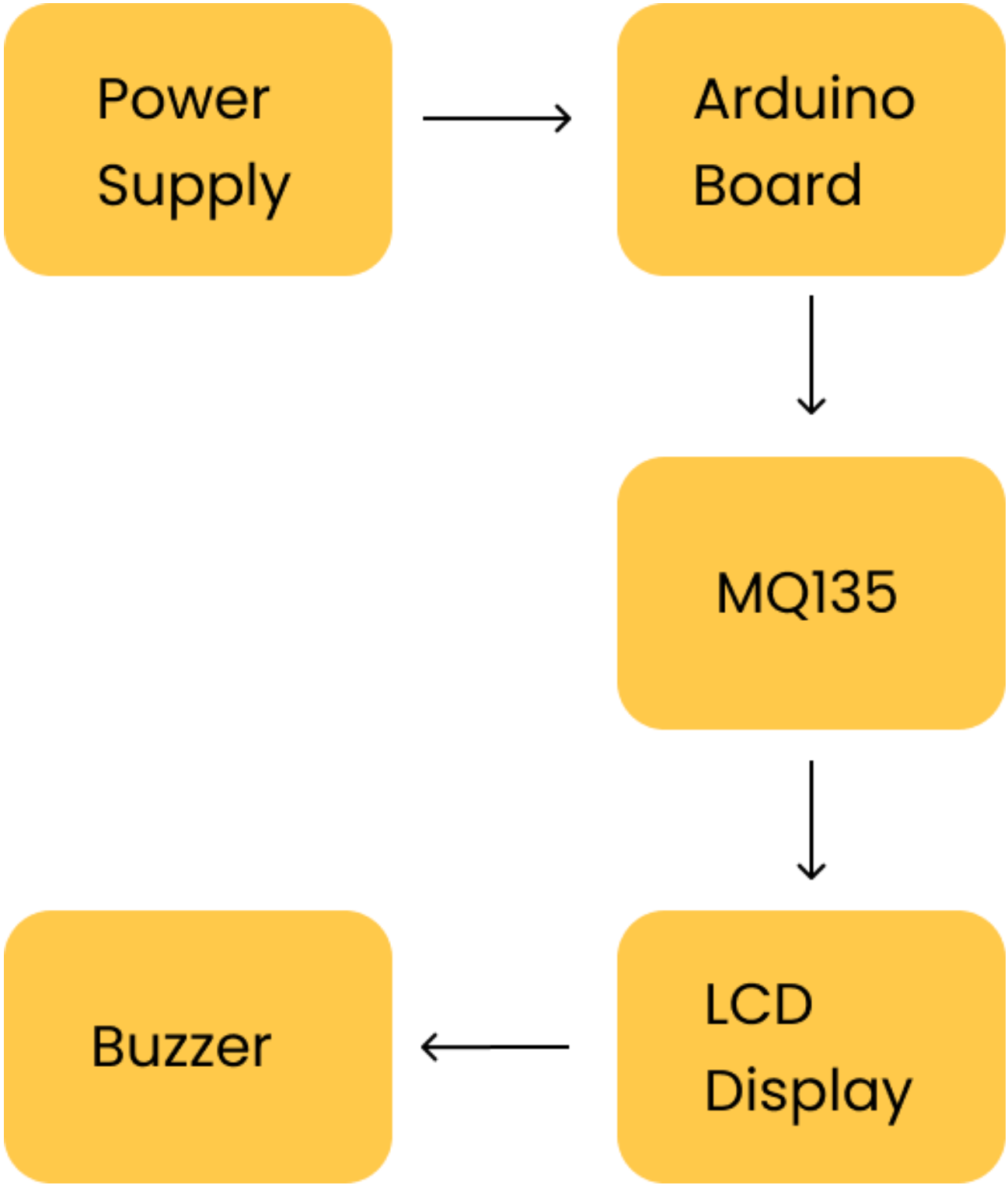
Traditional methods of air quality monitoring, typically reliant on complex and costly equipment, are often inaccessible to individuals and communities. Recognizing the importance of democratizing environmental monitoring, our project aims to provide an affordable, user-friendly solution that empowers users to make informed decisions about their surroundings.

The foundation of our system lies in the Arduino Uno board, a versatile microcontroller platform renowned for its accessibility and flexibility. Paired with the MQ135 gas sensor, capable of detecting a wide array of harmful gases, the Arduino serves as the brain of our monitoring system, processing sensor data and providing real-time feedback to users.

Central to the functionality of our system is the integration of a 2x16 LCD display, which presents air quality readings in a clear and comprehensible manner. A potentiometer enables users to adjust display contrast, ensuring optimal visibility under varying lighting conditions. Furthermore, an audible alert mechanism, facilitated by a buzzer, enhances user awareness by signaling when air quality surpasses predefined thresholds.

In this introduction, we set the stage for the development of our Real-Time Air Quality Monitoring System, highlighting the critical importance of addressing air pollution and the need for accessible monitoring solutions. Through the fusion of Arduino technology and MQ135 sensor capabilities, we endeavor to empower individuals and communities to safeguard their health and environment effectively. With simplicity, affordability, and effectiveness as our guiding principles, we embark on a journey to create a tangible impact in the fight against air pollution.

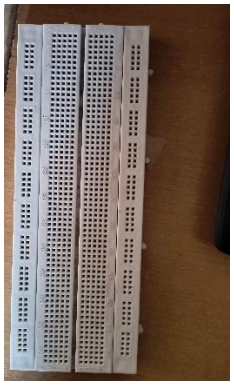
Block Diagram



Selection of Components

- **Arduino Board**

- **Breadboard**



- **Buzzer**

- **LCD Display**

- **MQ135 Sensor**

List of Components

Bill of materials – Electrical Component for the Air Monitoring System

Total Cost: INR 1150

Qty	Vendor	Part Number	Description	Unit Price	Cost
1	Amazon	$MQ135$	Air Quality Sensor	275	275
1	Amazon	$1602A$	LCD Display	200	200
1	Amazon	$TL-0949$	Buzzer	25	25
1	Amazon	Arduino Uno	Microcontroller Board	450	450
1	Amazon	Breadboard	Breadboard	200	200

Vendors

Name	URL	Location
Amazon	www.amazon.in	*India*

Notes

Wires, Cables, battery are not listed

Component Description

- **Arduino Uno**

The Arduino Uno is a microcontroller board based on the ATmega328P chip. It serves as the central processing unit of the system, facilitating communication between various components, reading sensor data, and controlling the display and alert mechanisms.

- **MQ135 Sensor**

The MQ135 sensor is capable of detecting a variety of harmful gases, including ammonia, nitrogen oxides, benzene, smoke, and carbon dioxide. It provides essential data on air quality levels, enabling the system to assess potential health hazards.

- **LCD Display**

The 2x16 LCD display is used to visualize real-time air quality readings. It provides a clear and easy-to-read interface for users, displaying information such as gas concentrations and alert messages.

- **Buzzer**

The buzzer acts as an alert mechanism, emitting an audible signal when air quality breaches predefined thresholds. It enhances user awareness by providing immediate feedback on potentially hazardous conditions.

Working And Circuit Diagram

Working of the Real-Time Air Quality Monitoring System

The Real-Time Air Quality Monitoring System operates through a series of interconnected components and processes, aimed at providing accurate and timely information regarding air quality levels. Here's how it works:

Sensor Data Acquisition: The heart of the system lies in the MQ135 gas sensor, which continuously samples the surrounding air for various pollutants. These pollutants include ammonia, nitrogen oxides, benzene, smoke, and carbon dioxide, among others. The sensor outputs analog data corresponding to the concentration of these gases in parts per million (ppm).

Arduino Processing: The analog data from the MQ135 sensor is fed into the Arduino Uno board, where it undergoes analog-to-digital conversion. The Arduino then processes this digital data to calculate the Air Quality Index (AQI). The AQI is a numerical scale used to quantify the level of air pollution, providing a standardized measure for comparison.

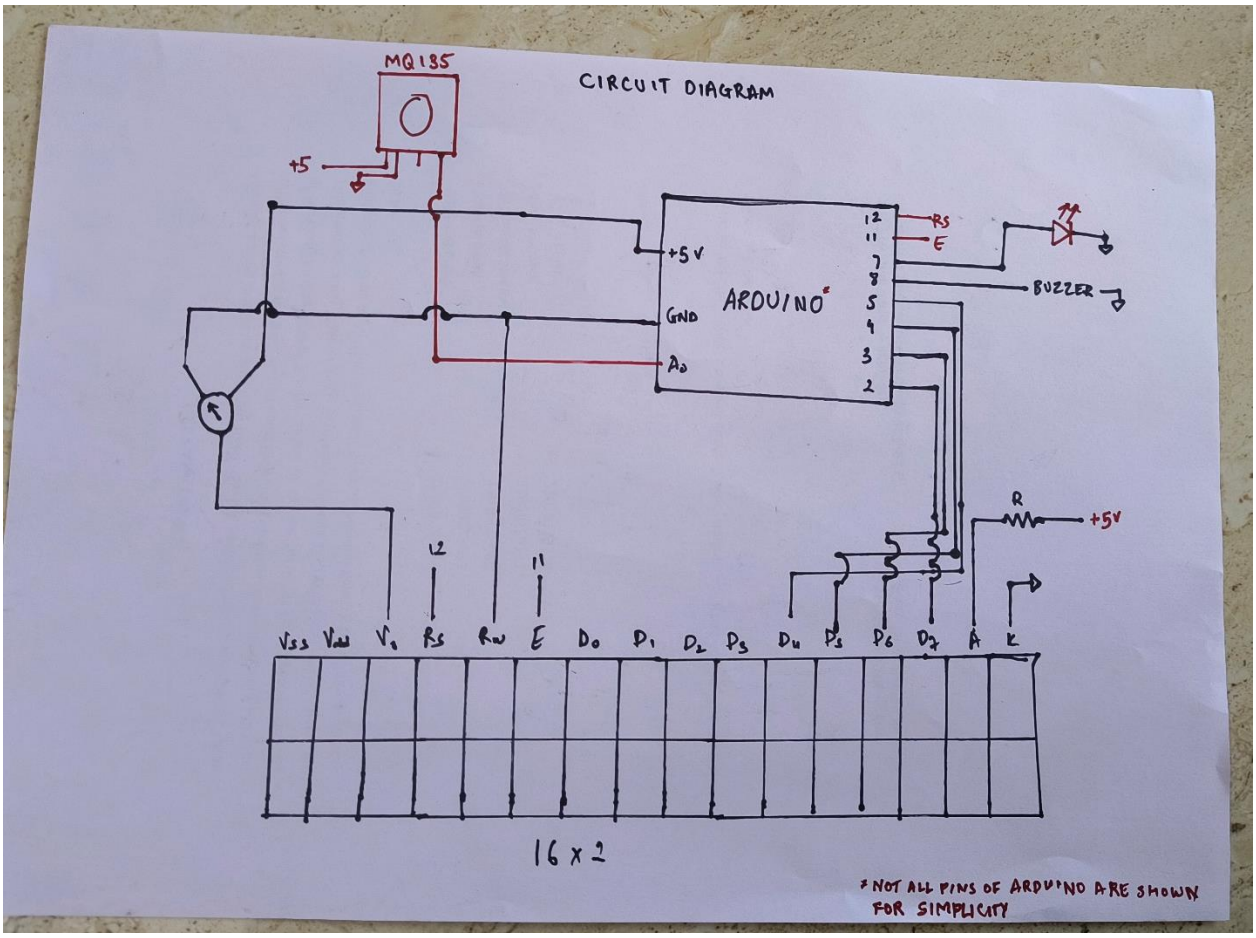
Data Visualization: The calculated AQI is then displayed in real-time on the 2x16 LCD display. This display interface presents the air quality readings in a clear and easily understandable format, allowing users to monitor pollution levels at a glance. The LCD display also provides space for displaying additional information such as gas concentrations and alert messages.

Alert Mechanism: To enhance user awareness and safety, the system incorporates an alert mechanism triggered by predefined thresholds. When the AQI surpasses these thresholds, indicating poor air quality, the Arduino activates the buzzer. The buzzer emits an audible signal, alerting users to the potential health risks associated with the detected pollution levels.

User Interaction: The system design includes provisions for user interaction and customization. For instance, a potentiometer can be incorporated to adjust the contrast of the LCD display, ensuring optimal visibility under different lighting conditions. Additionally, the system can be powered by either USB or batteries, providing flexibility and portability in deployment.

Continuous Monitoring and Response: The Real-Time Air Quality Monitoring System operates continuously, providing ongoing monitoring of air quality levels. Users can rely on the system to alert them to changes in pollution levels and take appropriate actions to mitigate potential health risks. Additionally, the system's scalability and adaptability allow for future enhancements and modifications to meet evolving monitoring needs.

Circuit Diagram



Simulation

Before implementing the Real-Time Air Quality Monitoring System in real-world environments, it's essential to conduct simulations to validate its functionality and performance. Simulation enables us to test the system under various scenarios, ensuring its reliability and effectiveness. Here's a brief overview of the simulation process:

Virtual Environment Setup: We create a virtual environment that emulates real-world conditions, including varying levels of air pollution. This environment may be implemented using software tools such as Arduino simulation platforms or circuit design software.

Sensor Data Generation: Synthetic data representing air quality readings is generated to simulate the output of the MQ135 gas sensor. This data includes concentrations of different pollutants within a predefined range, mimicking the sensor's response to varying pollution levels.

Arduino Programming Simulation: The Arduino code responsible for processing sensor data, calculating the Air Quality Index (AQI), and triggering alerts is simulated within the virtual environment. This simulation allows us to verify the correctness of the code logic and its interaction with simulated sensor data.

Visualization and Alerting: The simulated air quality data is visualized on a virtual LCD display, replicating the real-time display functionality of the system. Additionally, the alert mechanism triggered by predefined thresholds is simulated, ensuring that alerts are generated accurately based on simulated pollution levels.

Performance Evaluation: Various performance metrics, such as response time, accuracy of AQI calculations, and reliability of alert triggering, are evaluated during the simulation. This assessment helps identify any potential issues or areas for improvement in the system design or implementation.

Problem Faced / Troubleshooting

While creating the Real-Time Air Quality Monitoring System, we encountered some challenges that needed solving. Here's what we faced and how we solved it:

Sensor Calibration: The sensor we used to measure air quality sometimes gave readings that weren't quite right. This happened because things like temperature and humidity could affect its accuracy. We fixed this by regularly adjusting and fine-tuning the sensor to make sure it always gave correct readings, no matter what the conditions were like.

Setting Thresholds: Figuring out when to sound the alarm was a bit tough. If we set it too low, it beeped too often, even when the air wasn't too bad. But if we set it too high, it didn't beep when it should have. So, we did lots of testing until we found the right balance.

Power Stability: Sometimes, the system would stop working because the power supply wasn't stable, especially when using batteries. To fix this, we used reliable batteries, with proper connector.

In the end, by tackling these challenges one by one, we were able to create a Real-Time Air Quality Monitoring System that's accurate, dependable, and easy for everyone to use.

Application of the project

The Real-Time Air Quality Monitoring System we've developed holds significant potential for various applications across different sectors. Here's how our system can be applied to address key environmental and public health challenges:

Urban Environments: In densely populated urban areas, where air pollution levels are often elevated due to traffic congestion, industrial activities, and urban development, our monitoring system can play a crucial role in assessing and mitigating pollution hotspots. By deploying the system in strategic locations throughout cities, urban planners and local authorities can gather real-time air quality data to inform pollution control measures, traffic management strategies, and urban planning initiatives aimed at improving public health and quality of life.

Industrial Settings: Within industrial facilities, where emissions from manufacturing processes and chemical operations contribute to localized pollution, our monitoring system can provide valuable insights into workplace air quality and occupational health risks. By integrating the system into industrial hygiene programs, facility managers can identify potential exposure hazards, implement control measures to minimize employee exposure, and ensure compliance with occupational safety regulations.

Healthcare Facilities: In healthcare settings, where vulnerable populations such as patients with respiratory conditions and elderly individuals are particularly susceptible to the adverse effects of air pollution, our monitoring system can support proactive healthcare management and intervention strategies. By continuously monitoring indoor air quality in hospitals, clinics, and nursing homes, healthcare providers can identify environmental risk factors, implement preventive measures to protect patients and staff, and optimize indoor air quality for enhanced patient recovery and well-being.

Educational Institutions: Within educational institutions, where children spend a significant portion of their time indoors, our monitoring system can contribute to creating healthier learning environments. By installing the system in schools and childcare facilities, educators and administrators can monitor indoor air quality parameters such as carbon dioxide levels, temperature, and humidity, facilitating optimal learning conditions and safeguarding the health and well-being of students and staff.

Conclusion

In conclusion, the development of the Real-Time Air Quality Monitoring System represents a significant step forward in addressing the pressing challenges posed by air pollution. Through the integration of Arduino technology and the MQ135 sensor, we have created a cost-effective, accessible, and reliable solution for monitoring air quality in various environments.

This project has not only provided a means to detect and assess air pollution levels but has also empowered individuals and communities to take proactive measures to protect their health and well-being. By offering real-time air quality data and triggering alerts when pollution levels exceed predefined thresholds, our system facilitates informed decision-making and timely intervention, ultimately contributing to healthier living environments.

Furthermore, the versatility of our monitoring system opens up opportunities for diverse applications across urban, industrial, healthcare, educational, and community settings. Whether deployed in cities to inform pollution control strategies, in workplaces to safeguard occupational health, or in schools to create healthier learning environments, the potential impact of our system is far-reaching and multifaceted.

Looking ahead, the success of this project underscores the importance of continued innovation and collaboration in addressing environmental challenges. By leveraging emerging technologies, harnessing community engagement, and advocating for policy changes, we can work towards a future where clean air is accessible to all.

In conclusion, the Real-Time Air Quality Monitoring System represents a tangible step towards building healthier, more sustainable communities. Through our collective efforts, we can create a world where clean air is not just a luxury but a fundamental right for every individual.

Future Scope of Work:

While the Real-Time Air Quality Monitoring System has achieved significant milestones in providing accessible and reliable air quality data, there remain several avenues for future enhancements and expansion. Here are some areas of potential future work:

Integration of Additional Sensors: While the MQ135 sensor provides valuable data on various harmful gases, integrating additional sensors capable of detecting specific pollutants, such as particulate matter (PM2.5 and PM10), volatile organic compounds (VOCs), and ozone (O3), can enhance the system's capabilities for comprehensive air quality monitoring. This expansion would enable more accurate and detailed assessments of air pollution sources and their impacts on human health and the environment.

Data Analysis and Visualization Tools: Developing advanced data analysis algorithms and visualization tools can facilitate deeper insights into air quality trends, patterns, and correlations. By leveraging machine learning techniques and data analytics, the system can provide predictive modeling of pollution levels, identify pollution hotspots, and support evidence-based decision-making for pollution mitigation strategies and policy interventions.

Mobile and Web Applications: Creating mobile and web applications that interface with the monitoring system can extend its reach and accessibility to a broader audience. These applications can allow users to access real-time air quality data, receive personalized alerts and recommendations based on their location, and contribute crowd-sourced data for community-based air quality monitoring initiatives. Additionally, interactive dashboards and maps can provide intuitive visualization of air quality information, empowering users to make informed choices to protect their health and well-being.

IoT Integration and Smart Cities Initiatives: Integrating the monitoring system into Internet of Things (IoT) networks and smart cities initiatives can enable seamless integration with existing infrastructure and urban management systems. By leveraging IoT connectivity, the system can communicate with smart devices, environmental sensors, and urban infrastructure to optimize resource allocation, improve urban planning, and enhance environmental sustainability. Furthermore, collaboration with local governments and urban planners can facilitate the deployment of monitoring stations in strategic locations to support data-driven decision-making for urban development and pollution control measures.

Community Engagement and Citizen Science: Engaging communities and promoting citizen science initiatives can empower individuals to actively participate in air quality monitoring and environmental stewardship. By fostering partnerships with schools, community organizations, and citizen science networks, the system can support educational outreach programs, citizen-led monitoring campaigns, and participatory research projects to raise awareness about air pollution issues, promote behavioral changes, and advocate for policy reforms at the local and regional levels.

Long-Term Monitoring and Epidemiological Studies: Establishing long-term monitoring networks and conducting epidemiological studies can provide valuable insights into the long-term health impacts of air pollution exposure. By collecting continuous air quality data over extended periods, researchers can analyze trends, correlations, and health outcomes associated with air pollution, informing public health policies and interventions to mitigate the adverse effects of pollution on vulnerable populations.

References:

- Circuit digest: https://circuitdigest.com/microcontroller-projects/arduino-based-air-quality-monitoring-system
- Arduino Project Hub: https://projecthub.arduino.cc/abid_hossain/air-quality-monitor-14f9b4
- How to Mechatronics
- ECIT Engineering
- svsembedded
- LearningBix Robotics
- Arduino.cc
- Datasheet

Appendix:

- **MQ135: winsen-sensor.com Air quality sensor manual**
- **LCD: HITACHI HD44780U Datasheet**
- **Arduino: A000066 Datasheet by Arduino.cc**