Project Report: Air Quality Monitoring Dashboard

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202355672

December 11, 2024

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Web Application Programming

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Title: Air Quality Monitoring Dashboard

Objective:

This web application is designed to provide users with real-time air quality index (AQI) data, historical air quality trends, and other environmental factors such as temperature and humidity. The purpose is to help users monitor and analyze the air quality of their current location or any selected city worldwide. The data is sourced from OpenWeatherMap and WAQI APIs, and the application uses dynamic data visualizations powered by Chart.js.

Features:

- **Real-Time AQI Data**: Access live AQI data from various locations using the WAQI API.
- **Historical Data Visualization**: View past air quality data to observe trends.
- **AQI vs. Temperature/Humidity Analysis**: Compare AQI values with environmental factors such as temperature and humidity.
- **AQI Forecast**: View forecasted AQI data for different pollutants.
- **City Compare**: Compare AQI data for two cities at the same time.
- **Country and City Dropdowns**: Select specific locations to view air quality data.
- **User-Friendly Interface**: An intuitive layout and navigation make it easy for users to monitor air quality data.
- **Responsive Design**: The website is designed to be fully responsive

Technologies Used:

- **Languages**: HTML, CSS, JavaScript

- **Libraries/Frameworks**:
    - **Chart.js**: For creating interactive and dynamic charts to display AQI data and trends.
    - **jQuery**: A JavaScript library that simplifies DOM manipulation, event handling, and AJAX requests.
    - **Bootstrap**: A responsive front-end framework that helps build mobile-first, responsive web pages.
    - **FontAwesome**: A library of scalable vector icons used to enhance UI elements with recognizable icons for better user experience.
    - **Flatpickr**: A lightweight and customizable date picker library, used to select date ranges for viewing historical data.

- **APIs**:
    - **OpenWeatherMap API**: Provides real-time weather and AQI data, including temperature, humidity, and wind speed.
    - **WAQI API**: Provides real-time and historical AQI data from different cities around the world.
    - **CountryStateCity API**: API that provides all Countries, States, Cities with ISO2, ISO3, Country Code, Phone Code, Capital, Native Language, Time zones, Latitude, Longitude, Region, Subregion, Flag Emoji, and Currency.

- **Version Control**: GitHub for version control and collaboration.

Development Process

- **Initial Planning**:
  The main goal of this project was to create a web application that provides real-time and historical data related to air quality. The application would allow users to easily access AQI information, as well as analyze historical trends and compare data across cities. The overall design aimed to be user-friendly, ensuring a seamless experience for users across different devices.

- **UI/UX Design**:
  The website's design focused on clean navigation and ease of access to data. Bootstrap was used to create a responsive layout that works well on both desktop and mobile devices. The user interface was made simple and intuitive, allowing users to easily navigate between tabs such as Live Weather, Past AQI, and AQI Forecast.

- **Challenges and Solutions**:
  - **API Integration**: The integration of multiple APIs (WAQI and OpenWeatherMap) required managing asynchronous requests effectively. I used JavaScript's fetch() API and jQuery's AJAX methods to handle multiple data fetches.
  - **Data Visualization**: Visualizing AQI data and environmental factors (temperature, humidity) in a user-friendly manner was challenging. By using Chart.js, I was able to create dynamic charts that allow users to interact with the data and visualize trends.
  - **Data Consistency**: Sometimes, the data from APIs was inconsistent, especially during peak hours. I implemented error handling to ensure that the app gracefully handled missing or invalid data, such as displaying an error message when data couldn't be fetched.

- **Modifications During Development**:
  - I removed the **AQI vs Temperature or Humidity** and **AQI & Weather Trend** tabs to streamline the website, focusing on features that provide the most useful and interactive data.
  - The **"Click to see the detail"** button was also removed from the home page for a cleaner design and smoother user experience.

Challenges Faced

- **Handling Asynchronous Data**: Fetching data from APIs asynchronously can sometimes lead to issues such as race conditions or delays in data retrieval. I handled these using promises and async/await to ensure smooth data processing.
- **Responsive Layout**: Adapting the layout for different screen sizes while maintaining functionality required careful use of Bootstrap's grid system and custom media queries for specific elements.
- **API Rate Limiting**: Both APIs have rate limits on how frequently requests can be made. I implemented logic to minimize unnecessary requests and used caching strategies where appropriate.

Successes

- The real-time AQI data and environmental conditions are displayed correctly and updated in real time based on user input.
- The charts provide clear and responsive visualizations of AQI data and historical trends, making it easier for users to track air quality over time.
- The integration of multiple APIs was successful, and error handling ensured smooth operation even when data was not available.

Failures

- The responsive layout of the charts in the Home tab works as expected when transitioning from larger screens to smaller ones. However, the charts do not properly adjust when resizing from a smaller screen to a larger one. While the layout itself adapts, the size of the charts does not scale appropriately, leading to an inconsistent user experience on larger screens.

Features and Functionalities

Home Tab

- **Real-Time AQI Data**: Displays the current AQI for the user's location, providing immediate insight into local air quality.
- **AQI Color Coding**:
- **IAQI Bar Chart**: A dynamic bar chart visualizing the current IAQI for pollutants like PM10, PM2.5, CO, NO2, O3, and SO2.
- **PM10 IAQI Forecast**: A forecast chart showing the predicted PM10 IAQI for the next few days.

Live Weather Tab

- **Location Selection:** Allows users to select a country, state, and city via dropdown menus to view real-time weather conditions.
- **AQI Color Coding**
- **Weather Data Display:** Shows the current temperature, humidity, wind speed, and AQI for the selected location.
- **Pollutants Concentration Chart:** A visual representation of the concentrations of various pollutants in the selected city.
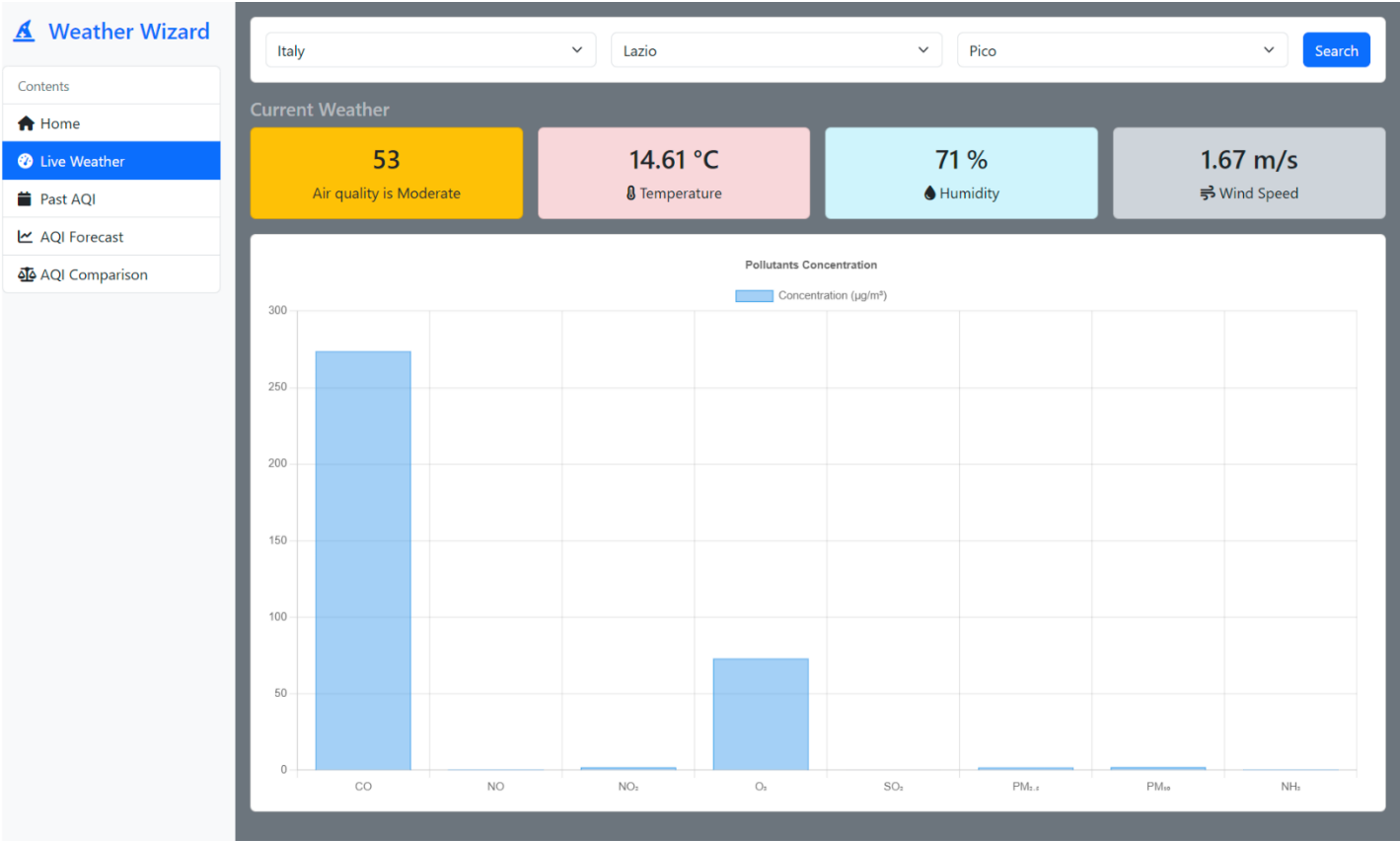
Past AQI Tab

- **Historical AQI Data:** Enables users to explore past AQI data for a specific location.
- **Date Range Selection:** Allows users to select a date range using the Flatpickr library to retrieve historical data for a particular period.
- **Data Visualization:** Displays historical AQI data in charts to help users analyze trends over time.


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AQI Forecast Tab

- **Pollutant Concentrations Over Time:** Displays the concentration levels of various pollutants (e.g., PM10, PM2.5, CO, NO2, O3, SO2) over time. Users can select from 1-hour, 3-hour, or 6-hour intervals to view the pollutant levels for the chosen timeframe.
- **Individual Air Quality Index Charts:** Shows separate charts for each pollutant, allowing users to select a specific pollutant (e.g., PM10, PM2.5) and view the corresponding IAQI forecast for that pollutant.
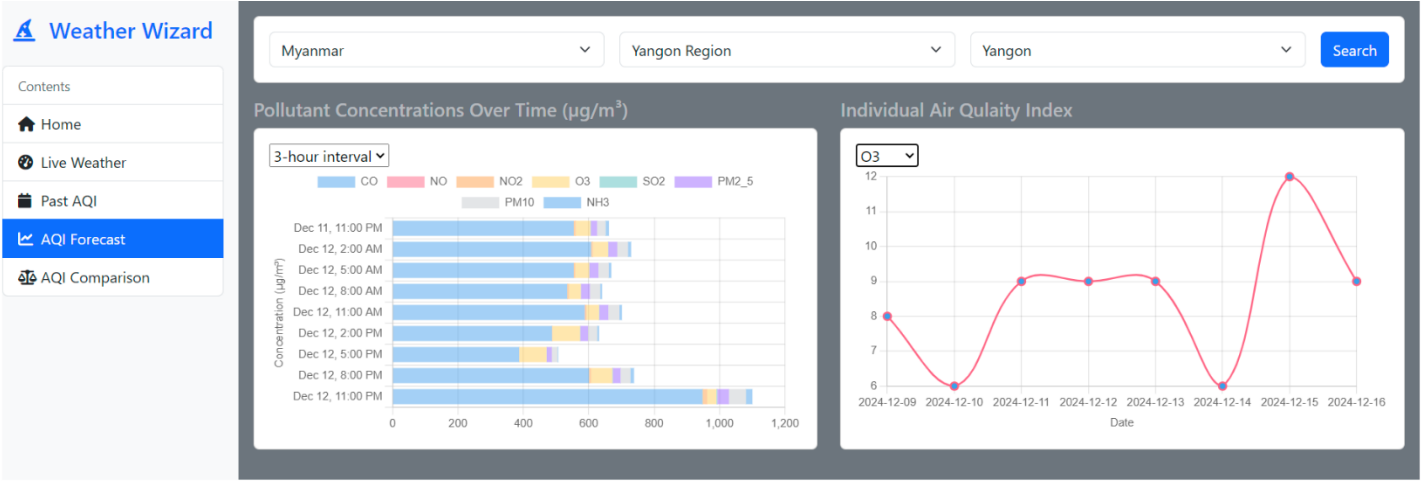
AQI Comparison Tab

- **City Comparison:** Allows users to compare the AQI values of two selected cities side by side, providing a direct comparison of air quality.
- **Pollutant Comparison (Radar Chart):** Uses a radar chart to compare the concentration levels of various pollutants (e.g., PM10, PM2.5, NO2, O3, SO2) across the two cities, giving a visual representation of the differences in pollutant levels.
- **AQI Comparison Bar Chart:** Displays a bar chart that visually compares the AQI values for each city across different pollutants, offering an easy-to-understand comparison of air quality.
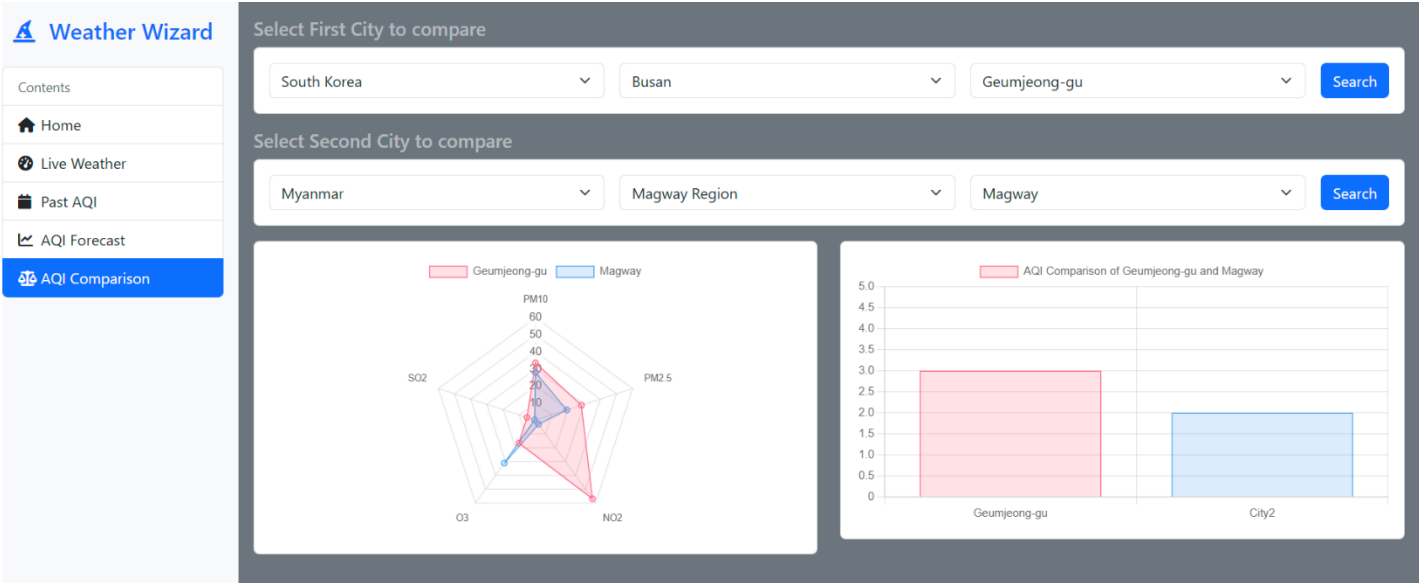
Conclusion

The Air Quality Monitoring Website successfully meets the objectives of providing real-time and historical air quality data in a user-friendly format. The integration of multiple data sources and interactive visualizations allows users to monitor air quality and environmental conditions, helping them make informed decisions about their health and the environment.
Moving forward, additional features such as **user notifications** for critical AQI levels or an expanded location database could further enhance the utility of this application.

GitHub Repository and Demo

- **Repository Link**: https://github.com/Myatthu17/AQI-website-project
- **Final Demo Link**: https://myatthu17.github.io/AQI-website-project/