AIR AWARE – Smart Air Quality Monitoring & Prediction System

An Infosys Springboard Project

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The Urgent Need for AIR AWARE: Addressing Air Pollution

Air pollution in major Indian cities has reached critical levels, posing significant health risks to the population. The concentration of particulate matter, particularly PM2.5 and PM10, frequently surpasses safe limits set by national and international health organisations, leading to a rise in respiratory and cardiovascular diseases.

Current solutions often lack an integrated approach, making it difficult for citizens to access comprehensive information. There is a distinct gap in platforms that can seamlessly combine real-time monitoring with predictive analytics and personalised health advice. This highlights the pressing need for a centralised, user-friendly, and data-driven system to empower individuals with actionable insights into their local air quality.

Project Objectives: Crafting a Comprehensive Solution

Secure Web Application

Develop a robust and secure web-based platform for monitoring air quality data, ensuring data integrity and user privacy.

Visualise Pollution Trends

Implement interactive visualisations to display city-wise and month-wise pollution trends, making complex data easily understandable.

Predict AQI Accurately

Incorporate a predictive model to forecast the Air Quality Index (AQI) based on critical PM2.5 and PM10 values, providing foresight to users.

Personalised Health Advisory

Offer tailored health advice and safety recommendations based on the predicted AQI, helping users mitigate risks.

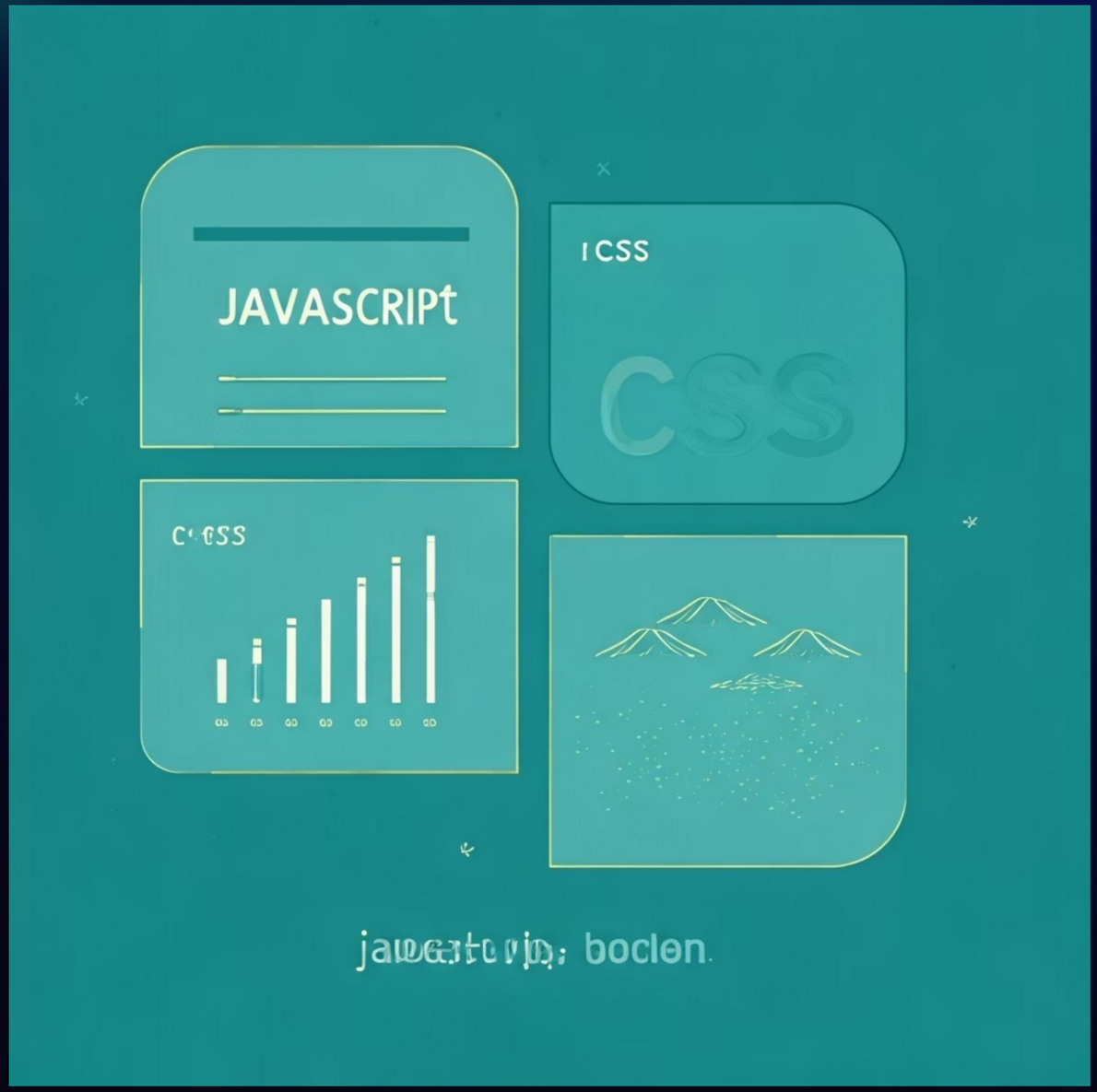
Data & Feedback Management

Enable users to download air quality data and provide feedback, fostering transparency and continuous improvement.

Multilingual Interface

Support multiple languages (English and Hindi) to ensure accessibility for a broader user base across India.

Technology Stack: The Foundation of AIR AWARE

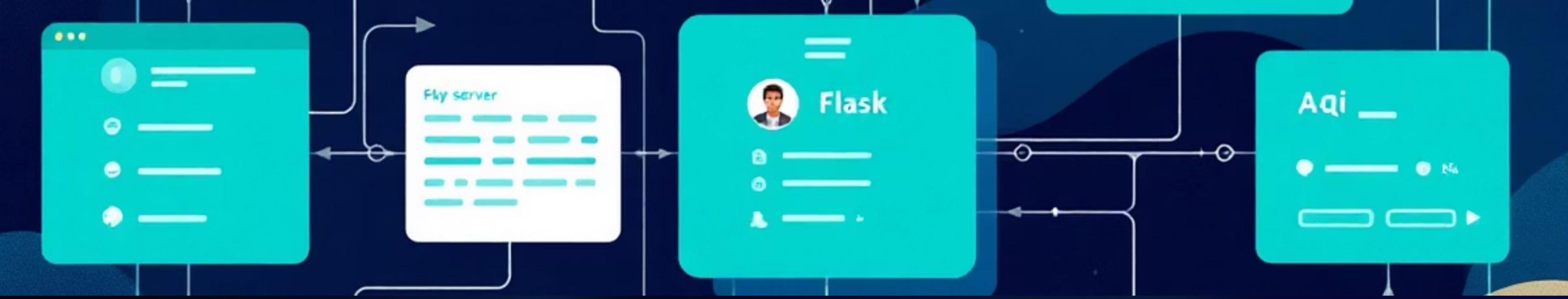


Backend Technologies

- **Python Flask Framework:** A lightweight and powerful micro-web framework for building the application's core logic and

Frontend Technologies

- **HTML5 & CSS3:** Standard markup and styling languages for structuring and presenting content on the web



System Architecture: How AIR AWARE Operates

The AIR AWARE system is designed with a clear separation of concerns, ensuring scalability and maintainability. The User Interface (UI), built with HTML, CSS, and JavaScript, provides a rich interactive experience. User interactions trigger requests to the Flask Web Server, which acts as the central hub.

The Flask server processes these requests, interacts with the MySQL Database for data retrieval and storage, and leverages the AQI Calculation & Logic Engine for processing air quality data and predictions. JavaScript plays a crucial role in fetching data dynamically from Flask APIs, allowing for real-time updates of charts and other visualisations without the need for full page reloads.

Database Design: Structuring Key Data

The `users` Table

Stores user authentication details:

- **username:** Unique identifier for each user.
- **password:** Securely hashed password for authentication.

The `air_quality` Table

Contains raw air quality measurements:

- **from_date:** Timestamp of the data recording.
- **city:** The city where the measurement was taken.
- **pm25:** Particulate matter 2.5 concentration ($\mu g/m^3$).
- **pm10:** Particulate matter 10 concentration ($\mu g/m^3$).

The `feedback` Table

Records user suggestions and comments:

- **name:** Name of the user submitting feedback.
- **message:** The user's feedback or query.

All data is housed within the **air_quality_db** MySQL database, designed for efficient storage and retrieval of critical environmental and user-related information.

Login & Session Management: Ensuring Secure Access

AIR AWARE prioritises user security through a robust login and session management system.

- **Secure User Authentication:** Users log in using their unique username and password. Passwords are securely hashed before storage to prevent unauthorised access.
- **Flask Session for Authentication:** Session-based authentication is implemented using Flask's built-in session mechanism. This ensures that user state is maintained across requests without storing sensitive information client-side.
- **Access Control:** Any attempt by unauthorised users to access protected routes will result in an immediate redirection to the login page, safeguarding sensitive data and features.
- **Logout Functionality:** A dedicated logout feature is provided, which securely clears all session data, preventing session hijacking and ensuring user privacy upon exiting the application.

Interactive Dashboard: Visualising Air Quality

The dashboard module offers a dynamic and interactive overview of air quality metrics.

Backend Operations

- The Flask backend efficiently aggregates average PM2.5 and PM10 values for each city.
- Data is meticulously fetched from the MySQL database using optimised SQL `GROUP BY` queries, ensuring accurate and timely statistics.
- Dedicated API endpoints serve this aggregated data to the frontend in a structured JSON format.

Month-Wise Data Visualization: Uncovering Pollution Trends

The month-wise data visualization feature allows users to analyse long-term air quality trends, crucial for understanding seasonal variations and the effectiveness of environmental policies.

- **Flask API Endpoint:** A dedicated Flask API at `/monthly-data` processes requests for historical air quality data.
- **JSON Data Return:** This API intelligently queries the MySQL database, aggregates average PM2.5 and PM10 values per month, and returns the data in a clean JSON format, including month identifiers and respective pollution averages.

AQI Prediction Module: Forecasting Air Quality

Input Parameters

The prediction module relies on two critical input values provided by the user:

- **PM2.5 value:** Concentration of fine particulate matter.
- **PM10 value:** Concentration of coarse particulate matter.

AQI Calculation Logic

The Air Quality Index (AQI) is computed using a weighted average formula:

```
AQI = (PM2.5 × 0.6) + (PM10 × 0.4
```

This formula provides a simplified yet effective way to combine both particulate matter concentrations into a single, easily interpretable index.

AQI Categories & Health Implications

The calculated AQI is then classified into one of several predefined categories, each with associated health implications:

- Good
- Satisfactory
- Moderate
- Poor
- Very Poor
- Severe

The prediction result, including the AQI value and its corresponding category, is displayed on the user interface instantly, providing immediate insights into the current or forecasted air quality conditions.

Machine Learning Integration: Linear Regression for AQI Prediction

Data Preparation

Historical PM2.5 and PM10 values, along with other relevant environmental factors, are collected and pre-processed to ensure data quality and consistency for model training.

Model Training

A Linear Regression model is trained on this prepared dataset. The model learns the relationship between input features and historical AQI values to identify patterns.

Prediction Output

Once trained, the model predicts future AQI values based on new input data. This provides users with proactive insights into upcoming air quality conditions.

The integration of Linear Regression enables AIR AWARE to provide accurate and timely AQI forecasts, empowering users with critical information to make informed decisions regarding their health and activities.

Thank You