

IoT Based Air Pollution Monitoring System

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By

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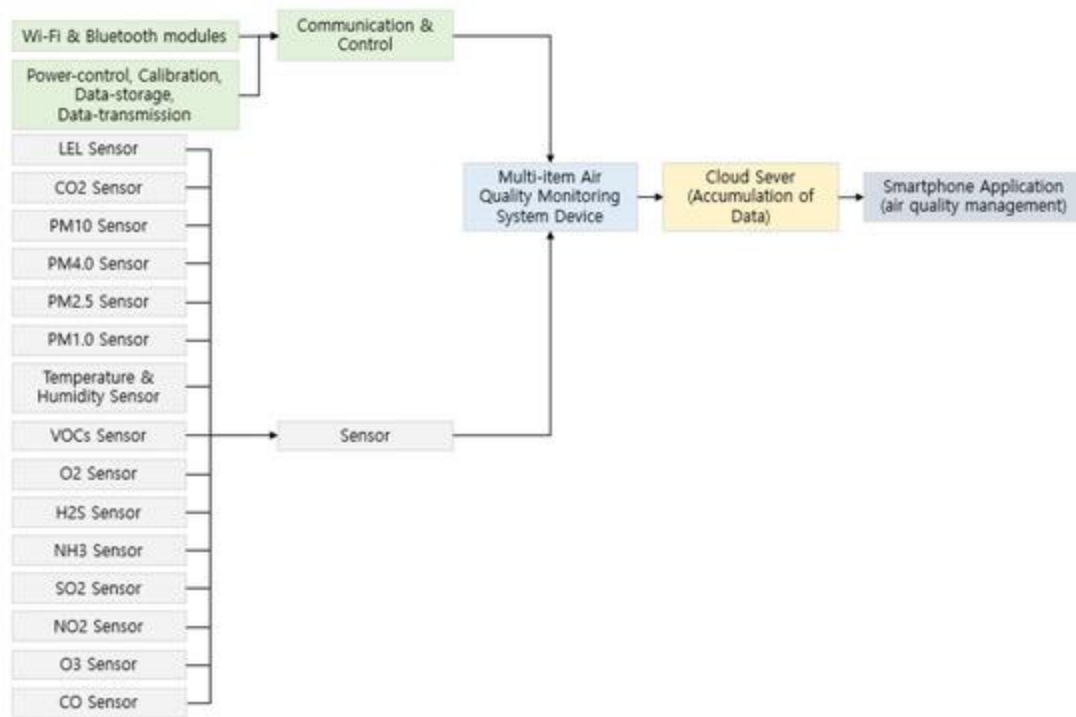
AIR QUALITY MONITORING SYSTEM

PHASE 4 : DEVELOPMENT PART – 2

Air quality plays a crucial role in human health and the well-being of the environment. Unfortunately, air pollution has been on the rise due to various sources such as vehicle emissions, industrial activities, energy production, and natural disasters like wildfires. Understanding and assessing the quality of the air we breathe is of utmost importance. Air Quality Monitoring (AQM) systems, integrated with sensors and advanced technologies, are utilized to measure particulate matter and air pollutants like ozone, nitrogen oxides, and sulfur dioxide. The data collected by these systems helps formulate policies, monitor pollution reduction efforts, and empower the public to make informed decisions regarding their health and well-being. Currently, AQM stations are primarily used for calculating the Air Quality Index (AQI) and monitoring pollution. However, the infrastructure requirements, operational complexities, and ongoing expenses associated with these stations limit the expansion of AQM networks and the availability of air pollution data. To overcome these limitations, it is imperative to develop low-cost, efficient, and real-time data-sensing devices. IoT technology provides a promising solution, with recent advancements allowing the use of IoT sensors in various domains, including smart cities, smart mobiles, smart refrigerators, and smartwatches. Leveraging IoT, air quality can be monitored remotely using sensors (e.g., temperature and pressure sensors, noise sensors), Arduino for data processing, and cloud platforms for storage. Machine learning algorithms, such as Linear Regression, Random Forest, XGBoost, and ARIMA models, have also proven effective in forecasting and predicting air pollutant levels. The availability of affordable sensors and data processing tools has enabled the deployment of air quality monitoring systems on a large scale. However, maintaining the accuracy of these systems is crucial, as erroneous data can lead to flawed policy decisions and ineffective mitigation efforts. Regular calibration and validation are essential to ensure the accuracy of air quality monitoring systems.

This paper presents several contributions:

- Development of a low-cost and user-friendly air pollution monitoring system.
- Real-time data gathering capabilities within the AQM system.
- Utilization of Blynk for real-time data visualization.
- Adoption of ThingSpeak, an open-source software, for day-to-day pollution visualization.



Materials and Methods

➤ Process of Multi-Item Air Quality Monitoring System

A multi-item air quality monitoring system component consists of a hardware part and a software part. The hardware part consists of a sensor unit and a communication control unit. The sensor unit consists of a total of 16 items: PM₁₀, PM_{2.5}, PM_{4.0}, PM_{1.0}, CO₂, CH₄, temperature, humidity, VOCs, O₂, H₂S, NH₃, SO₂, NO₂, O₃, and CO. The total number of installed sensors are eleven. The communication unit consists of a Wi-Fi module and a Bluetooth module. The software part consists of a web program and a smartphone application. The measurement process is that the sensor unit of the hardware part measures 16 air pollution items, the measured data are transmitted to the cloud server through the communication unit.

➤ *Hardware Process of Multi-Item Air Quality Monitoring System*

The hardware part of the multi-item air quality monitoring system is divided into a sensor part and a communication part. The sensor unit includes nine sensors including a PM sensor, a temperature and humidity sensor, a VOC sensor, an oxygen sensor, a hydrogen sulfide sensor, an ammonia sensor, a sulfur dioxide sensor, a nitrogen dioxide sensor, an ozone sensor, and a carbon monoxide sensor. The carbon dioxide and methane sensors are attached to the separated probe rod and used in connection with the main device.

IoT (Internet of Things) has become an integral part of our lives and it has already made an impact in various sectors, including the environment. Air pollution is a severe problem that has been affecting our planet for years. Therefore, there is a need for a reliable and efficient air pollution monitoring system to protect ourselves from its hazardous effects. An IoT-based air pollution monitoring system is an ideal solution that can provide real-time data and insights about the air quality in a particular area.

An IoT based air pollution monitoring system consists of several hardware and software components that work together to collect and process data. The hardware components include sensors, microcontrollers, and communication modules. The software components consist of a cloud platform, a mobile application, and a web-based dashboard.

IoT Monitoring System components

IoT-based air pollution monitoring systems comprise several components that work together to collect and analyze air quality data. The components include:

- 1. Sensors:** Sensors are the primary components of IoT-based air pollution monitoring systems. They measure various air quality parameters such as particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides. The sensors can be classified into two categories: physical and chemical sensors. Physical sensors measure parameters such as temperature, humidity, and pressure, while chemical sensors measure air pollutants.
- 2. Microcontroller:** The microcontroller is the brain of IoT-based air pollution monitoring systems. It receives data from the sensors, processes it, and sends it to the cloud server. The microcontroller is usually a microprocessor such as Arduino, Raspberry Pi, or similar devices.
- 3. Communication Module:** The communication module is responsible for transmitting data from the microcontroller to the cloud server. Communication modules can use various wireless technologies such as Wi-Fi, Bluetooth, or cellular networks.
- 4. Cloud Server:** The cloud server is a centralized platform for storing, analyzing, and sharing air quality data. It collects data from the communication module and stores it in a database. The cloud server also provides web and mobile applications for users to access the data.
- 5. Power Supply:** IoT-based air pollution monitoring systems require a power supply to operate. In case of permanent installations external power supply is provided and batteries are provided for portable devices.

Usage of Monitoring System

The IoT-based air pollution monitoring system can be used in various settings, including residential, industrial, and urban areas. It can also be integrated with existing air pollution monitoring systems to enhance their capabilities. The system can provide valuable data to government agencies, researchers, and the public to make informed decisions about air pollution.

How does IoT reduce air pollution?

IoT (Internet of Things) plays a crucial role in reducing air pollution through its ability to collect real-time data and enable smart decision-making. IoT devices, such as air quality sensors, can monitor pollutant levels in various environments, including cities, industries, and homes.

This data can be analyzed to identify pollution sources, implement targeted mitigation strategies, and track the effectiveness of pollution control measures. IoT-enabled smart city solutions optimize transportation, waste management, and energy consumption, reducing emissions and improving air quality.

Furthermore, IoT-based personal air quality monitors empower individuals to make informed choices and avoid high-pollution areas. By leveraging IoT technology, we can proactively address air pollution, create sustainable solutions, and promote healthier environments for present and future generations.

How IoT Based Air and Sound Pollution Monitoring System is Implemented?

An IoT-based air and sound pollution monitoring system is implemented using a network of sensors, connectivity technologies, and data analytics platforms. Air quality sensors are deployed in strategic locations to measure pollutant levels such as particulate matter, gases, and volatile organic compounds (VOCs). Sound sensors capture noise levels and patterns in the environment.

These sensors are connected to a central data management system through wireless or wired communication protocols. The collected data is then processed and analyzed in real-time, leveraging cloud-based analytics platforms. Users can

access the monitoring system through web or mobile applications, which provide visualizations, alerts, and historical data.

This allows authorities, environmental agencies, and individuals to monitor pollution levels, identify hotspots, and take necessary actions for pollution control and mitigation. The system can also integrate with existing infrastructure such as smart city platforms or industrial monitoring systems to provide a comprehensive view of environmental conditions and enable effective decision-making.

