Ideation and Design Document

Project Title: Air Pollution Monitoring System using IoT

Group ID: LYCORE613

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1. Introduction

Air pollution has emerged as one of the most serious global environmental challenges due to rapid industrialization, urbanization, and increasing vehicular emissions. The quality of the air we breathe directly affects human health, ecosystems, and climate balance. Prolonged exposure to polluted air causes respiratory diseases, cardiovascular problems, and even premature deaths.

Traditional air quality monitoring systems are large-scale, expensive, and primarily limited to specific urban centers. Hence, there is an urgent need for a **cost-effective, portable, and real-time solution** that can help individuals and local authorities monitor environmental conditions.

This project, **"Air Pollution Monitoring System using IoT,"** aims to address this issue through a smart, scalable IoT-based device that continuously monitors air quality using sensors, displays real-time readings on a cloud platform, and alerts users when air pollution levels become hazardous. The system utilizes **NodeMCU (ESP8266)** for communication, **MQ135 gas sensor** for gas detection, and **ThingSpeak Cloud** for visualization.

2. Ideation Process

The ideation process began with brainstorming sessions focused on finding an impactful, technology-driven solution to an everyday environmental problem. The team explored multiple topics such as “Smart Traffic Control System,” “IoT-based Water Level Detector,” and “Air Quality Detector.”

After analyzing all options, the **Air Pollution Monitoring System** was selected because:

- It is highly **relevant and socially useful**.
- It uses **easily available and low-cost components**.
- It provides **visible real-time results** through data visualization.

2.1 Problem Identification

- Rapid industrialization and vehicle emissions have made urban air unsafe.
- Common people are unaware of the air quality in their surroundings.
- Most monitoring systems are either expensive or not user-friendly.

2.2 Problem Statement

> “To design and implement an IoT-based air pollution monitoring system capable of detecting harmful gases in real-time, visualizing pollution levels on a cloud dashboard, and alerting users when air quality deteriorates.”

2.3 Proposed Solution

The system consists of a **NodeMCU microcontroller**, **MQ135 gas sensor**, and **buzzer** connected through Wi-Fi. It collects data on gas concentrations (CO_2, NH_3, Benzene), sends it to the **ThingSpeak cloud** for analysis, and triggers an alert if unsafe levels are detected.
This solution ensures **continuous monitoring**, **easy scalability**, and **real-time awareness** for environmental safety.

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3. Design Thinking Approach

The project development followed the **Design Thinking** methodology — a problem-solving approach that includes five key stages: **Empathize, Define, Ideate, Prototype, and Test.**

3.1 Empathize

At this stage, the focus was on understanding how air pollution impacts daily life.
We interacted with local residents, students, and health professionals to understand their perception of air quality.
Key observations included:

- People are concerned about health but lack real-time air data.
- They rely on vague assumptions ("the air feels bad today") instead of data.
- There is no affordable device for households or schools to track pollution levels.

This phase helped the team deeply connect with the problem and define a user-centered goal:

> "To empower individuals with real-time information about the air they breathe."

3.2 Define

The insights from the empathize phase helped define the **core need** — an IoT-based system that monitors, records, and alerts users about air pollution.
Requirements Identified:

- Real-time gas detection.
- Instant alert mechanism for unsafe air.
- Low power consumption and portability.
- Cloud integration for visualization and analytics.

Defined Challenge:

> "How might we design a smart yet affordable device that continuously monitors air pollution and alerts users in real time?"

3.3 Ideate

During ideation, various concepts and technologies were evaluated:

- Using **Arduino UNO + GSM module** for SMS alerts.
- Using **Raspberry Pi** for advanced computing.
- Using **NodeMCU + Wi-Fi + Cloud** for simple, scalable design.

After comparison, **NodeMCU with ThingSpeak Cloud** was finalized as it provided **real-time monitoring, low cost, and wireless connectivity**.

Brainstorming led to these final features:

- **Cloud visualization** via ThingSpeak.
- **Threshold-based buzzer alerts.**
- **Compact prototype** using low-cost hardware.
- **Scalable architecture** for future expansion.

3.4 Prototype

The prototype was designed and built using easily available components.

- **NodeMCU (ESP8266):** Acts as the brain of the system.
- **MQ135 Sensor:** Detects CO_2, NH_3, Benzene, and other gases.
- **Buzzer:** Gives immediate audio alerts.
- **ThingSpeak Cloud:** Visualizes real-time gas concentration graphs.

Circuit Design:

- MQ135 connected to analog pin of NodeMCU.
- NodeMCU programmed in Arduino IDE.
- Wi-Fi credentials and ThingSpeak API configured.
- Buzzer connected to a digital pin for alert generation.

This prototype allowed real-time visualization of air quality through ThingSpeak dashboards on a web or mobile interface.

3.5 Test

The prototype was tested under different environmental conditions:

- **Indoor testing:** showed stable readings and low pollution levels.
- **Outdoor/traffic testing:** sensor detected rapid gas level increases.
- **Cloud synchronization:** ThingSpeak graphs updated in real time.
- **Alert system:** buzzer successfully activated during poor air quality.

The testing phase confirmed the system's functionality, accuracy, and reliability.
Calibration adjustments were made for better accuracy and consistent threshold readings.

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4. System Design

4.1 Block Diagram Description

[MQ135 Sensor] → [NodeMCU Microcontroller] → [Wi-Fi Transmission] → [ThingSpeak Cloud] → [Dashboard Visualization] → [Buzzer Alert]

4.2 Working Flow

1. **Sensing:** MQ135 detects gas concentrations.
2. **Processing:** NodeMCU reads analog signals, converts to PPM.
3. **Transmission:** Data sent to ThingSpeak over Wi-Fi.
4. **Visualization:** ThingSpeak dashboard shows live graphs.
5. **Alert:** When pollution crosses threshold, buzzer rings.

4.3 Design Considerations

- **Compact hardware setup** with minimal wiring.
- **Low power usage** suitable for continuous operation.
- **Scalability:** More sensors can be added easily (PM2.5, GPS, etc.).

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5. Outcome

The final outcome was a **functional IoT-based air monitoring system** capable of accurately detecting and analyzing air pollution levels.

Key Achievements:

- Continuous monitoring of gases in real time.
- Instant buzzer alerts on exceeding limits.
- Cloud-based dashboard accessible via any device.

- Low-cost and reliable setup using minimal components.

This project demonstrates how IoT can be effectively used for environmental monitoring and public health awareness.

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6. Future Enhancements

- Integrate **GPS module** for location-based pollution mapping.
- Add **PM2.5 and PM10 sensors** for particulate matter detection.
- Create a **mobile application** for instant alerts and data sharing.
- Implement **machine learning** to predict pollution trends.
- Use **solar-powered NodeMCU** for sustainable, continuous operation.

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7. Conclusion

The Ideation and Design phase provided a structured approach to problem-solving using design thinking principles.
From understanding user pain points to defining a clear objective, brainstorming ideas, building prototypes, and testing real-world scenarios — each phase contributed to a practical, innovative solution.

The “Air Pollution Monitoring System using IoT” not only enhances awareness about environmental conditions but also encourages the use of low-cost technology for social impact.
This project can serve as a foundation for smart city pollution tracking networks and contribute to creating a cleaner, safer environment for everyone.