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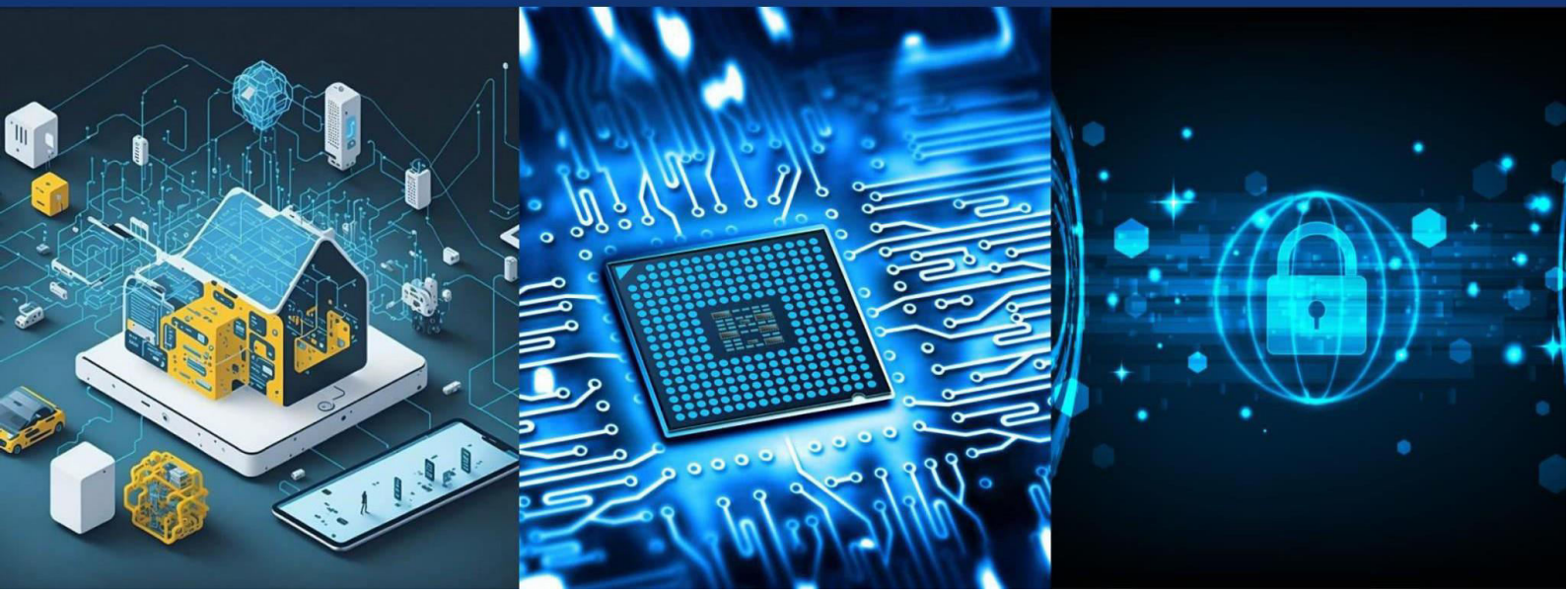

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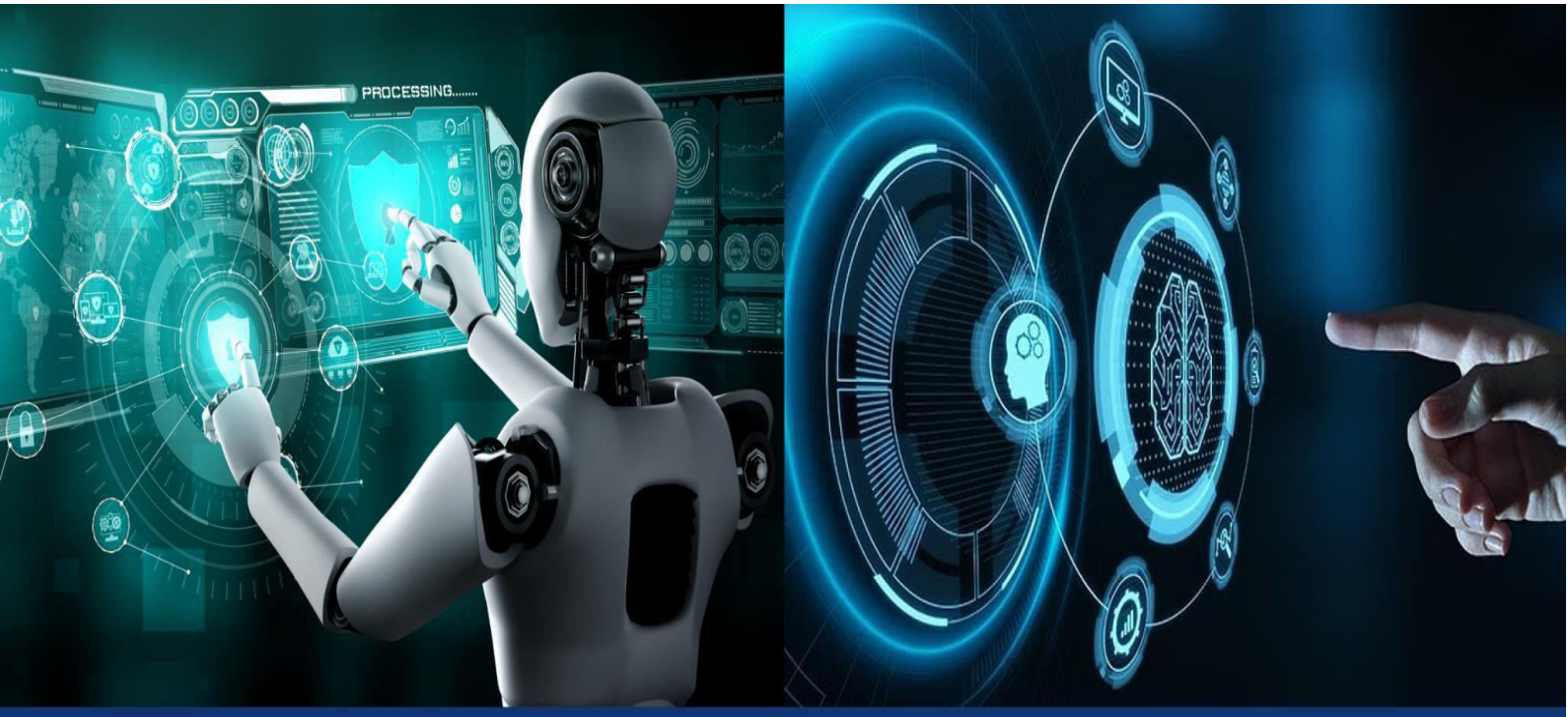

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Smart Air Quality Analytics and Visualization System using API Integration

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ABSTRACT: Air pollution is a major environmental and public health challenge caused by rapid urbanization, industrial growth, and increasing vehicular emissions. Continuous monitoring and effective communication of air quality information are essential to reduce health risks and raise public awareness. This research presents a web-based Air Quality Index (AQI) monitoring system that provides real-time air quality information using reliable environmental APIs. The proposed system retrieves live AQI data and pollutant concentrations such as PM2.5, PM10, NO_2, SO_2, CO, and O_3, and presents them through an intuitive, user-friendly web interface with color-coded indicators and health-based recommendations. Unlike traditional AQI monitoring approaches that rely on static monitoring stations and delayed reporting, the developed platform emphasizes real-time accessibility, scalability, and ease of use. The system also supports location-based queries and clear visualization, enabling users to quickly understand current air quality conditions and associated health impacts. Analysis of the system shows improved efficiency, reduced infrastructure dependency, and enhanced public awareness compared to conventional AQI dissemination methods. The proposed solution is suitable for smart city applications, environmental awareness initiatives, and decision support for the general public.

KEYWORDS: Air Quality Index (AQI), Air Pollution Monitoring, Real-Time Web Application, Environmental APIs, AQI Visualization, Public Health Awareness, Smart City Applications

I. INTRODUCTION

Air pollution is one of the most significant environmental and public health challenges faced by modern society. Rapid industrialization, uncontrolled urban expansion, increasing vehicular traffic, and energy consumption have led to a substantial rise in atmospheric pollutants. Pollutants such as particulate matter (PM2.5 and PM10), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and ozone (O_3) have been directly linked to respiratory diseases, cardiovascular disorders, reduced life expectancy, and premature mortality. According to global health studies, prolonged exposure to polluted air affects millions of people annually, particularly children, elderly individuals, and those with pre-existing health conditions.

To address the complexity of air pollution data and make it understandable to the general public, the Air Quality Index (AQI) was introduced as a standardized indicator. AQI converts multiple pollutant concentration values into a single numerical scale ranging from “Good” to “Hazardous,” accompanied by color codes and health advisories. Regulatory bodies such as the Central Pollution Control Board (CPCB), U.S. Environmental Protection Agency (EPA), and World Health Organization (WHO) use AQI to communicate air quality status and associated health risks. However, conventional AQI dissemination methods often rely on fixed monitoring stations, periodic updates, and static dashboards, which limit real-time accessibility and public engagement.

With the advancement of web technologies and the availability of open environmental data through APIs, there is a growing opportunity to enhance AQI awareness through digital platforms. Web-based AQI monitoring systems offer real-time access to air quality data without the need for expensive sensor deployment, making them cost-effective and scalable. Such platforms can provide instant location-based AQI information, pollutant breakdowns, and health recommendations to users across different devices.

This project introduces a real-time Air Quality Index identifying website that fetches live air quality data from trusted environmental APIs and presents it through an intuitive and interactive web interface. The system enables users to search for locations and instantly view AQI values, dominant pollutants, air quality categories, and health precautions. By combining real-time data access, visualization, and public-oriented design, the proposed system aims to bridge the gap

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between raw environmental data and meaningful public awareness. The platform contributes to smarter environmental decision-making, supports preventive health measures, and aligns with the objectives of smart city and sustainable development initiatives.

II. LITERATURE SURVEY

Air quality monitoring has been an active area of research due to the growing impact of air pollution on public health and the environment. Existing studies and systems can broadly be categorized into sensor-based monitoring, API-based data platforms, and web-based visualization systems.

A. Sensor-Based and IoT-Based AQI Monitoring Systems

Several researchers have proposed air quality monitoring systems using low-cost sensors and IoT devices. Kumar et al. developed an embedded AQI monitoring system using gas sensors such as MQ135 connected to microcontrollers, enabling real-time data collection and transmission to a web server. Similarly, Khan et al. implemented IoT-cloud integration platforms where pollutant data is uploaded to cloud services like Firebase and ThingSpeak for visualization and analysis. These systems demonstrate accurate localized monitoring but suffer from limitations such as high deployment cost, maintenance complexity, sensor calibration issues, and limited scalability.

B. API-Based Air Quality Information Systems

To overcome hardware constraints, many recent systems rely on publicly available air quality APIs such as CPCB, OpenWeatherMap, and WAQI. Sharma and Jain proposed a web-based AQI platform that fetches real-time air pollution data using government APIs and presents AQI values through graphical and color-coded representations. Such approaches significantly reduce infrastructure costs and provide wider geographic coverage. However, many existing API-based systems offer raw AQI values without detailed pollutant breakdowns or contextual health interpretation.

C. Machine Learning and Predictive AQI Models

Recent literature emphasizes the use of machine learning models to predict AQI based on historical pollutant data and meteorological parameters. Chatterjee et al. introduced regression and classification-based models to forecast AQI levels and generate early warnings. While these predictive models improve proactive decision-making, most studies focus on backend model accuracy and lack user-centric real-time visualization platforms for the general public.

D. Web-Based AQI Visualization Platforms

Popular applications such as AQICN, IQAir (AirVisual), and Plume Labs provide global AQI information using satellite and ground sensor networks. These platforms offer real-time AQI values but often present complex interfaces, limited pollutant explanations, and minimal customization for local regions. Furthermore, some platforms restrict detailed data access behind subscriptions.

E. Gap Analysis and Motivation for the Proposed System

From the literature review, it is evident that:
Sensor-based systems provide accuracy but lack scalability.
API-based systems provide scalability but often lack user-friendly interpretation.
Predictive models lack direct integration with real-time web platforms.
Existing platforms rarely combine AQI values, pollutant breakdowns, weather context, and health messaging in a single interface.

The proposed BreatheEasy Air Quality Index web application addresses these gaps by integrating real-time WAQI API data, presenting pollutant-wise concentration details (PM2.5, PM10, O_3, NO_2, SO_2, CO), including weather parameters, and providing AQI category-based health interpretations through a clean, minimal, and responsive web interface. This makes the system more accessible, informative, and suitable for public awareness and smart-city applications.

Problem Statement

Air pollution has become a critical environmental and public health issue due to rapid urbanization, industrial growth, and increased vehicular emissions. Although air quality data is generated by various governmental and global monitoring agencies, it is often fragmented, delayed, or presented in technical formats that are difficult for the general public to

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understand. Existing systems primarily rely on fixed monitoring stations, which limits spatial coverage and real-time accessibility, especially at the city or locality level.

Moreover, many available platforms lack an intuitive interface that combines real-time AQI values, pollutant-wise breakdowns, weather parameters, and health advisories in a single view. This gap prevents individuals from making timely, informed decisions regarding outdoor activities and health precautions. Therefore, there is a need for a web-based, real-time Air Quality Index monitoring system that fetches live data from reliable APIs and presents it in a simple, visually clear, and user-friendly manner to enhance public awareness and proactive health management

Objectives

The main objectives of the proposed Air Quality Index project are:

To develop a web-based application that displays real-time Air Quality Index (AQI) values for user-selected cities and locations.

To integrate reliable air quality data sources using environmental APIs (such as WAQI) for live pollutant information.

To present pollutant-wise concentration details including PM2.5, PM10, NO_2, SO_2, O_3, and CO for better understanding of air quality composition.

To categorize air quality levels (Good, Moderate, Poor, etc.) using standardized AQI scales and color-coded indicators.

To provide health-based interpretations and advisories corresponding to the current AQI level to assist users in taking precautionary measures.

To include supporting weather parameters such as temperature, humidity, wind speed, and pressure to give contextual environmental insights.

To ensure a clean, responsive, and user-friendly interface that can be accessed across devices without the need for specialized hardware.

To raise public awareness about air pollution and encourage environmentally responsible behavior through easy access to real-time air quality information.

III. METHODOLOGY

The proposed system follows a structured methodology to ensure accurate and real-time AQI monitoring:

Data Acquisition

Real-time air quality data is obtained from trusted environmental APIs (such as WAQI), which aggregate data from monitoring stations and satellite sources. The data includes AQI values, pollutant concentrations, and weather parameters.

Data Processing

The retrieved data is processed to extract relevant parameters such as dominant pollutants, AQI category, and meteorological information. AQI categories are mapped according to standard AQI guidelines.

Web Application Logic

The frontend communicates with the API through asynchronous requests. Based on the selected city, the system dynamically updates AQI values and pollutant details.

Visualization

AQI levels are displayed using numerical values, textual descriptions, and color-coded indicators to enhance readability and understanding.

User Interaction

Users can search for different cities and instantly receive updated air quality information.

Implementation

The implementation of the BreatheEasy AQI system is carried out using modern web technologies:

Frontend: Developed using HTML, CSS, and JavaScript to provide a clean and responsive user interface.

Backend/API Integration: Real-time AQI data is fetched from the WAQI API.

Features Implemented:

City-based AQI search functionality.

Display of AQI value and AQI category (e.g., Moderate).

Pollutant-wise breakdown including PM2.5, PM10, O_3, NO_2, SO_2, and CO.

Weather information such as temperature, humidity, wind speed, and pressure.

Timestamp showing the last updated data.

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Deployment: The application is deployed on a cloud-based development environment, ensuring availability and scalability.

IV. RESULTS

The implemented system successfully retrieves and displays real-time air quality data for different cities such as Bengaluru and Davangere. The results show:
Accurate AQI values fetched in real time.
Clear identification of dominant pollutants.
Improved user understanding through structured layouts and color-coded AQI indicators.
Minimal latency in data retrieval and display.
Consistent performance across different locations and multiple searches.
The system effectively bridges the gap between complex air quality datasets and public accessibility.

V. CONCLUSION

This project presents a real-time, web-based Air Quality Index monitoring system that effectively delivers live air quality information in a simple and user-friendly manner. By integrating reliable environmental APIs with modern web technologies, the system overcomes limitations of traditional AQI monitoring platforms such as delayed updates and poor visualization. The BreatheEasy application enhances public awareness by providing AQI values, pollutant breakdowns, and health-related interpretations in a single interface. The project demonstrates that API-driven AQI systems are efficient, scalable, and suitable for smart city and environmental awareness applications.

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