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Artificial Intelligence Method for Estimation of Air Quality Index

Nadia Patel, Prof. M. T. Hasan

Department of Electronics and Telecommunication, Anjuman College of Engineering and Technology, Nagpur, Maharashtra, India

ABSTRACT

Air Pollution has changed the way the world perceives climate change. The world has been forced to take cognizance of the way the things have changed over the years in reference to the air they are breathing. Number of vehicles, industries, air conditioners, refrigerator and other luxury are piling up every minute and the issue now demands serious introspection and measures to counter this. Prediction has a big role to play in this scenario as it allows to find out the probable quantum of pollution level that may be prevalent over the course of time and thus may help the authorities to initiate suitable measures in advance to counter the ill effects of air pollution. Numerous of techniques have been employed over the years. Artificial intelligence has been extensively used to predict the values of pollution. This paper tries to present the finding and the limitation of the existing prediction method.

Keywords : Artificial Intelligence, pollution prediction, Neural Network, Multilayer Perceptron.

I. INTRODUCTION

Air pollutants and their effects on human, environment and other living organisms are very important. These pollutants are reached to human body by accumulating on the soil and vegetation. They cause severe effects on the human such as respiratory problems, cancer and destruction of immune system. In order to take precautionary actions against harmful air pollutants, their prediction is one of the best options. The release of environmental air quality forecast can provide scientific basis for environmental management and decision-making departments to timely, accurately and comprehensively grasp the future change trend of urban environmental air quality. It can be targeted to increase pollution source control before the arrival of serious pollution day, timely warning and taking restrictive measures to mitigate the health hazards to the public. Therefore, urban environmental air quality forecast, as an important link of air pollution prevention and control, has been highly valued by governments at all levels. Unlike other modeling techniques, artificial neural networks (ANFIS) make no prior assumptions concerning the data distribution. ANFIS is capable of modeling highly non-linear relationships and can be trained to accurately generalize when presented with a new data set, The aim of this paper is to utilize the strong capability of artificial neural networks in predicting fuzzy data and the successful application of this approach in various fields gives the idea of implementing ANFIS to predict air quality based on previous data.

II. LITERATURE SURVEY

In this section we have surveyed some papers in which related works are performed.

[1] **Lu Bai, Jianzhou Wang, Xuejiao Ma, Haiyan Lu (2018)**, "Air Pollution Forecasts: An Overview" in International Journal of

Environmental Research and Public health (IJERPH) presented a clear perspective on air pollution forecasting, this study reviews the theory and application of those forecasting models. In addition, based on a comparison of different forecasting methods, the advantages and disadvantages of some methods of forecasting are also provided.

[2] **Kostandina Veljanovska, Angel Dimoski (2018)**, " Air quality index prediction using simple machine learning algorithms" in International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)which presents the comparison of four simple machine learning algorithms, neural network, k-nearest neighbour, support vector machines and decision tree. The air pollution database contains data for each day of 2017 from measurements stations in capital city of the Republic of Macedonia.

[3] **Gaganjot Kaur Kang, Jerry Zeyu Gao, Sen Chiao, Shengqiang Lu, Gang Xie (2018)**, "Air Quality Prediction: Big Data and Machine Learning approaches" in International Journal of Environmental Science and Development (IJESD),this research work focuses on investigation of various big-data and machine learning based techniques for air quality forecasting. This paper reviews the published research results relating to air quality evaluation using methods of artificial intelligence, decision trees, deep learning etc. Furthermore, it throws light on some of the challenges and future research needs.

[4] **Nazira Abdul Rahim, Zainal Ahmad (2017)**, "Graphical User Interface Application in Matlab Environment for Water and Air Quality Process Monitoring" in Chemical Engineering Transactions (CET), this system also offers a Graphical Interface Editing Sub-module, which allows a system administrator to change the water quality data of other rivers as well as the air quality data. This study is about exploring more towards the advanced monitoring system of the river water and air quality by neural network approach, which later will be presented in GUI for online testing /prediction which result in ease of monitoring, diagnostic and control.

[5] **Yuchao Zhou, Suparna De, Gideon Ewa, Charith Perera, Klaus Moessner (2017)**, "Data-driven Air Quality Characterisation for Urban Environments: a case study" in IEEE Access, in this study the researchers developed an air quality estimation framework that implements a neural network that is enhanced with a novel Non-linear Autoregressive neural network with exogenous input (NARX), especially designed for time series prediction. The framework is applied to a case study featuring different monitoring sites in London, with comparisons against other standard machine-learning based predictive algorithms showing the feasibility and robust performance of the proposed method for different kinds of areas within an urban region.

[6] **Vikram Reddy, Pavan Yedavall, Shrestha Mohanty (2017)**, "Deep Air: Forecasting Air Pollution in Beijing, China", this paper investigates the use of the LSTM recurrent neural network (RNN) as a framework for forecasting in the future, based on time series data of pollution and meteorological information in Beijing. Due to the sequence dependencies associated with large-scale and longer time series datasets, RNNs, and in particular LSTM models, are well-suited.

[7] **Khaled Bashir Shaban, Abdullah Kadri, Eman Rezk (2016)**, "Urban Air Pollution Monitoring System with Forecasting Models" in IEEE sensors journal, this paper presents system for monitoring and forecasting urban air pollution. The system uses low-cost air-quality monitoring motes that are equipped with an array of gaseous and meteorological sensors. These motes wirelessly communicate to an intelligent sensing platform that consists of several modules. The modules are responsible for receiving and storing the data, preprocessing and converting the data into useful information, forecasting the pollutants based on historical information, and finally presenting the acquired information through different channels, such as mobile application, Web portal, and short message service.

[8] **Kanchan Prasad Amit Kumar Gorai Pramila Goyal (2016),**"Development of ANFIS models for air quality forecasting and input optimization for reducing the computational cost and time " in Atmospheric environmental journal, This study aims to develop adaptive neuro-fuzzy inference system (ANFIS) for forecasting of daily air pollution concentrations of five air pollutants [sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), ozone (O3) and particular matters (PM10)] in the atmosphere of a Megacity (Howrah). of the models were evaluated on the basis of four statistical indices (coefficient of determination, normalized mean square error, index of agreement, and fractional bias).

[9] **Varun Noorani Subramanian (2016)**, "Data analysis for predicting air pollutant concentration in Smart city Uppsala", this paper shows the use of data analysis for application which will provide users with real-time pollution concentration level along with the predicted value of the location hereby helping in raising awareness of its causes and consequences.

[10] **Aiswarya Baby, Aneena Ann Alexander (2016)**, "A Review on Various Techniques used in Predicting Pollutants" in IOP Conf. Series: Materials Science and Engineering, this paper discusses findings and limitations of existing contributions in the field of pollution prediction.

[11] **Fatma Kunt, Zeynep Cansu Ayturan, Sukru Dursun (2016)**, "Used Some Modeling Applications in Air Pollution Estimates" inJ. Int. Environmental Application & Science (JIEAS), in this study the researchers compared different modeling programs with some gases which cause air pollution were estimated. The results were compared to select the most suitable modelling program.

[12] **Dhirendra Mishra, Pramila Goyal (2016)**,"Neuro-Fuzzy Approach to Forecast NO2 Pollutants Addressed to Air Quality Dispersion Model over Delhi, India" in Aerosol and Air Quality Research, the application of introducing AERMOD aims to improve the forecasting ability of model on the basis the emissions from anthropogenic sources. The training and validation have been made with the eight and two year's available seasonal daily data respectively. The evaluation of the model has been made by comparing its results with observed values as well as other statistical models like MLR and ANN, which reveals that the NF model is performing well and can be used for operational use.

[13] **Lidia Contreras Ochando, Cristina I. Font Juli´an, Francisco Contreras Ochando, C`esar Ferri (2015)**, "Airvlc: An application for real-time forecasting urban air pollution", this paper presents Airvlc, an application for producing real-time urban air pollution forecasts for the city of Valencia in Spain. The application employs regression models able to predict the levels of four different pollutants (CO, NO, PM2.5, NO2) in three different locations of the city. These models are trained using features that represent traffic intensity, persistence of pollutants and meteorological parameters such as wind speed and temperature.

[14] **Suhasini V. Kottur, Dr. S. S. Mantha (2015)**, "An Integrated Model using Artificial Neural Network (ANN) and Kriging for Forecasting Air Pollutants using Meteorological Data" in International Journal of Advanced Research in Computer and Communication Engineering, this paper presents an integrated model using Artificial Neural Networks and Kriging to predict the level of air pollutants at various locations in Mumbai and Navi Mumbai using past data available from meteorological department and Pollution Control Board.

[15] **Godbless Swagarya, Shubi Kaijage, Ramadhani S. Sinde (2014)**, "Air Pollution Monitoring System based on Wireless Networks –Simulation" in Innovative Systems Design and Engineering, this paper proposes an industrial air pollution monitoring system based on the technology of wireless sensor networks (WSNs). This system is integrated with the global system for mobile communications (GSM) and its communication protocol used is Zigbee. The system consists of sensor nodes, a control center and data base through which sensing data can be stored for history and future plans.

[16] **Anikender Kumar, P. Goyal (2012)**, "Forecasting of Air Quality Index in Delhi Using Neural Network Based on Principal Component Analysis" in Pure and Applied Geophysics, the main objective of the present study is to forecast the daily AQI through a neural network based on principal component analysis (PCA). The AQI of criteria air pollutants has been forecasted using the previous day's AQI and meteorological variables, which have been found to be nearly same for weekends and weekdays.

[17] **Prachi, Kumar Nishant, Matta, Gagan (2011)**, "Artificial neural network applications in air quality monitoring and management" in International Journal for Environmental Rehabilitation and Conservation, shows the comparison of various for the prediction of air quality ranging from numerical, mathematical and statistical methods (e.g., regression) to techniques based on artificial intelligence, particularly ANNs. All the meteorological variables and factors have a non-linear relationship with air quality, which can be accurately captured by nonlinear models such as ANNs and Support Vector Machines.

[18] **Suraya Ghazali, Lokman Hakim Ismail (2010)**, "Air Quality Prediction Using Artificial Neural Network", the aim of this research was to develop neural network air quality prediction model. In this study, a prediction method is developed using feed-forward neural network.

[19] **Anurag Kandya, Manju Mohan (2009)**, "Forecasting the urban air quality using various statistical techniques" in the seventh International Conference on Urban Climate, Yokohoma, Japan; in this study, five statistical techniques i.e. Single Exponential Smoothing (SES), Adaptive Response Rate Single Exponential Smoothing (ARRSES), Holt's Linear Method (HLM) ARX (Auto Regressive eXogenous) Model and Auto Regressive Integrated Moving Averages (ARIMA) are adopted for predicting the urban air quality over Delhi.

[20] **Vincent Henri. Peuch (2005)**, "Air Quality Forecasting" in ECMWF Seminar on Global Earth-System Monitoring, describes the use of RAQ modeling and forecasting models for the measurement of air quality index.

[21] **Air Quality Forecasting - A Review of Federal Programs and Research Needs (2001)**, describes the need of forecasting system to support operational air quality forecasting. The system must include a method to continuously evaluate and improve the forecast consistent with the needs of the users. A program plan should be put in place that identifies operational, research, and developmental needs and, where possible, agency resources that can be used to address these needs.

III. CONCLUSION

The alarming problem of air pollution caused serious changes to the earth. Hence to monitor the pollutant level feature based model is deployed which considers the meteorological data along with pollutant level of in order to make the forecast of AQI. The model shows a reduced error rate when compared with other machine learning algorithms and also ranks the metrological factors based on their order of importance. The model will in lower RMSE values which makes it suitable for real me AIQ prediction.The model can be further extended to predict the AQI in a wider geographical area by augmenting additional factorsAlthough a conclusion may review the main points .

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