AIR SHPERE: AI Powered Real-Time Air Quality Monitoring and Health Intelligence System

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Abstract - **AIR SPHERE is an intelligent web-based system designed to monitor, analyze, and predict air quality and climate conditions in real time. The project aims to address growing environmental concerns by providing users with accurate Air Quality Index (AQI) data along with future predictions using machine learning techniques. By integrating environmental datasets such as temperature, humidity, and pollutant concentrations (PM2.5, PM10, CO, NO₂), the system delivers meaningful insights into air quality trends.**

The platform utilizes advanced algorithms to forecast AQI levels, helping users take preventive measures for health and safety. A user-friendly and visually appealing interface ensures easy understanding of complex environmental data through graphs, indicators, and alerts. Additionally, the system can provide recommendations based on AQI levels, such as whether it is safe to go outdoors.

AIR SPHERE serves as a practical solution for individuals, researchers, and urban planners by promoting awareness and enabling data-driven decisions toward a healthier and more sustainable environment.

Keywords: Real-Time AQI monitoring, AQI Prediction using ML, Uses Climate and pollution data, Provides health alerts, User-friendly interface.

I. INTRODUCTION

Air pollution has become a major environmental and health concern in today's world, especially in urban areas. Rising levels of harmful pollutants in the atmosphere directly affect human health, leading to respiratory and other serious diseases. Therefore, monitoring and predicting air quality has become essential for ensuring a safer and healthier lifestyle.

AIR SPHERE is a smart solution developed to provide real-time air quality monitoring along with future AQI predictions using machine learning techniques. The system collects and analyzes environmental data such as temperature, humidity, and pollutant levels to generate meaningful insights. With a user-friendly interface, it presents complex data in a simple and understandable format.

The main objective of this project is to create awareness about air quality and help users make informed decisions regarding their daily activities. By combining technology and environmental science, AIR SPHERE aims to contribute towards a cleaner and healthier environment.

1.1 Literature Review

Air quality monitoring and prediction have become essential research areas due to the increasing impact of air pollution on public health and environmental sustainability. The Air Quality Index (AQI) is widely used to represent pollution levels based on key pollutants such as PM2.5, PM10, CO, and NO₂. Organizations like the Central Pollution Control Board provide real-time AQI data; however, these systems are mainly limited to monitoring and lack predictive capabilities.

Recent studies have focused on applying machine learning techniques to forecast AQI levels. Supervised learning models such as Linear Regression, Decision Trees, Support Vector Machines, and Random Forest are commonly used to model relationships between environmental factors like temperature, humidity, and pollutant concentrations. Additionally, time-series models such as ARIMA and deep learning approaches like LSTM have shown effectiveness in capturing temporal patterns and improving prediction accuracy.

Despite these advancements, existing systems face challenges such as dependency on data quality, limited real-time interactivity, and lack of user-centric features. Most

solutions emphasize prediction accuracy but do not provide intuitive visualization or health-based recommendations for users.

Therefore, there is a need for an integrated system that combines real-time monitoring, accurate prediction, and user-friendly visualization along with health insights. AIR SPHERE addresses this gap by developing a smart platform that unifies data analytics, machine learning, and interactive design to deliver a comprehensive air quality intelligence solution.

1.2 Problem Statement

Air pollution has become a major environmental and public health issue, especially in urban areas where pollutant levels are continuously rising. Existing air quality monitoring systems primarily focus on providing real-time AQI data but lack predictive capabilities that can help users anticipate future conditions. Moreover, these systems often present data in complex formats that are not easily understandable for the general public.

There is also a lack of integrated platforms that combine real-time monitoring, accurate AQI prediction, and personalized health recommendations in a single system. As a result, users are unable to take timely preventive measures to protect their health from harmful air quality conditions.

Therefore, there is a need to develop a smart and user-friendly system that not only monitors air quality in real time but also predicts future AQI levels and provides meaningful insights and health-based guidance. The proposed system, AIR SPHERE, aims to address these challenges by offering an intelligent, interactive, and comprehensive air quality prediction platform.

1.3 Objective

The primary objective of the AIR SPHERE – Smart Climate & AQI Predictor project is to develop an intelligent system capable of monitoring and predicting air quality in real time. The system aims to analyze key environmental parameters such as temperature, humidity, and pollutant concentrations to generate accurate AQI insights. It also focuses on implementing machine learning techniques to forecast future air quality levels, enabling users to take preventive actions. Additionally, the project emphasizes providing health-based alerts and personalized recommendations based on AQI conditions. A user-friendly and interactive interface is designed to present complex data through visualizations like graphs and dashboards, making it easy to understand. Overall, the objective is to raise awareness about air pollution and assist users in making informed decisions for a healthier lifestyle.

1.4 System Architecture

The AIR SPHERE system follows a modular, client-side web architecture that integrates the user interface, application logic, and data handling into a single platform. The client layer consists of a web-based interface built using HTML and Tailwind CSS, providing a responsive and interactive user experience. Navigation between different sections is handled dynamically using a Single Page Application (SPA) approach without reloading pages.

The application logic layer is implemented using JavaScript, which manages core functionalities such as navigation control, data handling, health analysis, and analytics. It also incorporates Three.js for rendering interactive 3D visual elements. User inputs, such as city searches, are processed to retrieve relevant AQI data.

The data layer uses a local dataset to simulate real-time air quality information. This data is processed and managed within the system, and the results are displayed through dynamic DOM updates. Overall, the system ensures smooth data flow from input to output, providing real-time insights, predictions, and visualizations in an efficient and user-friendly manner.
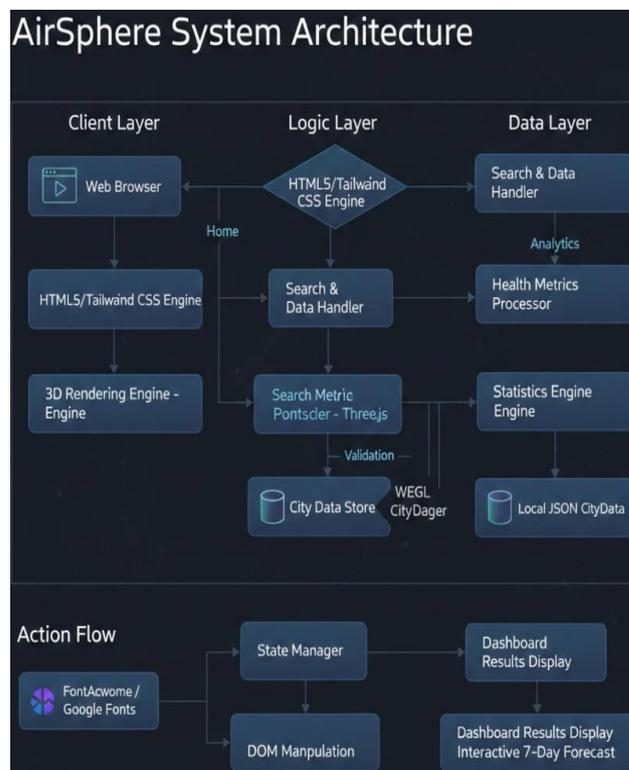

Figure 1: AIRSPHERE System Architecture

II. METHODOLOGY

The methodology of AIR SPHERE follows a structured approach involving data collection, processing, prediction, and visualization. Environmental data such as temperature, humidity, and pollutant levels (PM2.5, PM10, NO₂) are collected from datasets or predefined sources. This data is then preprocessed through cleaning and normalization to ensure accuracy and consistency.

The processed data is analyzed to identify patterns, and machine learning techniques are applied to predict future AQI levels. The system generates short-term forecasts, such as a 7-day AQI prediction, to help users understand upcoming air quality conditions.

Finally, the results are displayed through an interactive web interface, where users can view AQI data, pollutant levels, predictions, and health recommendations. This methodology ensures efficient and user-friendly air quality monitoring and forecaste.

2.1 Model Implementation

AIR SPHERE implements a machine learning-based model to predict AQI using key environmental parameters such as temperature, humidity, PM2.5, PM10, and NO₂. The collected data is first preprocessed through cleaning and normalization to improve accuracy and consistency.

A supervised learning algorithm, such as Linear Regression or Decision Tree, is then used to model the relationship between input features and AQI values. The model is trained on historical data and utilized to generate short-term forecasts, including 7-day AQI predictions. The predicted results are integrated into the system and presented through the user interface, enabling users to understand future air quality conditions effectively.
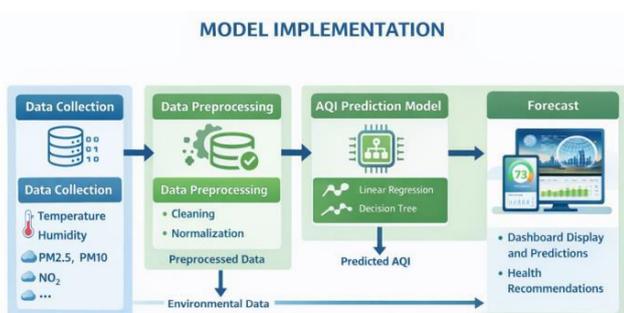

Figure 2: Model Implementation flow chart

2.2 System Implementation

The implementation of AIR SPHERE involves integrating data acquisition, processing, prediction, and visualization into a unified system. Environmental data such as temperature, humidity, and pollutant concentrations (PM2.5, PM10, NO₂, etc.) is collected from reliable APIs and datasets. This data is then preprocessed using techniques like data cleaning, normalization, and handling missing values to ensure consistency and accuracy.

The processed data is fed into machine learning models developed using libraries such as Scikit-learn, where algorithms like Linear Regression and Decision Tree are trained to predict AQI values. The trained model is integrated into the backend system, which continuously processes incoming data and generates real-time predictions.

The frontend of the system is developed using standard web technologies (HTML, CSS, JavaScript), providing an interactive user interface that displays AQI levels, forecasts, and health recommendations. The system ensures smooth communication between frontend and backend through APIs, enabling real-time updates and user-friendly visualization of air quality data.

## III. RESULTS AND DISCUSSIONS

The AIR SPHERE system successfully predicts AQI levels using environmental parameters such as temperature, humidity, and pollutant concentrations. The implemented machine learning model demonstrates satisfactory accuracy in generating short-term forecasts, including 7-day AQI predictions. The system effectively visualizes real-time data through an interactive interface, allowing users to easily understand air quality conditions. Additionally, the integration of health recommendations based on AQI levels enhances the practical usefulness of the system.

The results indicate that the model performs well for general trends, although accuracy may vary depending on data quality and availability. Overall, the system proves to be efficient, responsive, and user-friendly, making it suitable for real-world air quality monitoring applications.
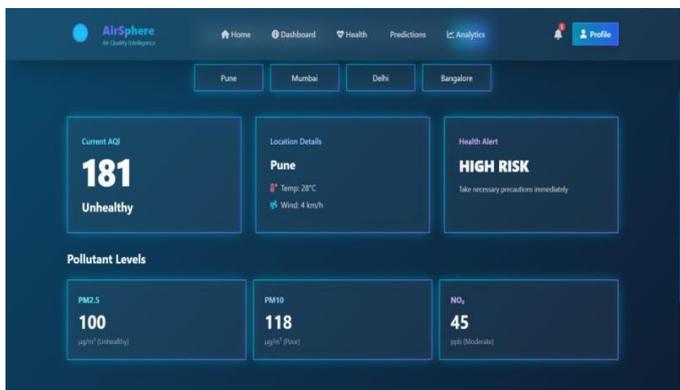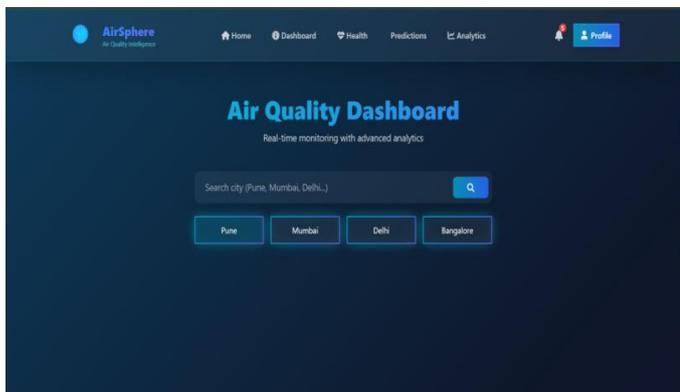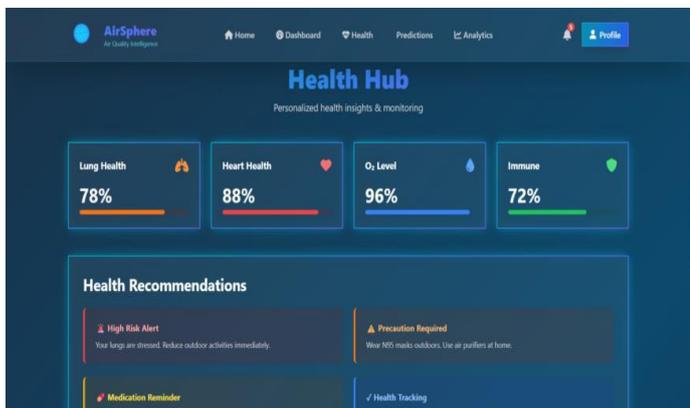
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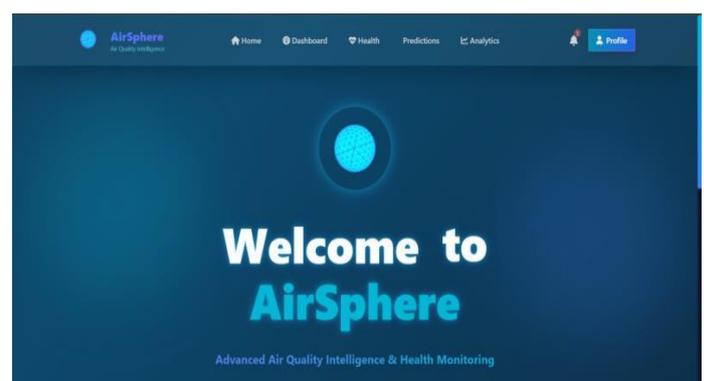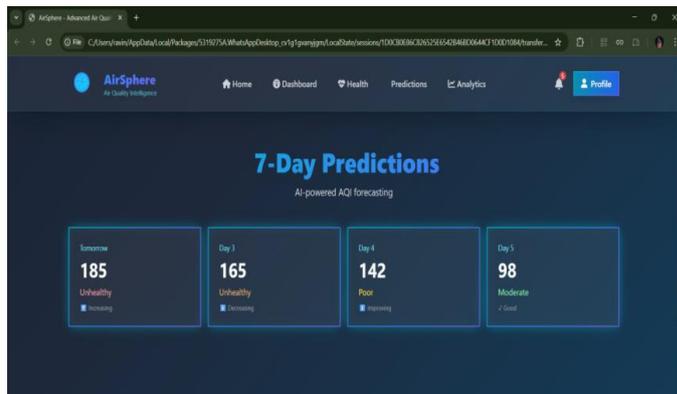
Monitoring:

Wellness:

Forecasting:

IV. CONCLUSION

The AIR SPHERE – Smart Climate & AQI Predictor project provides an effective solution for real-time air quality monitoring and prediction using machine learning techniques. The system successfully analyzes environmental parameters and generates accurate AQI forecasts, helping users understand current and future air conditions. Its interactive interface, combined with health alerts and insights, enhances user awareness and usability. Overall, the project demonstrates a practical and scalable approach to addressing air pollution challenges and supports informed decision-making for a healthier environment.

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Ravindra Waghmare is a Third Year Diploma student in Artificial Intelligence and Machine Learning at Ajeenkya D Y Patil School of Engineering, Polytechnic, Pune. He led the frontend development and UI/UX design of the system, building an interactive dashboard using HTML, Tailwind CSS, and JavaScript. He also integrated frontend components with backend APIs and ensured a responsive and user-friendly interface.

Samiksha Khandagale is a Third Year Diploma student in Artificial Intelligence and Machine Learning at Ajeenkya D Y Patil School of Engineering, Polytechnic, Pune. She contributed to research analysis, system evaluation, and documentation. Her work included AQI standard analysis, health risk categorization, testing, and improving overall system accuracy and workflow.

Swaroop Jadhav is a Third Year Diploma student in Artificial Intelligence and Machine Learning at Ajeenkya D Y Patil School of Engineering, Polytechnic, Pune. He contributed to system architecture design, frontend structuring, and backend validation. He also assisted in API integration testing, debugging, and performance optimization to enhance system reliability.

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