Intelligent Air Quality Monitoring System

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Abstract-Many times, we may feel very weak while waking up from the bed even after getting a good sleep at night. This sometimes happens because of the poor air quality in the closed room at night. This Air Quality Monitor can monitor the air quality of a room using MQ135 air quality sensor. It also measures the temperature and humidity using DHT11 and shows the data on an OLED display. Also, this can detect any gas leakage, and toxic gas and generate alarm, so it can save the lives of people in case of any explosion of venomous or toxic gas. To create a device for air quality monitor which can measure surrounding air quality also shows temperature and humidity in your room.

Keywords: Arduino UNO development board, Air Quality sensor (MQ135), DHT11 Temperature & Humidity Sensor, Piezo Electronic Buzzer, 220-ohm resistor.

1. INTRODUCTION

The Technological capability to measure and record levels of outdoor air pollution is rapidly expanding with an increasing number of agencies and individuals developing various air quality monitoring technologies. However, there remain significant resource and technological limitations to reliably monitoring outdoor air pollution in many parts of the world. In addition, many of these experts work in relative isolation, limiting the potential use of their technological and quantitative developments. These divisions are particularly evident across monitoring fields, including remote sensing using satellite technology, use of regulatory and nonregulatory air quality networks for stationary monitoring, computational air quality modeling, and use of low-cost sensor systems. Integration between technology groups is essential to maximizing the potential public health benefit of these technologies.

Most high-income nations already have ground monitoring networks in place, with varying levels of spatial coverage, producing accurate and consistent data for common pollutants (i.e., particulate matter [PM], nitrogen oxides [NOx], sulfur dioxide [SO2], ozone [O3], and carbon monoxide [CO]) as well as other pollutants of interest for regulatory compliance and other purposes. However, these regulatory-quality networks are much sparser in LMICs that may lack sufficient resources to implement and sustainably operate such monitoring networks. Owing to the high per-monitor and operating costs of these networks, there are spatial and, if monitors are only operated sporadically, temporal limitations in accurately reflecting exposures that are essential for medical research and patient care.

In addition to complementing any existing monitors, new and emerging air quality monitoring technologies may allow LMIC to begin to characterize outdoor pollution concentrations in the absence of regulatory-quality monitoring networks. These technologies include satellite remote sensors and global atmospheric models, from which the data are typically free for the end user (e.g., from NASA and the European Space Agency). Similarly, emerging non regulatory stationary sensors and low-cost portable sensors have potential for expanding monitoring in LMIC, as well as enhancing the spatial resolution of traditional networks where these exist.

Data derived from low-cost sensor systems offer the potential for finer spatial, and in some cases temporal, scales; however, their reliability and accuracy merit further attention. He efforts to develop monitoring capabilities have generally occurred without much input from health professionals, resulting in decisions that may not fully take into account the needs and opportunities for collecting data in ways that are most useful for health research and patient care. This work was convened among health and air quality experts to improve understanding of how different technologies can be brought together to better monitor and disseminate global air quality data.

2.CURRENT CAPABILITIES AND NEAR-FUTURE ASPIRATIONS FOR AIR POLLUTION MONITORING

Current technologies for monitoring particulate and gaseous air pollutants go far beyond traditional regulatory monitoring networks and now include remote sensing of air pollutants using instruments on satellites, low-cost portable sensors, nonregulatory monitoring networks, and air quality model simulations. Each of these technologies has strengths and weaknesses when considered in the context of monitoring air pollution for health research and in disseminating clinically relevant information to the public. These limitations range from technical (e.g., data accuracy, spatial coverage, spatial and temporal resolution) to practical (e.g., cost, general awareness of data availability, difficulty accessing and using data).

Various monitoring technologies can be distinguished by the spatial and temporal scales at which their data are reliably generated. Figure 1 summarizes the current capabilities of regulatory-quality monitors, nonregulatory stationary sensors, low-cost portable monitors, remote sensing from satellites, and global atmospheric models as a function of the spatial scale (resolution and coverage) and temporal scale at which data can be used to conduct health research studies with the eventual goal of improving patient care. Figure 1 not only demonstrates how these various monitoring technologies can complement each other but also emphasizes that no one technology group alone is able to provide the full range of temporal and spatial coverage needed in health research and for use in public communication.

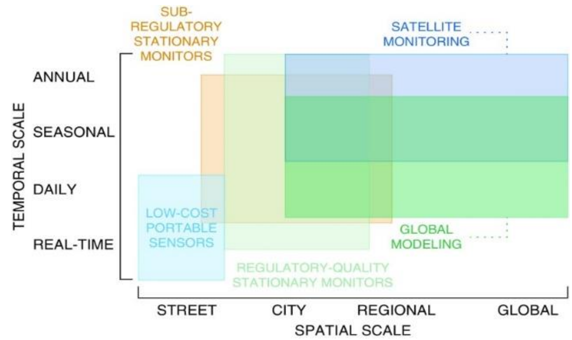


Figure 1: Monitor Scale

There has been great interest in the potential of low-cost sensor systems comprised of stationary and portable sensors that typically employ optical methods for counting particles and estimating PM mass or metal oxide and electrochemical approaches for measuring gas species. Owing to their lower investment costs and setup time, deployment of these types of nonregulatory monitors as part of a stationary network can improve the spatial characterization of highly variable pollution exposures within a city and can be used in a greater number of locations around the world. Similarly, deployment of air quality instruments as part of mobile monitoring platforms is promising for monitoring with greater temporal and spatial resolution, often continuously and in real time, capturing transient or short-term peaks in concentrations at the street level.

3.WHY IS AIR QUALITY MONITORING IMPORTANT?

There are numerous air quality monitoring benefits. The most important ones include the possibility to:

- improve air quality – monitoring helps to identify areas with poor air quality and the pollutants responsible for it. This information can be used to implement air pollution control measures to improve air quality. Reducing the levels of pollutants in the air can lead to improved health outcomes for the population and a better quality of life.
- monitor compliance with regulations – air quality sensors and other devices make it possible to keep an eye on the emissions from industrial sources, such as power plants and factories, to ensure they meet the standards set by government agencies

and adjust your outdoor activities accordingly. One of the main benefits of air quality monitoring is that it helps us to ensure that the air we breathe is safe.

- monitor climate change – changes in weather patterns, such as increased frequency of heat waves and wildfires, can affect the levels of pollutants in the air. By monitoring these changes, air quality monitoring can help to identify the impact of climate change on air quality and take action to mitigate it.
- support research and development – collected data on air quality is a unique source of inspiration for research and development of new pollution control technologies that have the potential to reduce emissions from industrial sources.
- protect health – why is air quality monitoring important? Pollution has been linked to a range of health problems, including respiratory and cardiovascular diseases. Air quality monitoring can help to identify areas where the air is polluted and take action to protect public health.

4.PROPOSED SYSTEM

Distributed storage different servers and key servers. AES used to encryption and decryption the data in Storage system.MD5 can used to generate the hash value and proxy re-encryption can stored in multiple blocks.

4.1 ADVANTAGES OF THE PROPOSED SYSTEM

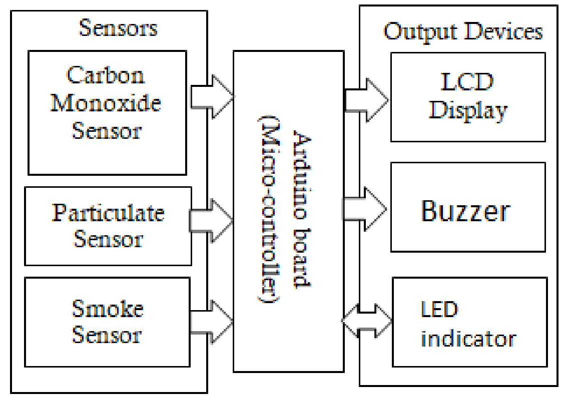
Usage:

- This H/W is useful for detecting invisible toxic gas.
- Useful in the places where people do mine to identify if there is any toxic gas.
- Useful to check if there was any toxic gas in drainage, before starting to clean the drainage.

5.WORK DESCRIPTION

An air quality monitoring system typically consists of several components to measure and analyze various air quality parameters. Here is a simplified block diagram of an air quality monitoring system:

Figure 2. Block Diagram:



1. Sensor Array:
    - Gas Sensors: Measure concentrations of specific gases such as carbon dioxide (CO2), carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), etc.
    - Particulate Matter (PM) Sensors: Detect and quantify fine particulate matter in the air, categorized as PM2.5 and PM10.
2. Data Acquisition System:
    - Collects raw data from the sensor array.
3. Signal Conditioning:
    - Processes raw sensor data to ensure accuracy and reliability.
    - Calibration and filtering are performed at this stage.
4. Microcontroller/Processor:
    - Receives conditioned signals.
    - Executes algorithms for data analysis.
    - Controls the overall functioning of the monitoring system.
    - An open-source micro controller Arduino UNO is used in this project.
5. Data Storage:
    - Stores historical data for trend analysis and reporting.
6. User Interface:
    - OLED mini display to display the Air quality.
    - Provides alerts or notifications for critical air quality levels.
    - Color LED to indicate the air quality level.
7. Power Supply:
    - Provides power to the entire system. It could be a combination of mains power and/or battery, depending on the application.
8. Alarm System:

- Triggers alarms or notifications when air quality levels exceed predefined thresholds.

This block diagram represents a basic structure, and the complexity can vary based on the specific requirements and the intended application of the air quality monitoring system.

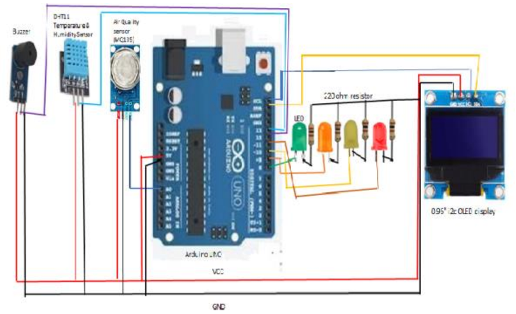
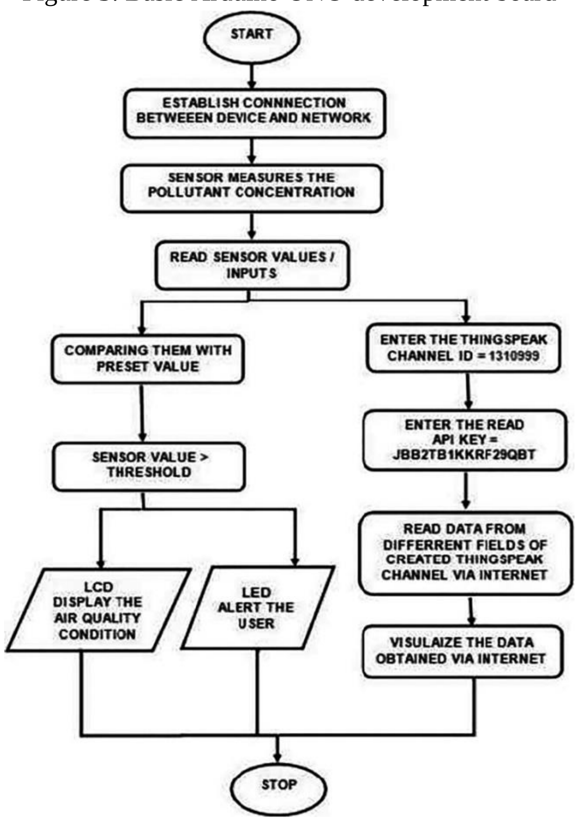


Figure 3. Basic Arduino UNO development board



2. Working Principle

The MQ-135 gas sensor utilizes a tin dioxide (SnO2) semiconductor as its sensing element. Tin dioxide has the property of being an excellent conductor at high temperatures when exposed to certain gases. The sensor consists of a ceramic element coated with SnO2, and when this element comes into contact with a specific gas, the conductivity of the sensor changes. This change in conductivity is then converted into an electrical signal that can be measured and interpreted. The sensitivity of the MQ-135 sensor is influenced by the concentration of gases in the surrounding environment. The higher the concentration of the target gas, the greater the change in conductivity, resulting in a more significant electrical signal. This makes the MQ-135 an effective tool for measuring air quality and detecting the presence of harmful gases.

Calibration and Accuracy

It's important to note that MQ series sensors, including the MQ-135, require calibration for accurate readings. Calibration involves exposing the sensor to a known concentration of the target gas and adjusting the sensor's output accordingly. Without proper calibration, the sensor's readings may not be accurate, making it essential for users to follow calibration procedures provided by the sensor's datasheet.

Applications of the MQ-135 Gas Sensor

1. Air Quality Monitoring:
One of the primary applications of the MQ-135 sensor is in air quality monitoring systems. It is widely used in indoor air quality monitors, wearable devices, and IoT-based solutions to measure the concentration of pollutants and ensure that air quality meets health and safety standards.
2. Industrial Safety:
In industrial settings where the release of gases is a concern, the MQ-135 sensor plays a crucial role in ensuring the safety of workers. It can be integrated into gas detection systems to monitor the levels of hazardous gases and provide timely warnings in case of elevated concentrations.
3. Environmental Monitoring:
The MQ-135 sensor is also employed in environmental monitoring applications, helping to assess the impact of human activities on air quality. Researchers and environmentalists use these sensors in field studies to gather data on pollution levels and contribute to efforts aimed at reducing environmental degradation.
4. Smart Home Automation:
With the rise of smart homes and IoT, the MQ-135 sensor finds its place in smart home automation systems. It can be used to detect and control ventilation

systems, alerting homeowners to poor air quality and triggering actions to improve the indoor environment.

Challenges and Considerations

While the MQ-135 sensor is a valuable tool for gas detection, there are certain challenges and considerations that users should be aware of:

Cross-Sensitivity:

The MQ-135 sensor exhibits cross-sensitivity, meaning it may respond to multiple gases, not just the target gas. This cross-sensitivity can affect the accuracy of the sensor, especially in environments where multiple gases are present.

Temperature and Humidity Dependency:

The sensor's performance is influenced by temperature and humidity levels. Users must take these factors into account and, if necessary, implement temperature and humidity compensation techniques to ensure accurate readings.

Limited Gas Specificity:

While the MQ-135 sensor can detect a variety of gases, it lacks specificity for certain gases. Users should be cautious when interpreting readings and consider potential interference from other gases in the environment.

DIY Projects and Education:

The accessibility and affordability of the MQ-135 sensor make it an ideal component for do-it-yourself (DIY) projects and educational purposes. Students, hobbyists, and electronics enthusiasts often incorporate the MQ-135 into their projects to learn about gas sensing principles, microcontroller interfacing, and data interpretation. This hands-on experience helps individuals develop practical skills in electronics and sensor technology.

Health Monitoring Devices:

The MQ-135 sensor can be utilized in wearable devices designed for health monitoring. By integrating this sensor into devices such as smartwatches or portable air quality monitors, individuals can track their exposure to certain gases and pollutants. This application becomes particularly relevant in urban environments where air quality can vary significantly.

Automotive Air Quality Systems:

With a growing emphasis on environmental concerns and the impact of vehicular emissions, the MQ-135 sensor can be employed in automotive air quality systems. These systems can monitor the air inside a vehicle's cabin and activate ventilation or air purification systems when pollutant levels exceed predefined thresholds, contributing to a healthier driving experience.

Agricultural Applications:

The MQ-135 sensor finds applications in agriculture for monitoring the air quality in greenhouses. It can detect gases emitted by plants or pesticides, helping farmers optimize environmental conditions for crop growth. Additionally, the sensor can be part of automated systems that control ventilation and gas levels to enhance crop productivity.

6.CONCLUSION

The smart way to monitor the indoor environment and air quality with the help of a low-cost and compact module is presented in the proposed work. The proposed hardware architecture functions of different sensors and their working procedure were discussed. The operation, functionality, optimal uses, data-taking techniques, and comparison with standard base data are also analysed. The sensors measured the concentration of pollutants indoors, monitored the pollutant levels on different days, and viewed the result on the LCD. It also sent the sensor parameters to the data server. The proposed method showed that it is effective, inexpensive, and reliable for everybody. The final AQI output will play a crucial role for every individual to take the necessary steps to better our home and other indoor areas. It will help identify the affected surrounding to take early steps to reduce the risk of COPD and other respiratory illnesses. Thus, COPD can be prevented but cannot be cured completely. Perhaps, future work relies on the permanent curing of COPD by correlating the exposures and their frequency. Thermal imaging and gas detection technologies are critical for environmental monitoring and detecting invisible threats. By utilising these tools, early detection and prevention of gas leaks, fires, biological hazards, and toxic gas exposure can be achieved, significantly enhancing the safety of individuals and the environment.

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