

Air Pollution Monitoring System

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Abstract- Air pollution has become a critical environmental issue affecting human health, climate, and overall quality of life. Traditional pollution monitoring is limited due to manual data collection, insufficient real-time updates, and lack of public accessibility. This project proposes an IoT-based Air Pollution Monitoring System that continuously measures air quality parameters such as CO₂, CO, PM2.5, PM10, smoke level, humidity, and temperature. The system uses sensors integrated with a microcontroller and IoT cloud platform to upload live data. A web/mobile dashboard displays AQI, alerts, and pollution trends. The solution improves monitoring accuracy, enables early warnings, and helps government and citizens take corrective actions.

I. INTRODUCTION

Air pollution is one of the major environmental issues worldwide. Rapid urbanization, industrial growth, vehicular emissions, and burning of fossil fuels are the major contributors to poor air quality. Polluted air leads to respiratory diseases, reduced life expectancy, and severe environmental damage.

In most cities, pollution levels are manually measured using large stations that are expensive, limited in number, and updated only once or twice a day. Citizens do not have access to real-time information. To solve this issue, an affordable IoT-based Air Pollution Monitoring System is required. It collects and uploads live pollution values and displays them on the internet, enabling people to check air quality anytime.

II. PROBLEM STATEMENT

The existing air pollution monitoring system faces the following challenges:

1. Lack of real-time air quality updates.
2. Manual measurement methods that are slow and inaccurate.

3. Limited number of government monitoring stations.
4. No instant alert system for dangerous pollution levels.
5. Citizens cannot check pollution levels in their specific area.

Hence, there is a need for a low-cost, portable, and real-time IoT-enabled monitoring system.

III. OBJECTIVES

- To design a system that monitors air quality parameters in real time.
- To provide alerts when pollution exceeds safe limits.
- To help the public and government take quick action.
- To create a low-cost, scalable system suitable for smart cities.
- To store historical pollution data for analytics and prediction.

IV. LITERATURE REVIEW

Air pollution monitoring has been an active research area for more than two decades due to the increasing environmental and health impacts of polluted air. Many researchers have developed systems using IoT, cloud computing, wireless sensor networks, and machine learning to improve the accuracy and efficiency of pollution detection.

1. IoT-Based Real-Time Monitoring Studies

1.1. S. Patel et al. (2020)

Patel proposed an IoT-based air pollution monitoring device using MQ series sensors and Arduino. Data was uploaded to ThingSpeak cloud for visualization.

Key findings:

- Low-cost sensors can measure CO₂ and CO with acceptable accuracy.
- Cloud dashboards improve accessibility.

Limitations:

- Did not include PM_{2.5}/PM₁₀ measurement.
- Accuracy varied with temperature changes.

1.2. S. Sharma & R. Gautam (2021)

Developed a portable IoT system for measuring PM_{2.5} and PM₁₀ using a laser-based dust sensor.

Key findings:

- PM sensors improve precision over MQ sensors.
- Real-time analytics help predict AQI trends.

Limitations:

- No GSM/wireless long-range communication.
- Battery life limitations in portable system.

2. Wireless Sensor Network (WSN) Based Research

2.1. V. Singh et al. (2021)

Implemented city-wide air monitoring using multiple stationary sensor nodes connected through a WSN.

Key findings:

- Large-scale monitoring improves mapping of pollution zones.
- Data interpolation methods create detailed pollution maps.

Limitations:

- Deployment and maintenance cost is high.
- Nodes require periodic calibration.

2.2. A. Shelar et al. (2022)

Proposed WSN with Zigbee technology. Nodes measured temperature, humidity, and CO levels.

Key findings:

- Zigbee is power-efficient for long-term monitoring.
- Suitable for small city monitoring applications.

Limitations:

- Zigbee range is limited compared to WiFi/LTE.
- Website dashboard lacked data analytics.

3. Cloud and Big Data Analytics-Based Studies

3.1. P. Singh & K. Joshi (2023)

Created an air quality monitoring system with cloud storage and machine learning prediction.

Key findings:

- ML predicting AQI provides early warnings.
- Cloud storage enables long-term analysis.

Limitations:

- Requires high-quality data for accurate prediction.
- Expensive for large-scale systems.

3.2. WHO Global Air Quality Database (2023)

Analyzed global air pollution datasets from 117 countries.

Key findings:

- 99% of the global population is exposed to unsafe air.
- PM_{2.5} and PM₁₀ are the major causes of respiratory diseases.

Limitations:

- Data is updated slowly (weekly or monthly).
- Not suitable for real-time public alerts.

4. Smartphone-Based Monitoring Systems

4.1. H. Kim & J. Lee (2022)

Developed a smartphone app with built-in optical sensors for estimating dust concentration.

Key findings:

- Easy to use and accessible to the general public.
- Uses image-processing techniques.

Limitations:

- Accuracy depends on lighting and camera quality.
- Cannot measure gas pollutants.

5. Research Gaps Identified

Based on the review of existing systems, the following gaps exist:

1. Most systems do not monitor all major pollutants together (CO₂, CO, PM_{2.5}, PM₁₀, smoke, temperature, humidity).

2. Lack of low-cost, real-time solutions suitable for developing countries.
3. Limited use of cloud dashboards for live AQI alerts.
4. Less focus on portable and scalable pollution monitoring devices.
5. Inadequate integration of machine learning for future AQI prediction.

V. PROPOSED SYSTEM

The proposed IoT-based Air Pollution Monitoring System includes:

Modules

1. Sensor Module

- MQ135 – CO₂, NH₃, NO_x
- MQ7 – CO level
- PM2.5/PM10 sensor
- DHT11/DHT22 – temperature & humidity

2. Processing Unit

- Arduino / ESP32 / NodeMCU microcontroller
- Collects and processes sensor values
- Calculates AQI

VI. SYSTEM ARCHITECTURE

Block Diagram Description:

- Sensors measure pollutants.
- Microcontroller reads values and converts them into digital form.
- Data is sent to IoT cloud (ThingSpeak / Blynk / Firebase).
- Dashboard shows real-time readings and AQI.

VII. METHODOLOGY

Phase 1: Requirement Analysis

- Study air quality parameters
- Select cost-effective sensors
- Understand cloud platform needs

Phase 2: System Design

- Architecture
- ER diagram
- Data flow diagram
- AQI formula integration

Phase 3: Development

- Arduino/ESP32 coding
- API integration
- Dashboard creation

Phase 4: Testing

- Hardware testing
- Cloud communication test
- User acceptance test

Phase 5: Deployment

- Install device outdoors
- Connect to power & network

VIII. EXPECTED OUTCOME

Parameter	Before System	After Proposed System
Data Availability	Manual & slow	Real-time data
Accuracy	Low	High due to sensors
Public Awareness	Limited	High with mobile app
Alerts	No alerts	Live SMS/notification alerts
Accessibility	Only stations	govt Everyone can access

IX. CONCLUSION

The IoT-based Air Pollution Monitoring System provides an efficient and real-time method to measure and monitor environmental pollution. It enhances public awareness, supports government agencies, and helps reduce health risks by providing continuous updates and alerts. The system is scalable, low-cost, and suitable for smart city implementation.

REFERENCES

- [1] Kulkarni A., “Real-Time CO Monitoring System,” IJERT, 2022.
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