Air Quality Monitoring System - Project Report

# Abstract

This project presents an IoT-based Air Quality Monitoring System designed to monitor environmental parameters such as particulate matter (PM2.5 and PM10), temperature, humidity, and noise levels. The system uses ESP32 microcontroller interfaced with SDS011 Dust Sensor, AHT10 Temperature & Humidity Sensor, and a Sound Sensor. The monitored data is transmitted in real-time to ThingSpeak and CTOP platforms for visualization and further analysis.

# Introduction

Air pollution has become a serious concern in modern cities, contributing to health issues and environmental degradation. Monitoring air quality in real-time helps in preventive measures and awareness. IoT-based systems provide a cost-effective and scalable solution for such monitoring applications.

# Objectives

- To design and implement an IoT-based air quality monitoring system.  
- To measure PM2.5, PM10, temperature, humidity, and noise levels.  
- To provide real-time visualization of data on cloud platforms (ThingSpeak and CTOP).  
- To use LED indicators for system status monitoring.

# Components Required

1. ESP32 Development Board  
2. SDS011 Dust Sensor (PM2.5 & PM10)  
3. AHT10 Temperature & Humidity Sensor  
4. Sound Sensor (Microphone module)  
5. LEDs (for Wi-Fi and transmission status)  
6. PCA9685 or I2C expander (if multiple sensors need I2C)  
7. Jumper Wires, Breadboard, Power Supply

# System Design

The system design consists of ESP32 as the central controller. The SDS011 is connected via UART, the AHT10 via I2C, and the Sound Sensor via analog input. LED indicators are connected to GPIO pins for Wi-Fi and data transmission status. The data is processed and sent to cloud platforms.  
  
Block Diagram and schematics are included separately.

# Working Principle

The ESP32 continuously reads data from SDS011 (air particulate levels), AHT10 (temperature and humidity), and the sound sensor (noise levels). After preprocessing, the data is uploaded through Wi-Fi to ThingSpeak and CTOP platforms. LEDs provide local feedback for Wi-Fi connectivity and transmission.

# Software Implementation

The system is programmed using Arduino IDE with ESP32 board support. Required libraries include WiFi.h, HTTPClient.h, and sensor-specific libraries (SDS011, AHT10). Data is sent via HTTP POST requests to ThingSpeak and MQTT/HTTP for CTOP. The firmware ensures continuous monitoring and data reliability.

# Results & Output

The system successfully monitors and uploads real-time air quality data. ThingSpeak and CTOP dashboards show graphical representation of PM2.5, PM10, temperature, humidity, and noise levels. LED indicators provide visual feedback for connectivity and data transmission.

# Applications

- Smart Cities  
- Environmental Monitoring  
- Industrial Zones  
- Indoor Air Quality Monitoring  
- Research and Academic Projects

# Advantages

- Low-cost and scalable solution  
- Real-time monitoring with cloud integration  
- Portable and energy efficient  
- Easy to deploy and maintain

# Future Scope

- Integration with mobile applications for live alerts  
- Addition of more sensors (CO2, CO, NO2, etc.)  
- AI-based prediction of pollution levels  
- Solar-powered autonomous system

# Conclusion

The IoT-based Air Quality Monitoring System provides a cost-effective and efficient way to monitor environmental conditions. By using ESP32 with SDS011, AHT10, and Sound Sensor, real-time data is collected and visualized on cloud platforms. This project demonstrates the practical use of IoT in addressing real-world challenges like air pollution and environmental awareness.