AIRAWARE: A COST-EFFECTIVE, CUSTOMIZABLE AIR QUALITY STATION USING IOT TECHNOLOGY

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Keywords:

Air Quality Monitoring, Internet of Things, Low-Cost Sensors, 3D Printing, ESP32.

Introduction:

Poor air quality is a major global concern affecting human health and the environment. Conventional air quality monitoring systems are expensive and limited in deployment, making real-time monitoring difficult in many areas. To address this, the AirAware project proposes a cost-effective and customizable IoT-based air quality monitoring system that measures parameters such as particulate matter, gas concentration, temperature, humidity, and pressure. The system uses sensors integrated with an ESP32 microcontroller to collect and transmit data to a cloud platform for real-time monitoring and analysis. This approach provides a portable, scalable, and affordable solution for continuous air quality monitoring in indoor, outdoor, and smart city environments.

Figure 1: Prototype

Objectives:

1. To develop a portable and cost-effective air quality monitoring system housed in a 3D-printed enclosure, reducing material use and enabling efficient data sampling.
2. To design a modular system capable of customizing pollutant measurements based on user needs.

Methodology:

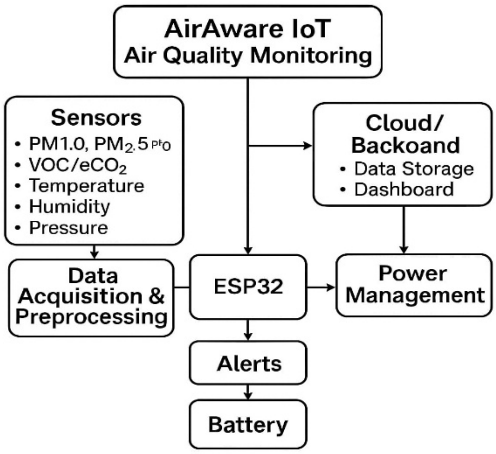

Figure 2: Block Diagram

The AirAware air quality monitoring system is developed by integrating multiple environmental sensors with the ESP32 microcontroller for real-time data acquisition and processing. Sensors such as PMS7003, MQ series gas sensors, and BME680 are used to measure particulate matter, gas concentration, temperature, humidity, and pressure. The ESP32 collects sensor data, performs basic filtering and processing, and transmits the data to a cloud platform through Wi-Fi using HTTP or MQTT protocols. The cloud platform stores the data and displays it on a dashboard for real-time monitoring and analysis. The system also includes an alert mechanism that activates when air quality exceeds predefined limits. The device is powered by a rechargeable battery and enclosed in a protective casing, making it portable and suitable for indoor and outdoor air quality monitoring.

Result and Conclusion:

The developed AirAware air quality monitoring system was tested under different environmental conditions to evaluate sensor response, system performance, and data transmission reliability. The system was tested for particulate matter measurement, gas sensor response under smoke exposure, and environmental parameter monitoring. The results obtained from the sensors and system testing are shown in the following graphs.

1. CO2 Levels: Closed Room vs Ventilated Room:

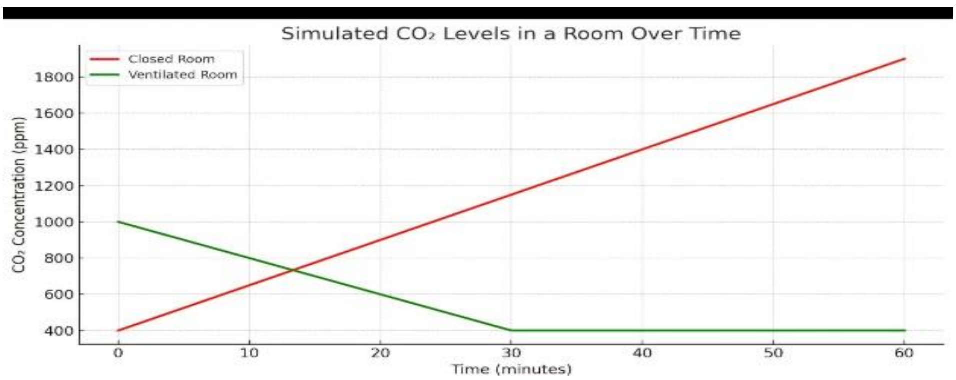

Figure 3: CO2 Test

2. PM2.5 Concentration: Roadside vs Park:

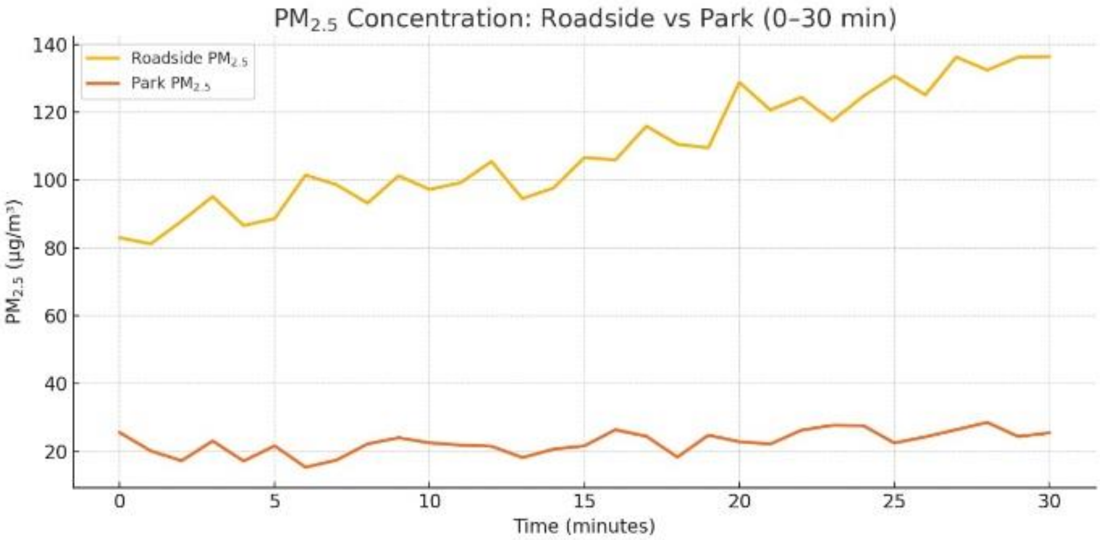

Figure 4: PM2.5 Concentration

3. Smoke Exposure Test (MQ-2 and MQ-135):

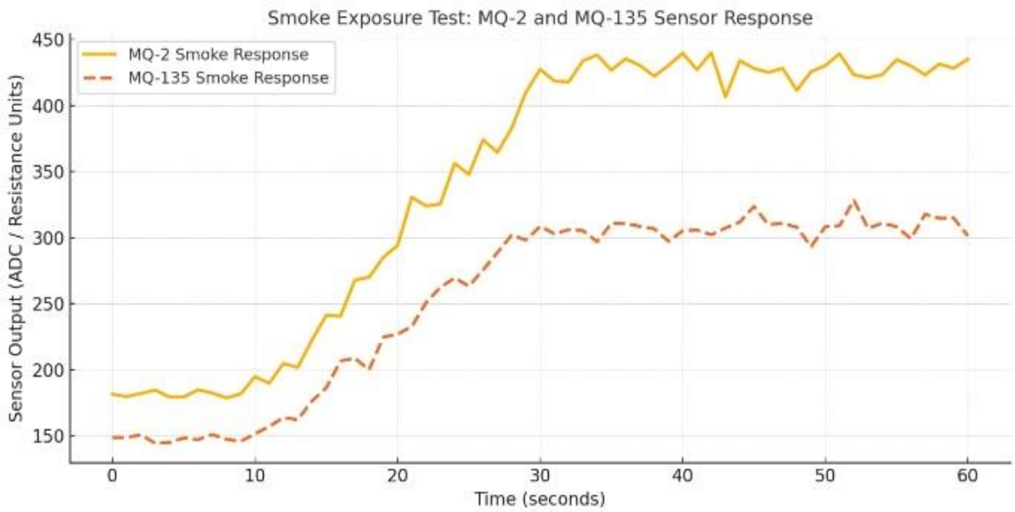

Figure 5: Smoke Test

The Air-Aware project successfully demonstrates the development of a cost-effective and customizable IoT-based air quality monitoring system capable of measuring environmental parameters such as particulate matter, gas concentration, temperature, humidity, and pressure in real time. The system integrates multiple sensors with the ESP32 microcontroller for data acquisition, processing, and wireless transmission to a cloud platform for visualization and analysis. The prototype was tested under different environmental conditions and showed reliable performance in monitoring air quality parameters and transmitting data to the cloud dashboard. The developed system provides a portable, scalable, and low-cost solution for air quality monitoring and can be used in applications such as indoor air quality monitoring, industrial monitoring, environmental monitoring, and smart city systems.

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Future Scope:

The future scope of this project includes:

1. Integration of a mobile application for real-time air quality monitoring and alerts.
2. Implementation of machine learning algorithms for air quality prediction and trend analysis.
3. Development of a solar-powered version of the device for outdoor and remote area deployment.
4. Integration with smart home and industrial automation systems for automatic air quality control.