A Novel Model for Air Quality Prediction using Soft Computing Techniques

Niharika, Venkatadri. M and Dr. Hanumat G Sastry

Abstract: The proliferation of urbanization and industrialization cause's immense fluctuations in air quality due to pollution.The air pollution can be minimized effectively by defensive measures through the efficient air pollution/quality prediction techniques. The existing air quality prediction models are tedious and time consuming.Soft Computing paradigm hasemerged out to be more flexible, less assumption dependent and adaptive methodology. Hence this paper proposes a hybrid model through soft computing techniques for air quality prediction.

Key words: Air Quality, Air Quality prediction, Artificial Neural Networks (ANN), Fuzzy logic, Hybrid Model, Soft computing.

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1 INTRODUCTION

The rapid increase of urbanization and industrialization causes immense fluctuations in air quality [1[.This unmanaged rapid growth of urbanization, industrialization and anthropogenic activities have led to the change of chemical composition of the atmosphere [2]. All the biotic and abiotic components of the environment are directly or indirectly correlated to the Quality of air. Since there is a varied fluctuations in the composition of constituents of the environment as a result of which air quality is degrading at a rapid rate. Air Pollution has many major consequences such as, detrimental effect on human health and other animals, a great harm to the vegetation and also to the monuments and an immense effect on climate changes.Thus, it is a matter of great concern since air pollution is leading to such harmful effects. Setting up of monitoring station, application of air pollution control technology, implementation of various environmental management plans etc. are some important steps taken by governments to minimize effect of air pollution. A lot of research has been carried out to solve this problem, but these steps are not adequate for today's extreme climatic situation. Hence, this paper proposes a novel hybrid soft computing technique for air quality prediction. This paper is organized as follows section 2 presents literature review, followed by section 3 presents the proposed model for air quality prediction and the implementation of the model, last is section 4 containing the conclusion.

2 LITERATURE REVIEW

• *Niharika Singh is currently pursuing her master's degree program in computer science and engineering in University of Petroleum and Energy Studies, India,. E-mail: niharika1519@gmail.com*

• *Venkatadri. M and Dr. Hanumat G Sastry are faculty at University of Petroleum and Energy Studies, India.*

Air quality prediction plays an important role in environmental management plan [3].Analysis and forecasting

of air quality parameters are important topics of atmospheric and environmental research. There are various models and techniques exist for air quality prediction [4], existing models can be classified as below
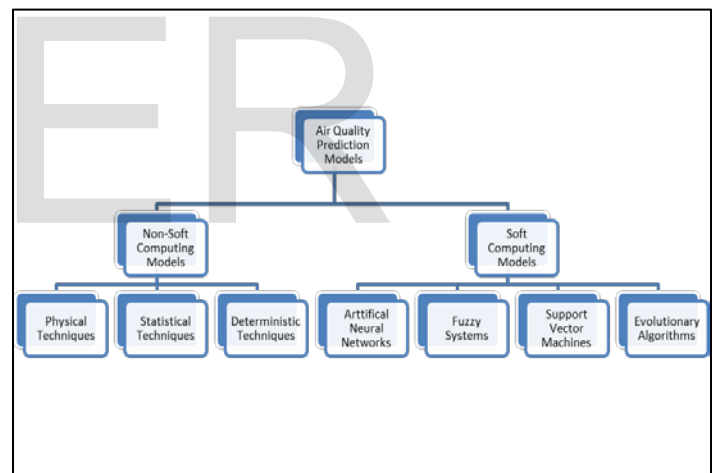

Figure 1: Various Air Quality Prediction Models

2.1 Limitations in Non Soft Computing Air Quality Prediction Models

The existing non soft computing models have the following limitations or disadvantagesin air quality prediction [4][5][6][7]:

➤ Large amount of historical datasets are needed in training phase.
➤ Lack of physical interpretation.
➤ Under performance with non-linear systems.
➤ Lot of costly computation techniques are needed like autocorrelation function (ACF) and partial auto correlation function (PACF) etc.
➤ Statistical models are site specific.
➤ Semi-empirical statistical relations among available data and measurements.
➤ Complex to deal with the non-linear relationships

of multiple variables.

Soft Computing techniques have contemplated to create air quality prediction models to overcome the issues in Statistical and Physical models. The following table presents the various air quality prediction models based on soft computing techniques.

Table 1: Air Quality Forecasting models using different soft computing techniques

S.No.	Air Quality Forecasting models using Soft-computing Techniques	References
1.	Artificial Neural Network (ANN)	[8][9][10][11]
2.	Support Vector Machines (SVM)	[12]
3.	Fuzzy Logic	[13]
4.	Evolutionary Algorithm	[14][15][11]
5.	Particle-Swarm Optimization	[16]

2.2 Limitations in Existing Soft Computing Air Quality Prediction Models

Though the soft computing techniques are robust, there are certain issues/drawbacks in existing models of air quality prediction [17] [18].

- The air quality prediction through ANN model becomes complex as the number of air pollutants increases for prediction.
- In ANN there are no general rules to determine the size of network and learning parameters, which will greatly affect the prediction performance.
- ANN models still need to improve in order to achieve good prediction performance as effectively and efficiently as expected.
- Multilayer neural network performs well when used for interpolation, but poorly, if used for extrapolation.
- No thumb rules exist in selection of data set for training, testing and validation of neural network based model.
- In Fuzzy Logic, the problem of finding membership functions and appropriate rules very frequently a tiring process of attempt and error.
- SVM is capable of good generalization model for air quality prediction, but the performance of SVM model is often hinged on the appropriate choice of the Kernel.

After careful analysis of existing Soft Computing techniques, we found the fusion of soft computing techniques can be used to design an efficient air quality prediction model. The following section presents our Hybrid Model for Air Quality Prediction.

3 HYBRIDMODEL FOR AIR QUALITY PREDICTION

The fusion of soft computing techniques generates the Hybrid Soft Computing model and thesetypes of modelshare robust in modeling of real world systems [5].

In this paper we are proposing a hybrid model which is a fusion of Artificial Neural Networks (ANN) and Fuzzy Logic. The reason behind selecting of these two techniques is their robustness in complex data systems modeling.Artificial Neural Networks (ANN) has inbuilt advantage in modeling the complex systems without prior knowledge. Fuzzy logic is wonderful tool in modeling of decision making systems where the multi class data exist.

Our proposed model consists of 4 layers, the first layer represents the input variables, the middle layer consists of the ANN model comprising of the hidden layers and the output layer. The weights and bias are updated in the hidden layer; the output of the ANN layer will be given as input to the next layer, this layer generates the if-then rules using Fuzzy logic. The range of output parameter will be generated as either Low or High as final output. The following diagram depicts the entire process.
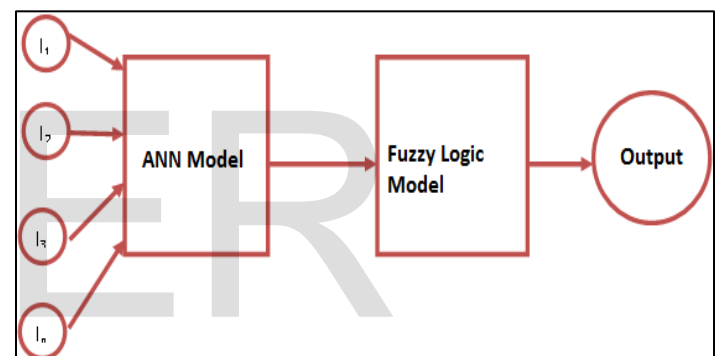
Figure 2: Hybrid Model for Air Quality Prediction

We have implemented the proposed model using MATLAB to predict the air pollutant RSPM (Respiratory Suspended Particular Matter), for this we considered temperature, relative humidity, average wind speed and mean visibility as input parameters. We will present results in next paper.

4 CONCLUSION

The fusion of Artificial Neural Networks (ANN) and Fuzzy Logic in modelling of Air Quality Prediction system has been presented. We have implemented this system for predicting the RSPM. The initial test results of this system are encouraging and we will present the results with cross comparison to demonstrate the superiority of the proposed hybrid model in next paper.

Studies, India, for the support extended to them for research in thrust areas of Computer Science.

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