OPTIMIZATION OF THE PERFORMANCE OF THE WIND POWER GENERATION UNIT BY USING DIFFERENT NEURAL NETWORKS

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OPTIMIZATION OF THE PERFORMANCE OF THE WIND POWER GENERATION UNIT BY USING DIFFERENT NEURAL NETWORKS

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Abstract: The wind power generation is a pollution free technique for electricity production, and also it does not requires additional driving source like coal hence after installing once the generation cost can be minimize but the power generation by this method requires a continuous wind flow in all weather. Unfortunately the wind velocity is weather dependent and changes widely with time to time. This create difficulties in the system scheduling, dispatching & power distribution hence it requires a predictive system which can estimate the wind velocity in advance & so will help in power management. In this paper we analyzed RBF (radial basis function), FFBP (feed forward back propagation) & CFBP (cascade forward back propagation) neural networks for this purpose. At last the simulation results and discussion are presented.

Keywords: Wind Power Generation, Neural Networks, Wind Forecasting.

1. INTRODUCTION

A wind velocity forecast corresponds to an estimate of the expected velocity of wind for some specific duration. Since the wind velocity depends upon many parameters from long term effecting parameters like weather changing (earth position respective to sun & earth tilt on its axis) to temporary effecting parameters like temperature, atmospheric pressure, humidity, fog & dust etc.

The large number of effecting parameters makes the prediction of wind is very difficult there is also problem with collection of all effecting parameters at once so there is always a possibility of missing some important parameters but it can be minimized because some parameters having the deep interconnections.

But even after this we need a rouged regression model which is not only be capable of following the lower slope but also the discontinuities.

The rest of the paper is arranged as follows, the second section presents some recent works used during study then third section explains the different neural networks used for analysis, the fourth section presents the proposed work followed by simulation results and conclusion in section five & six respectively.

2. RELATED WORK

Because of the development and increasing requirements of wind power generation systems many researchers attracted to this field which results a number of research papers & articles some of them which we have used during our work are presented here. Munir Ahmad Nayak and M. C. Deo [1] presented some analysis on wind speed prediction by using ARMA (Auto Regressive Moving Average Model), ARIMA (Auto Regressive Integrated Moving Average Model) & FFBP neural network and they found that the FFBP outperforms other models,

in their analysis the total sample was divided into a training set (first 70 percent) and a testing set (remaining 30 percent) of the data based on analysis of three hourly wind data collected through a wave rider buoy deployed off Goa in deep water and far away from the shore. The data were collected for 4 years from February 1998 to February 2002. Makarand A Kulkarni et. a.l [2] presented statistical regression and neural network for same purpose and they found that wind speed can be success fully predicted using only previous knowledge of the wind speed (not other parameters like temperature, pressure etc.) by regression techniques and neural network. The prediction of wind speed improves if wind speed is assumed to be a function of previous wind speed and local time. Boot strapping method is not useful for prediction of wind speed with neural networks. Another analysis is presented by Gnana Sheela K. [3] who used neural network, ARMA, Time-series prediction model, Statistical (ARX) model, Numeric weather prediction (NWP), Hybrid model which uses, Combination of physical and statistical approaches, combination of models for the short term and for the medium term or combination of alternative statistical models and Support vector machines finally they concluded that the neural network outperforms to other algorithm.

3. ARTIFICIAL NEURAL NETWORK (ANN)

An Artificial Neural Network, often just called a neural network, is a mathematical model inspired by biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases a neural network is an

adaptive system that changes its structure during a learning phase. Neural networks are used to model complex relationships between inputs and outputs or to find patterns in data [4].

3.1 Feed Forward Back Propagation

Feed-Forward Neural Network (FFNN) consists of at least three layers of neurons: an input layer, at least one intermediate hidden layer, and an output layer. Typically, neurons are connected in a feed-forward fashion with input units fully connected to neurons in the hidden layer and hidden neurons fully connected to neurons in the output layer. Back propagation is the traditional training method for FFNN during which the neurons adapt their weights to acquire new knowledge [5].
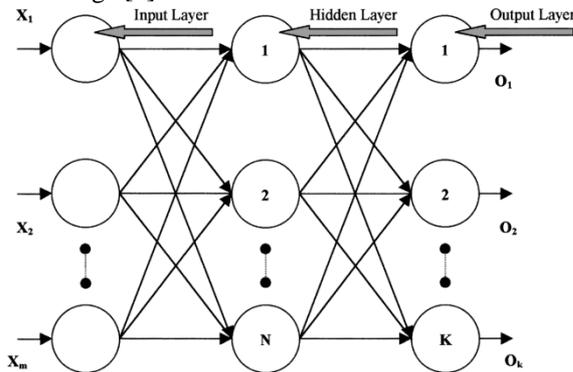

Figure 1: Feed Forward Back Propagation Neural Network.

3.2 RBF Neural Network

A Radial Basis Function (RBF) neural network has an input layer, a hidden layer and an output layer. The neurons in the hidden layer contain Gaussian transfer functions whose outputs are inversely proportional to the distance from the center of the neuron.

RBF networks are similar to K-Means clustering and PNN/GRNN networks. The main difference is that PNN/GRNN networks have one neuron for each point in the training file, whereas RBF networks have a variable number of neurons that is usually much less than the number of training points. For problems with small to medium size training sets, PNN/GRNN networks are usually more accurate than RBF networks, but PNN/GRNN networks are impractical for large training sets.
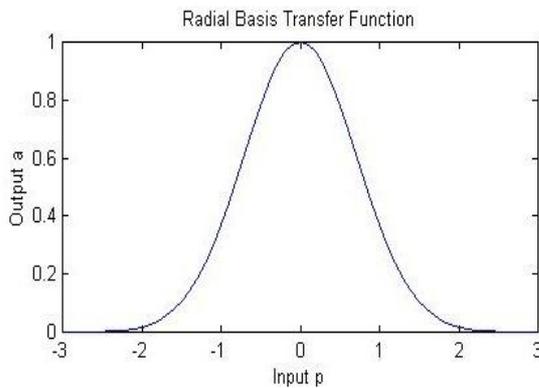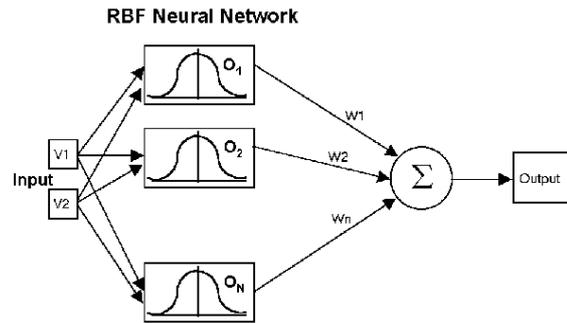

Figure 2: Radial Basis Function (RBF)

Figure 3: RBF Neural Network Architecture

3.3 Cascade Forward Back Propagation Network

CF models are similar to feed-forward networks, but include a weight connection from the input to each layer and from each layer to the successive layers. While two-layer feed forward networks can potentially learn virtually any input output relationship, feed-forward networks with more layers might learn complex relationships more quickly. The three-layer network also has connections from the input to all three layers. The additional connections might improve the speed at which the network learns the desired relationship [8]. CF artificial intelligence model is similar to feed forward back propagation neural network in using the back propagation algorithm for weights updating, but the main symptom of this network is that each layer of neurons related to all previous layer of neurons [9]. Tan-sigmoid transfer function, log - sigmoid transfer function and pure linear threshold functions were used to reach the optimized status [7] [8].

4. PROPOSED WORK

In this paper we used the 12 months wind data at 10 meter height with average wind speed and the wind speed is assumed as a function of previous values. Then the all three networks are trained, tested & validate by dividing the data at the ratios of 0.8/0.1/0.1.

The simulation is performed using Matlab and the results are shown below

4.1 Results for RBF
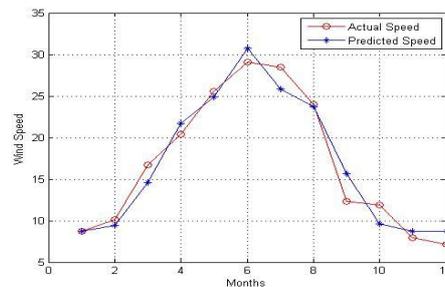
Network Parameters: Spreading = 1, Neurons = 3.

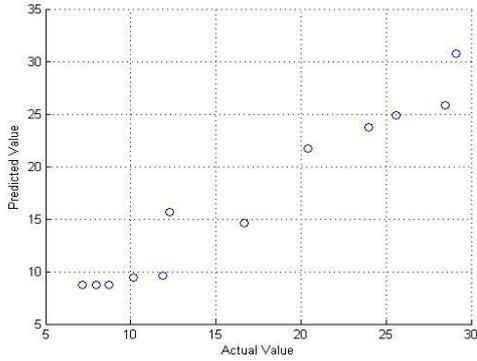**Figure 4: Comparison of Actual & Predicted Value for different months.**

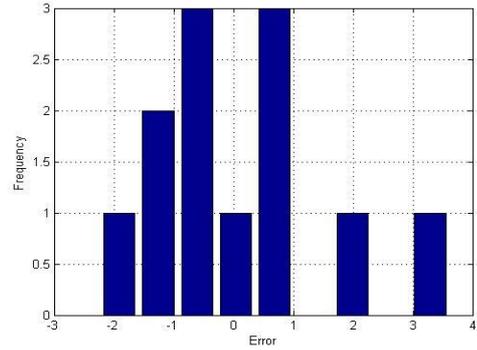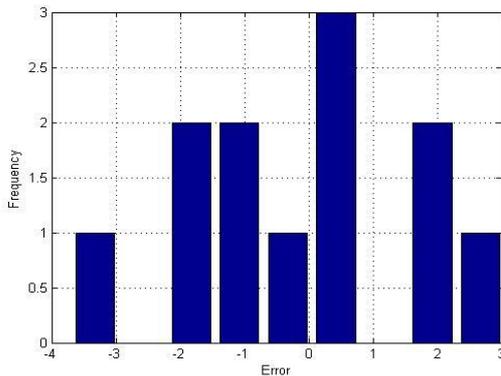**Figure 5: Scatter plot for Actual vs. Predicted Values.**

Figure 6: Histogram of errors in prediction.

4.2 Results for FFBP

Network Parameters: Layers = 3, Neurons in Layers = 3, 2, 2, Epochs = 100

Figure 7: Comparison of Actual & Predicted Value for different months.

Figure 8: Scatter plot for Actual vs. Predicted Values.

Figure 9: Histogram of errors in prediction.

4.3 Results for CFBP
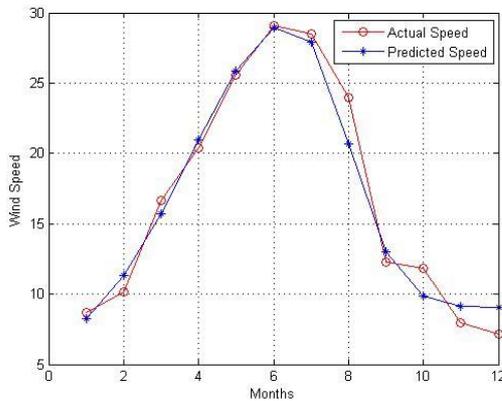**Network Parameters: Layers = 3, Neurons in Layers = 3, 2, 2, Epochs = 100**
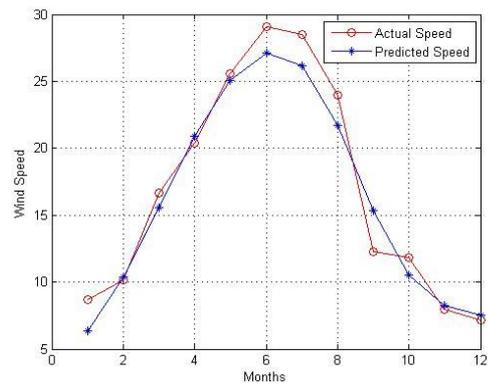

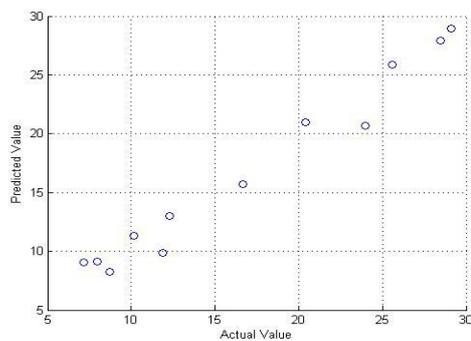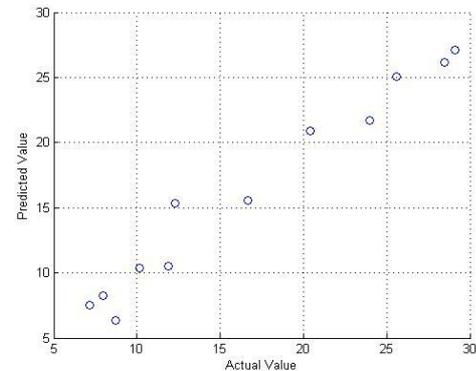**Figure 10: Comparison of Actual & Predicted Value for different months.**

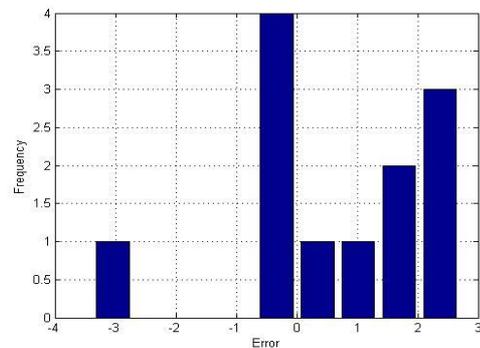**Figure 11: Scatter plot for Actual vs. Predicted Values.**

Figure 9: Histogram of errors in prediction.

5. CONCLUSION

It has been found that wind speed can be successfully predicted using only previous knowledge of the wind speed by regression techniques and neural network. The prediction of wind speed improves if wind speed is assumed to be a function of previous wind speed and local time. Boot strapping method is not useful for prediction of wind speed with neural networks as neural network is based on pattern recognition. It is well known that the wind speed is a function of several parameters like pressure gradient, air temperature, logography, etc. But the only data available for this study were the wind speed and direction. Therefore, no dynamical methods could be developed for the prediction of wind speed for the station.

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