

Analysis of Air Quality Estimation based on Air Pollutants Parameters

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Air quality is the degree that tells us how pure or polluted the air is. It is important to know air quality in our surrounding as it negatively impacts human health and environment. Modernization and industrialization have given birth to air pollution which has become hidden killer. Making cities more respirable starts by analyzing and seizing the air pollution data. Long-established air quality prediction model gave less accurate and unsatisfactory result. There is a need of reliable data-analytics based solutions which will optimally predict air quality thereby enhancing our quality life. We evaluated various studies in this domain and summated the important researches done. This work will give future directions to the upcoming researchers.

Keywords— Air Quality Prediction, Deep Learning, Neural Networks, meteorological factors, PM values.

INTRODUCTION

Air Quality notifies how good or bad the air is to breathe. Bad quality air causes pollution which is one of the key causes of death in the world. A massive nine in 10 people on Earth breathe extremely polluted air, and more than 80% of urban residents have to tolerate outdoor pollution that exceeds health standards, according to the WHO's World Global Ambient Air Quality Database. Dismally, India is one of the countries with maximum number of most polluted cities in the world. Though Delhi air pollution is at the peak there are other 70 cities all over India that indicated unhealthy air quality. In 2017, air pollution estimated for 12.4 lakh deaths in India, in which 6.7 lakh deaths were due to outdoor particulate matter emission and 4.8 lakh deaths due to household air pollution.

To restrict the effect of air pollution and to save the people from its effect, real-time air quality information is required. Air quality prediction is essential to take important decisions for environmental management. Along with the power of big data and analytics, policymakers can provide solutions that whenever used optimally will reduce air pollution helping to enhance healthy life.

LITERATURE SURVEY

Over the past few years an immense work is done in the study and analysis of air pollution. Many research efforts

have focused on approaches to predict air pollutant concentration.

In [1] deep learning model is applied on AirNet[2] dataset to predict the PM_{10} values. Framework used RNN, LSTM and GRU networks to forecast prediction. [3] adopted a distributed fusion architecture to fuse urban data using DNN-based approach. Proposed system is compared with previous online system and the result is 2.4%, 12.2%, 63.2% improved accuracy on long-short term prediction.

Cloud-based ETL framework is developed for Air quality analysis in [4]. Data mining algorithms are applied to store, preprocess and analyse the data. Results of air quality prediction are visualized through browser. [5] focused on implementing data mining techniques to predict patterns in pollutants. R studio and tableau platform are used for time series regression forecasting.

[6] developed a heuristic recurrent air quality predictor (RAQP) to infer air quality. RAQP method recurrently applies the one-hour prediction model, which learns the current records of meteorology and pollution-related factors to measure the future air quality one hour later, to then estimate the air quality after several hours. [7] presents Long-Short Term Memory model to predict air pollutant concentration based on historical data. To look over the performance $PM_{2.5}$ concentration in Beijing City is collected. Different models like Spatiotemporal deep learning, time delay neural network, autoregressive moving average model and support vector regression model are compared. Among all LSTM performs well.

[8] used data driven models, ST-DNN, to predict $PM_{2.5}$ over 48 hours. The model shows that including an LSTM module improved first hour predictions, involvement of CNN module being more useful for longer time frame predictions, since CNN can extract the temporal delay factor from surrounding target features by learning spatial information. Result of proposed model is daily report shown on the Facebook chatbot to send the $PM_{2.5}$ forecasts to users who subscribed the daily report of specific stations.

[9] aims to develop a decisive prior-warning system that consists of air quality prediction and assessment model. To mark the ambiguity in prediction use of back propagation neural network algorithm, combined with a probabilistic parameter model and data preprocessing techniques are used. Second model aims to provide clear description of air quality condition using fuzzy theory and Analytics Hierarchy Process [10] using raw images CNN model is applied for air

quality estimation model involves a negative log-log ordinal classifier to fix the ordinal output well. A new activation function is developed to improve the discriminative property of model. [11]Threenonlinear Auto Regressive model based Artificial Neural Network are used to predict industrial air quality.

Sr. no	Paper Title	Predicted Parameter	Methodology	Accuracy
1	A Solution for Air Quality Monitoring & Forecasting [12]	NO ₂ , temperature, humidity, pressure	Multiple linear regression model	Model performed well, having high coefficients of determination (R ²), close to 1 and Standard Error of 3.3183
2	A Bayesian hierarchical model for urban air quality prediction under uncertainty [13]	SO ₂ , NO _x , and dust fall	Bayesian hierarchical model	Average relative errors between observed data and mean values from model for SO ₂ , NO _x , and dust fall is 6.81%, 6.79% and 3.52%.
3	Performance Analysis of SVM ensemble methods for Air Pollution Data [14]	SO ₂	SVM, Bagging, Adaboost M1	Accuracy of single SVM method was 76.33% & of bagging algorithm it was 79.66%. Adaboost M1 algorithm proved to be best with accuracy 91.28%
4	Air Pollution Analysis Using Enhanced K-Means Clustering Algorithm for Real Time Sensor Data. [15]	SO ₂ , NO _x , PM ₁₀ , O ₃ and CO	K-Means Clustering algorithm, Possibility Fuzzy C-Means (PFCM) clustering algorithm.	K-means algorithm gives 40% more time than PFCM Algorithm.
5	Evolving Different evolution method with random forest for prediction of Air Pollution [16]	C ₆ H ₆ , NO ₂ , O ₃ , SO ₂ , CO, PM _{2.5} and PM ₁₀	Random Forest Algorithm	Combined differential evolution strategy with random forest method outperforms the stand with existing independent classifier of Bayesian network & multi-label classifier technique.
6	A deep learning model for air quality prediction in smart cities [17]	NO ₂ , O ₃	Long Short-Term Memory (LSTM) Support Vector Regressor (SVR)	The prediction accuracy of the LSTM and SVR based model were calculated as 95% and 92.9%, respectively.

Result shows model 3 has highest accuracy that include combined meteorological variable with pollutants as compared to other two models. Thus as given in Table I, related work in the area of air quality prediction involves different analysis and prediction algorithm.

DATA SOURCES

The data can be obtained Central Pollution Control Board (CPCB). Currently, CPCB tracks the Air Pollution levels across different dimension (variables). Day wise, hour wise (for some variables). Following are some dimensions that can be considered:

1. Carbon Dioxide (CO₂): Carbon dioxide is high density

greenhouse gas than dry air. A high concentration can upset oxygen in the air. Major sources of CO₂ are industrial emission, fertilizers, deforestation as well as the burning of fossil fuels like coal, oil and natural gas. CO₂ contributes 65% of total air pollution. Human exposure to high level of CO₂ causes suffocation, unconsciousness, headache.

2. Ozone (O₃): Ground level Ozone is perilous air pollutant. Chemical reaction of pollutants discharged from vehicles, power plants, factories with sunlight gives rise to ozone gas. It harms lungs and causes diseases such as asthma, chronic bronchitis.
3. Carbon Monoxide (CO): Carbon Monoxide is very poisonous odourless gas. It acts as a silent killer. Automobile exhaust, gasoline, furnaces are sources of CO. It causes dizziness, vomiting, and nausea.
4. Sulphur Dioxide (SO₂): It is a nonflammable gas with a penetrating odour. Volcanic eruptions, fuel combustion, emission from locomotives, ships, industrial activities give rise to SO₂. Sulphur dioxide causes acid rains. It causes eye irritation, coughing, mucus secretion, lung malfunctioning.
5. Nitrogen Dioxide (NO₂): It is one of a group of highly reactive gases known as nitrogen oxides (NO_x). Burning of fuel are main source of (NO₂). Excess inhalation of (NO₂) causes respiratory disease.
6. Particulate Matter: It is a mixture of solid particles like dust, pollen, ash, smoke and liquid droplet suspended in air many of which are hazardous. There are two types Particulate Matter PM₁₀ (particle size 10 micrometers or less in diameter) and PM_{2.5} (particle size 2.5 micrometers or less in diameter). It causes lung cancer, asthma, cardiovascular problems.

TABLE I. LITERATURE SURVEY

It is important to measure the following factors as they can help us understand the chemical reactions that occur in the atmosphere:

1. Relative Humidity (RH)
2. Temperature

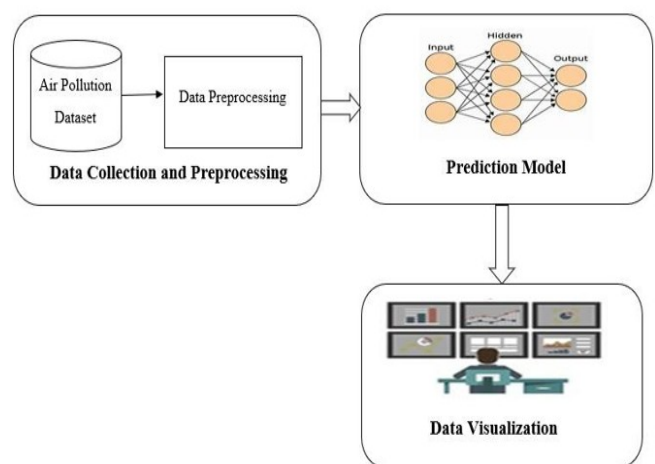
3. Wind Speed (Wind speed S)
4. Vertical Wind speed (Wind speed V)
5. Wind Direction
6. Solar Radiation

Not all monitoring stations track Air Pollution on all the above mentioned parameters and for all days.

PROPOSED SYSTEM ARCHITECTURE

Proposed System architecture for our current study is given in Figure 1. Air quality prediction model consists of three parts. In the first part, data is collected from Central Pollution Control Board. This dataset is preprocessed to remove outliers, noise and redundancy. In the second part, the preprocessed dataset is given to the prediction model as input. Based on the previous labels, the model is trained and values for air pollutants are predicted.

Data visualization part generates the report. According to changing parameters and standards of Environment Protection Agencies, we need to update the dashboard. Updates of the dashboard include changes in values, graphs, charts. Statistical report Air Quality Index will be generated.



Proposed System Architecture

Application :

- Industrial: Industries are giants emitting hazardous gases in the environment. There is a great scope for an air quality prediction model in industries. It will alert the industries with information needed to minimize pollution levels before they are likely to happen.

- Traffic Signals : Traffic Signals are major contributors of Vehicular Pollutions. Vehicles waiting at signals emits toxic gases that badly impact on humans and environment. Dashboard displaying future air quality will help in taking decisions to reduce pollution.
- Government Agencies: Organizations like Environmental Protection Agency (EPA) and Pollution Control Boards can use this prediction model to forecast the daily air quality index. Model will give authorities the required information that will help in preventing and controlling pollution.

CONCLUSION

Prediction algorithms are developing as a promising technique for forecasting non-linear time series information like meteorological and pollution data. It results to good performance for air quality prediction by extracting air quality features. In Future, we need to focus on long-term sudden changes in air quality level as it is very important. Large data set consisting various pollutants need to be considered for prediction. Forecasting model which is adaptable to dynamic atmosphere variable need to be build. The connection between different features can likewise be assessed hence enabling us to see whether there is any hidden parameter which will correlate the performance of features that appears to be different from the first peek.

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