Real-Time Air Quality Monitoring & Weather Forecasting System

1. Introduction

1.1 Overview

Air pollution is one of the serious environmental problems that is leading to millions of premature deaths each year. Air quality monitoring systems will be one of the proactive solutions for reducing deaths.

To solve any real-world problem an in-depth study of the data is necessary and it's really important to develop a model which is reliable and highly accurate. So we have decided to work on this problem statement not because it's easy but because it is difficult.

Our project provides air quality measurement and pollutant values(PM2.5, PM10, NO2, NH3, CO, etc) of each city in India.

We have built our model using the **Xgboost(Extreme Gradient Boosting)** algorithm with high accuracy of 99%. After that, we used an API to collect real-world pollutant values. With this data we predicted air quality and with the help of tableau software, we have represented air quality in India Map. Eventually, we integrated this map with a web application which is developed using front-end technologies(**HTML, CSS, and JS**).

1.2 Purpose

Air pollution is the greatest environmental threat to public health globally and accounts for an estimated 7 million premature deaths every year. Air pollution and

climate change are closely linked.

The use of our project(Real Time Air Quality Monitoring System) is to provide one of the curative solutions to resolve all the negative impacts of air pollution.

Through our Real-time air quality monitoring system we can achieve the following.

1. The data collected from air quality monitoring helps us assess the impacts caused by poor air quality on public health.
2. Air quality data helps us determine if an area is meeting the air quality standards devised by CPCB, WHO, or OSHA.
3. The data collected from air quality monitoring would primarily help us identify polluted areas, the level of pollution, and the air quality level.
4. Air quality monitoring would assist in determining if air pollution control programs devised in a locality are working efficiently or not.
5. Based on the data collected control measures can be devised for the protection of the environment and the health of all living organisms.

The main goal of our project is to achieve a *safe and healthy tomorrow*.

2. Literature Survey

2.1 Existing Problem

The existing system that we have referred to is not accurate enough to meet all the provided achievements in our project. The existing system model accuracy is too low for real-time monitoring.

The main observations of the existing system are

1. The existing system uses Linear Regression algorithm for building the model.
2. The existing system **only provides an air quality index of the cities.**
3. It **doesn’t provide any chemical pollutants measures** to analyze chemical emission levels.
4. It doesn't provide any required data for understanding the air pollution of the respective location.

To provide an effective solution for the improvising of the existing system we have developed the proposed solution.

2.2 Proposed Solution

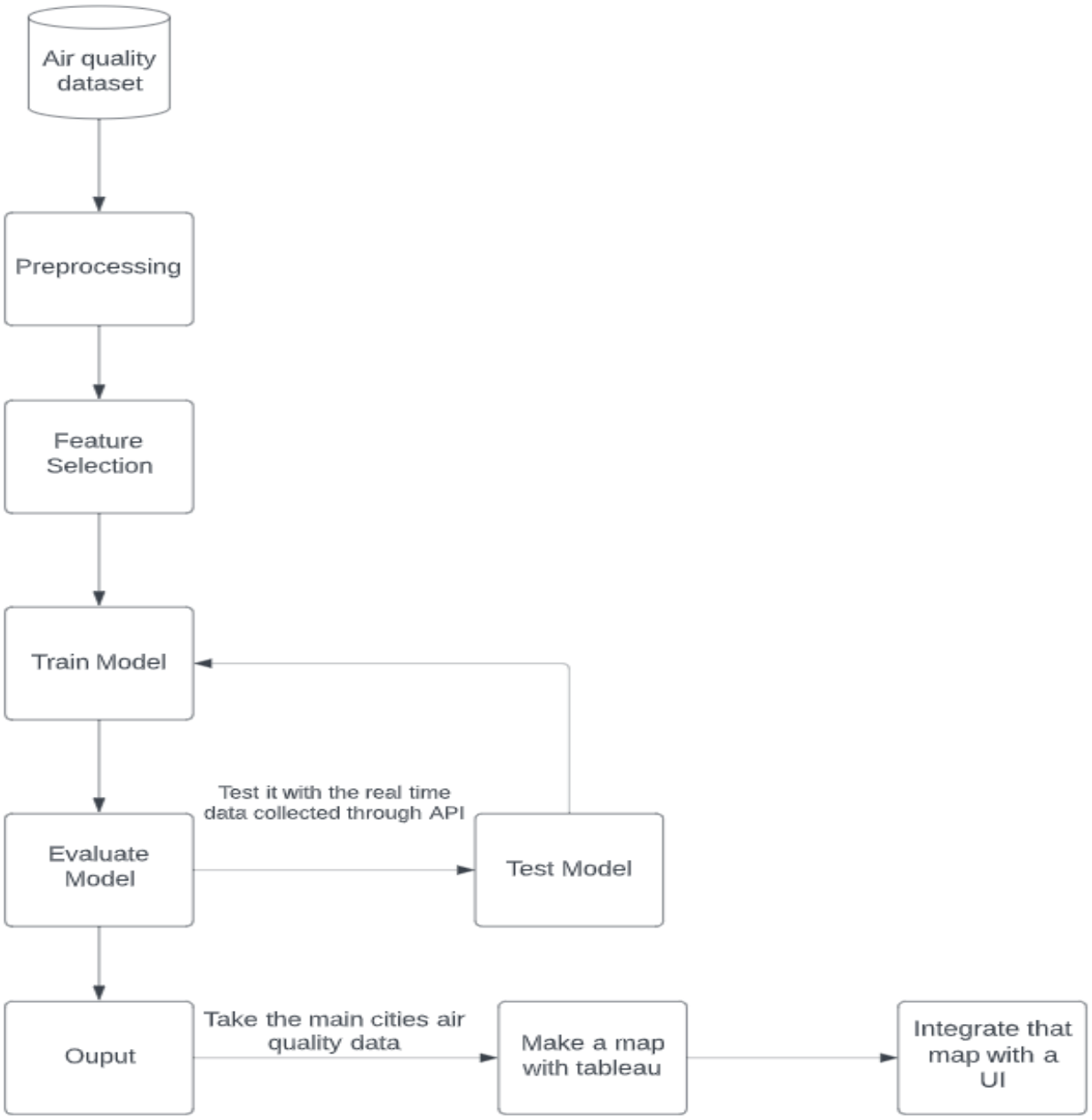
Our proposed solution mainly focuses on the effectiveness and accuracy of the air monitoring system.

The solution proposed by us will provide:

- **More accuracy** than the existing system.
- Algorithm used for building the model is **Xgboost(Extreme Gradient Boosting)**
- **Air quality index along with pollutant concentration** of the respective cities in India to understand the air pollution levels.

3. Theoretical Analysis

3.1 Block Diagram



3.2 Hardware/ Software designing

Hardware requirements

- Processor : Intel i3 or above
- Speed: 1.1GHZ
- RAM: 4GB
- Hard disk capacity : 16GB

Software requirements

- Operating System : Windows 7 or above
- Programming language : Python and related libraries
- Google Colab(IDE)
- Front End Tools : HTML,CSS and JS

4. Experimental Investigation

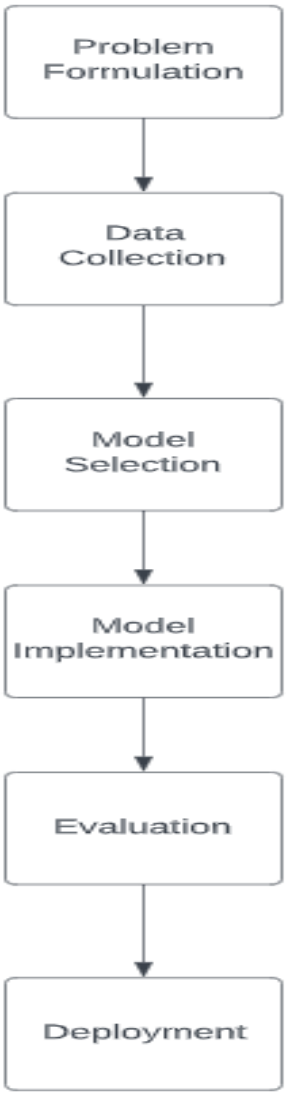
Firstly we had done a clear investigation of the dataset by performing some visualization techniques. We got to know that there are a lot of missing values in the dataset.

After that, we analyzed the data distributions by using the Missingno library. If the data distribution is symmetric then we thought to replace those missing values

with mean. If it is not symmetric then we thought to replace the missing values with the median. But after performing data visualizations we got to know that all the column's data distributions are not symmetric so we have replaced the missing values using the median.

We have worked on **Support vector machine, Random forest classifier and Xgboost classifier.**We have analyzed that Xgboost outperforms both support vector machine and Random forest classifier.

5. Flowchart



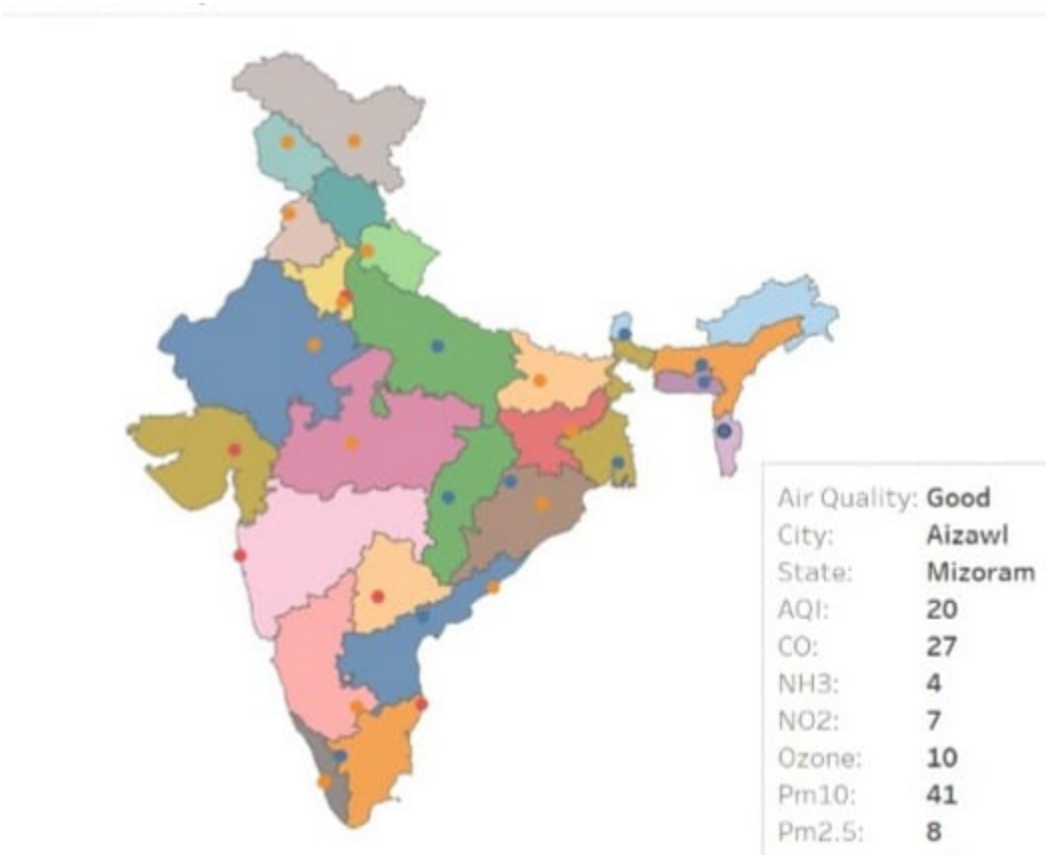
6. Result

- We found that pollutants such as CO, NH3, NO2, PM2.5, PM10, and S02 and secondary pollutants such as Ozone values have a great impact on the air quality index.

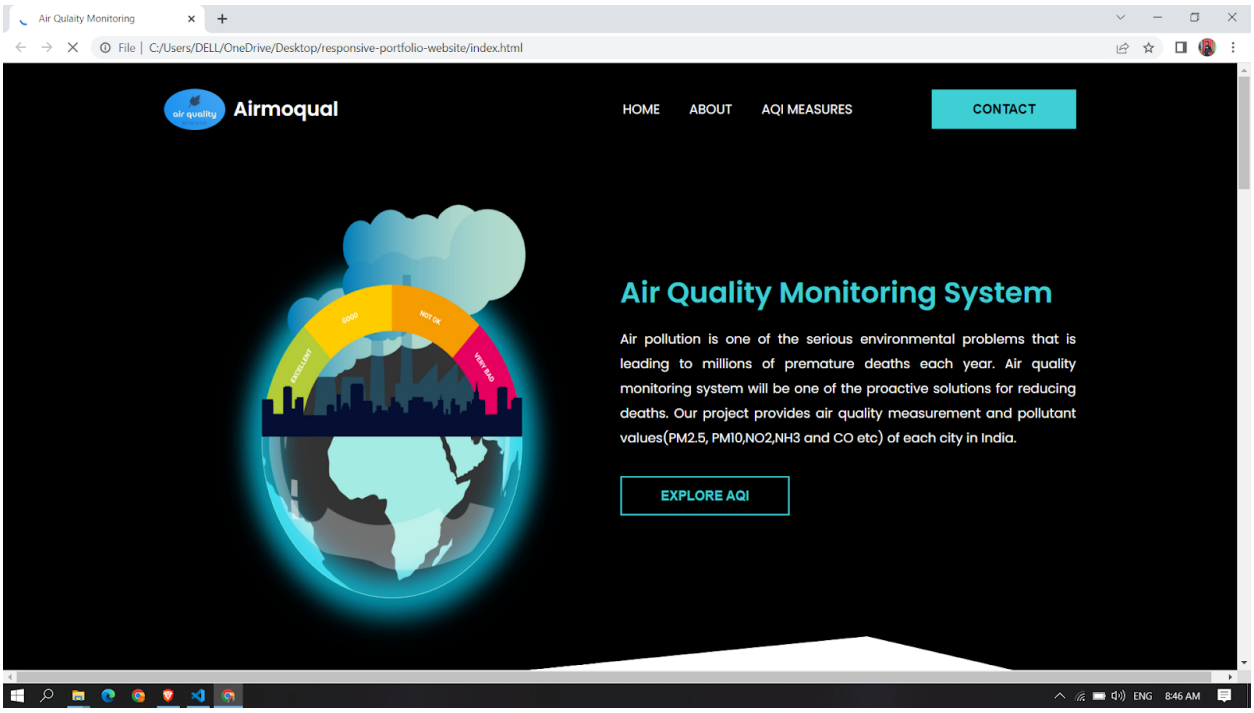
- We have divided the level of air quality into three groups
    1. Good

2. Satisfactory
3. Moderate

- We analyzed that there are 12 cities with good air quality indexes, 5 cities with moderate air quality, and 14 cities with satisfactory air quality.



We integrated our model with UI. The screenshots of the website are as follows.


Air Quality Monitoring
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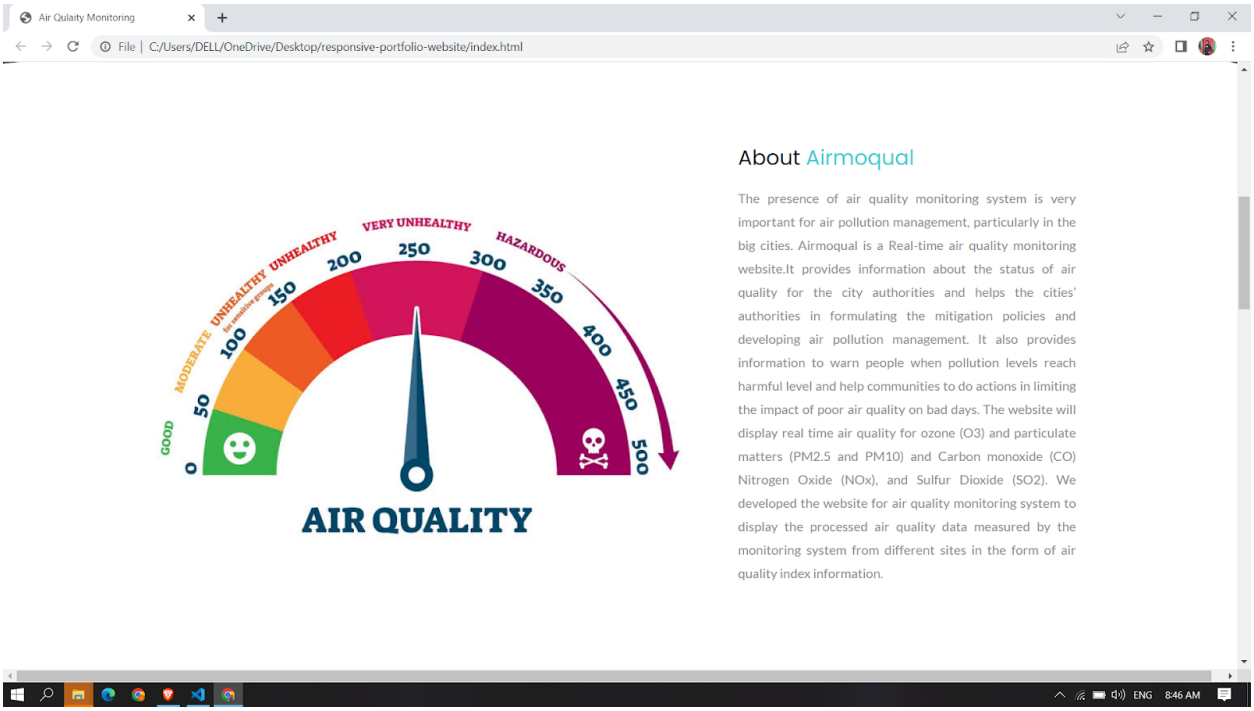
Airmoqual
HOME
ABOUT
AQI MEASURES
CONTACT
Air Quality Monitoring System
Air pollution is one of the serious environmental problems that is leading to millions of premature deaths each year. Air quality monitoring system will be one of the proactive solutions for reducing deaths. Our project provides air quality measurement and pollutant values(PM2.5, PM10,NO2,NH3 and CO etc) of each city in India.
EXPLORE AQI
ENG
8:46 AM


Air Quality Monitoring
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GOOD
MODERATE
UNHEALTHY
UNHEALTHY for sensitive groups
VERY UNHEALTHY
HAZARDOUS
0
50
100
150
200
250
300
350
400
450
500
AIR QUALITY
About Airmoqual
The presence of air quality monitoring system is very important for air pollution management, particularly in the big cities. Airmoqual is a Real-time air quality monitoring website.It provides information about the status of air quality for the city authorities and helps the cities' authorities in formulating the mitigation policies and developing air pollution management. It also provides information to warn people when pollution levels reach harmful level and help communities to do actions in limiting the impact of poor air quality on bad days. The website will display real time air quality for ozone (O3) and particulate matters (PM2.5 and PM10) and Carbon monoxide (CO) Nitrogen Oxide (NOx), and Sulfur Dioxide (SO2). We developed the website for air quality monitoring system to display the processed air quality data measured by the monitoring system from different sites in the form of air quality index information.
ENG
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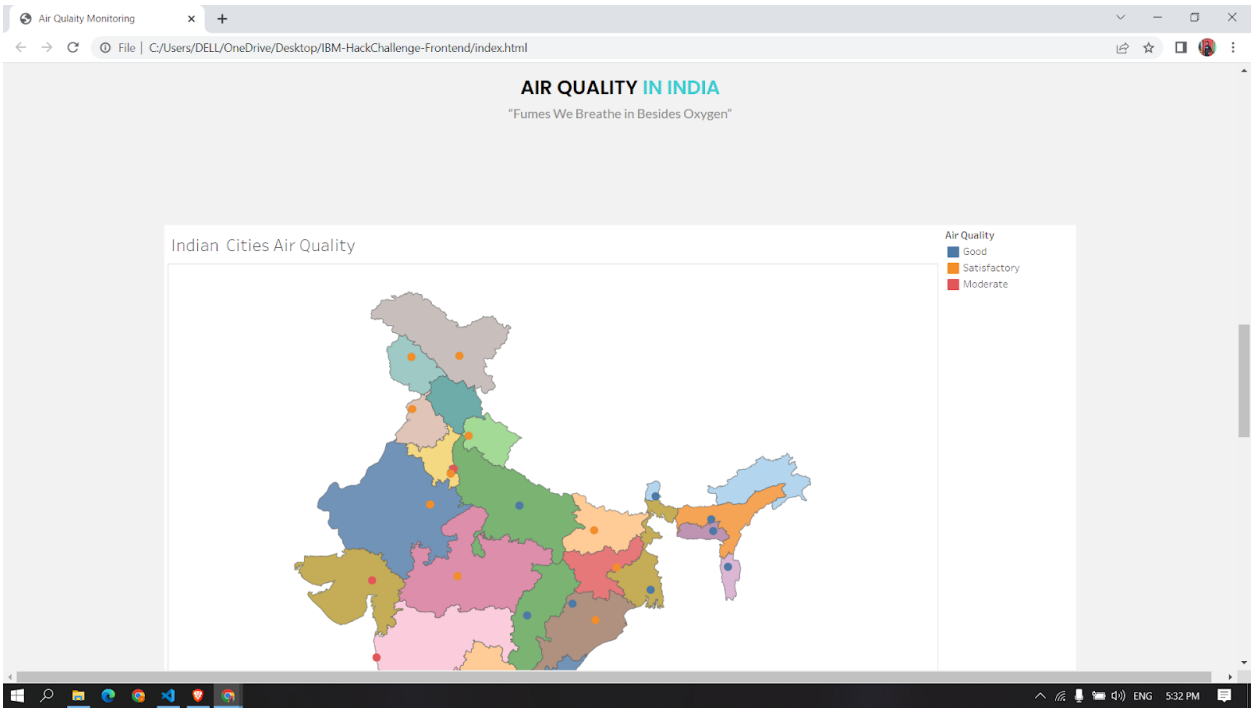
Air Qulaity Monitoring
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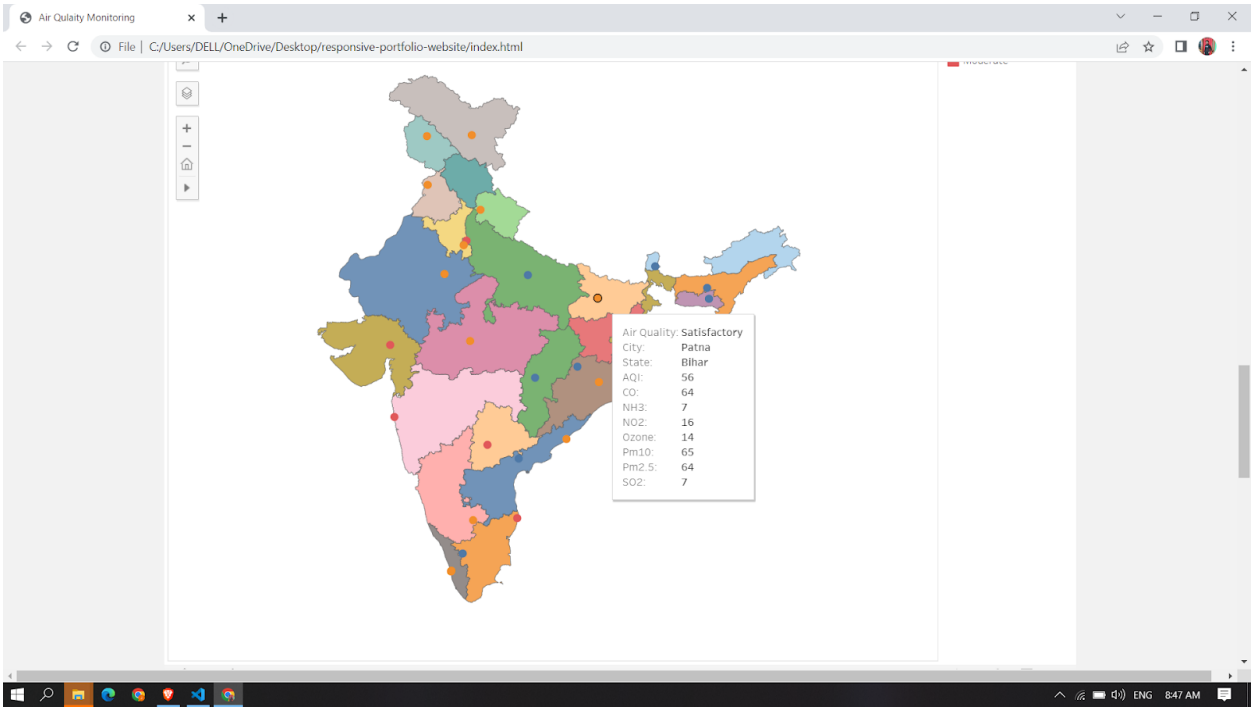
AIR QUALITY IN INDIA
"Fumes We Breathe in Besides Oxygen"
Indian Cities Air Quality
Air Quality
Good
Satisfactory
Moderate
ENG
5:32 PM


Air Qulaity Monitoring
File | C:/Users/DELL/OneDrive/Desktop/responsive-portfolio-website/index.html
Air Quality: Satisfactory
City: Patna
State: Bihar
AQI: 56
CO: 64
NH3: 7
NO2: 16
Ozone: 14
Pm10: 65
Pm2.5: 64
SO2: 7
ENG
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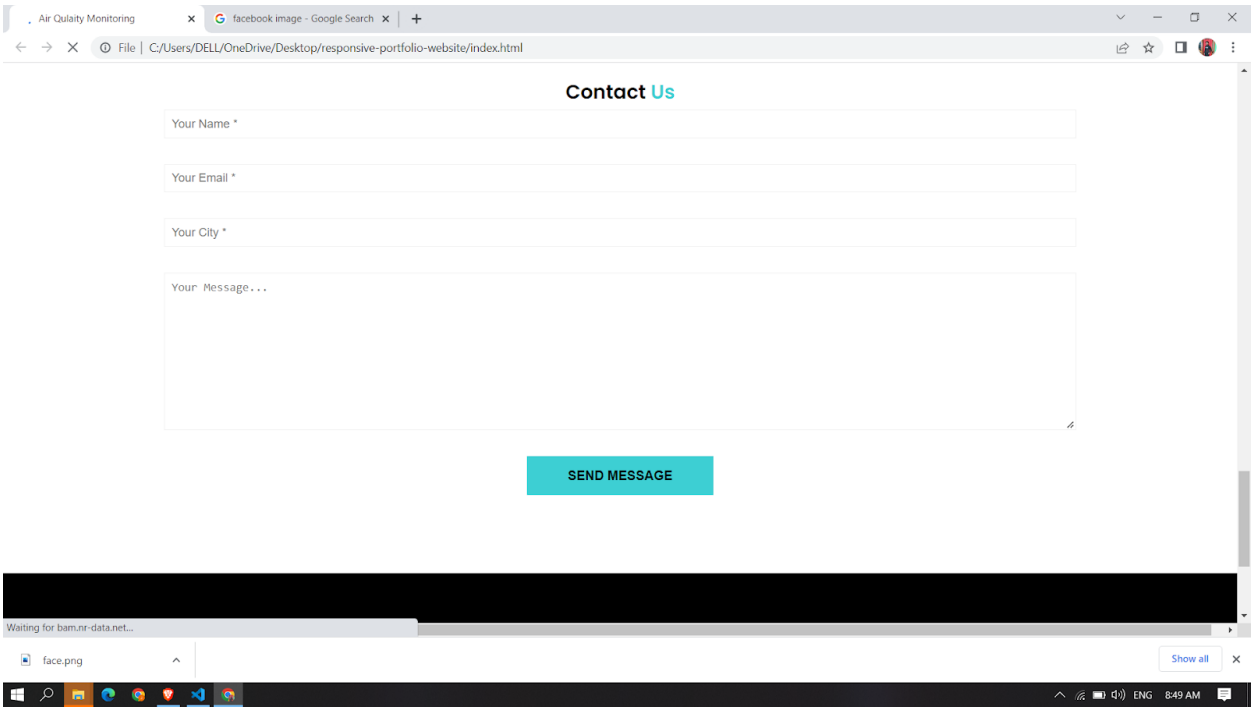
Air Quality Monitoring
facebook image - Google Search
File | C:/Users/DELL/OneDrive/Desktop/responsive-portfolio-website/index.html
Contact Us
Your Name *
Your Email *
Your City *
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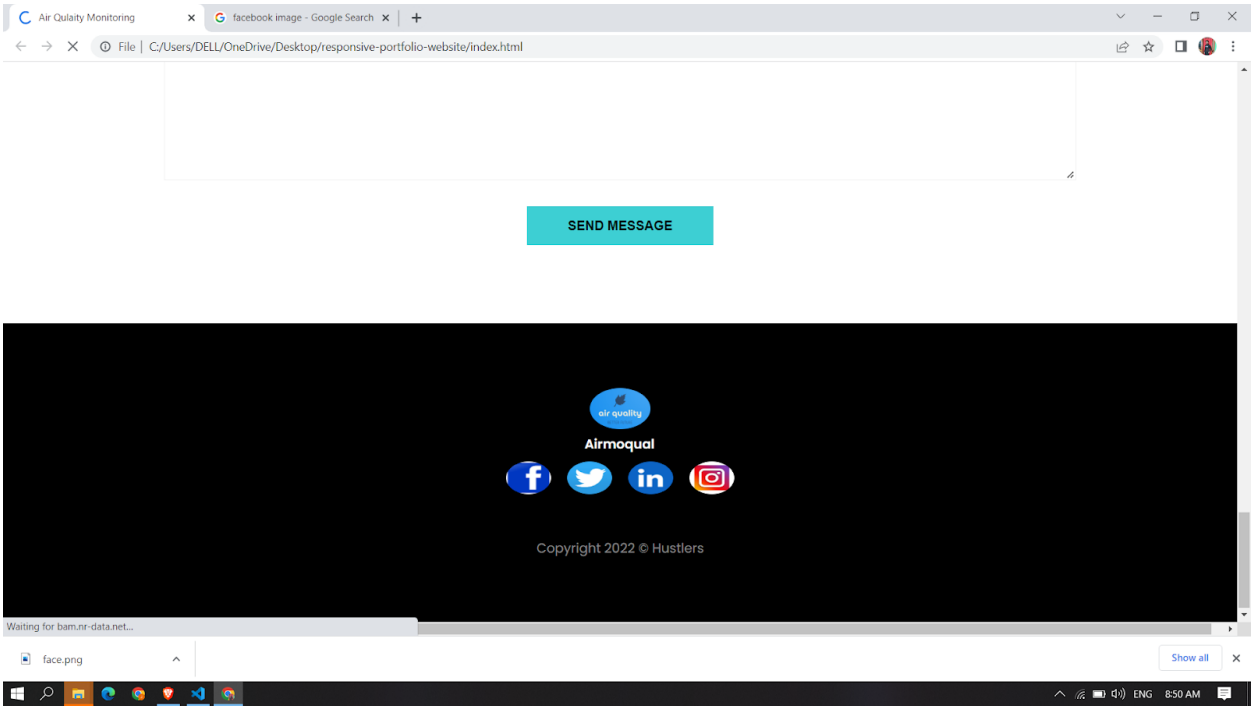
Air Quality Monitoring
facebook image - Google Search
File | C:/Users/DELL/OneDrive/Desktop/responsive-portfolio-website/index.html
SEND MESSAGE
air quality
Airmoqual
Copyright 2022 © Hustlers
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7. Advantages and Disadvantages

Advantages

- Better accuracy
- Provide precise air quality index and pollutant values
- An Interactive UI

Disadvantages

- We have covered only major cities in India.
- Can’t monitor internal stations air quality

We will take this as a challenge and work on it and mold all our disadvantages as advantages.

8. Applications

- Real-time air quality monitoring systems have a huge ongoing demand in areas such as agriculture, manufacturing, and automation.

- Through our proposed solution, the public can know the expected air quality and the Government authorities can help the city administration by issuing health alerts and advisories during the case of emergencies. It is also the central goal of smart cities to provide a clean and healthy environment for their citizens. So there is a big scope for generating revenue through collaboration with the government.

- Air quality monitoring system plays a crucial role in the domain of transportation as bad conditions are not suitable for safe travel, especially in the case of Air traveling. This generates a way to generate revenue by providing services to airline companies.

9. Conclusion

- As part of the IBM Hack Challenge, we have developed a real-time air quality monitoring system. We used the Xgboost**(Extreme Gradient Boosting) classifier algorithm** for developing our model after that we used an API to collect real-world pollutant values with this data we predicted air quality and with the help of tableau software, we have represented the air quality in India Map and integrated that map with a website.

- The chemical pollutant measures played a crucial role in predicting air quality.

- Cities such as Hyderabad, Delhi,Mumbai and Chennai, etc come under a moderate air quality range.

- Thiruvananthapuram, Shillong, Lucknow cities, etc come under a good air quality range.

- Visakhapatnam, Jaipur, Kochi, etc come under a satisfactory air quality range.

10. Future Scope

The future scope of the project is the usage of online machine learning for model building as learning takes place as data becomes available. And we also want to include all the cities in the entire world that will be more efficient than the proposed solution.

The plan is promising, and it will gain more functionality in future works. So we will work on this to build a better solution for a better tomorrow.

11. Bibliography

We have referred the following articles and papers for getting an idea about the project

Air Quality Monitoring System Using Machine Learning and IoT | Request PDF

Machine Learning (ML)-Based Air Quality Monitoring Using Vehicular Sensor Networks

Air Quality Prediction and Monitoring using Machine Learning Algorithm based IoT sensor- A researcher's perspective | IEEE Conference Publication

Real-time air quality monitoring system for Bangladesh's perspective based on Internet of Things | IEEE Conference Publication

Data Cleaning in Machine Learning: Steps & Process [2022]

Support Vector Machine (SVM) Algorithm - Javatpoint

https://xgboost.readthedocs.io/en/stable/

Random Forest | Introduction to Random Forest Algorithm.

Real-Time Monitoring of Indoor Air Quality with Internet of Things-Based E-Nose

Get Started Mapping with Tableau

Models for machine learning - IBM Developer

Exploring Data -IBM Developer

Appendix

Source Code

Air Quality Index API

Machine Learning Model

Frontend-UI