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LONG TERM LOAD FORECASTING BASED ON INTELLIGENT TECHNIQUE

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***Abstract*— Long term load forecasting has a vital role in generation, transmission and distribution network Planning. One of the primary tasks of load forecasting is to accurate predicting the load demand requirements at all times. The purpose of this paper is to develop the advanced model for load forecasting by two approaches based on Regression method and Artificial Neural Network (ANN). Long term forecasting is affected by several economic factors such as GDP, no. of households, temperature, consumer price index, electricity price, population, GNP, index of industrial production (IIP) etc. Economic factor are more influential than weather conditions. Weather conditions are omitted in our study, to prevent noise. 6 economic factors are considered as input of forecasting model in regression analysis and neural network. The result obtained from these methods is compared. It is found that performance of ANN is better than regression method.**

Keywords— **long term load forecasting, Neural Network, Regression method, Economic factors**

I. INTRODUCTION

The accuracy of long term load forecast has significant effect on developing future generation and distribution planning. It plays a dominant part in the economic optimization and secure operation of electric power system. The time horizon for long term load forecasting range between a few weeks and several years. The time horizon may be up to 5, 10 and 15 years for planning and construction of new generating capacity and purchasing of generating units [1].

It is difficult to forecast load demand accurately over a planning period of this length because there are large no of factors affecting load characterized by direct or indirect effect on the underlying forecasting process [2]. In general load forecasting problems can be broadly divided in three main categories (i) Short term forecast (few minute, hours or days to few weeks ahead) (ii) Mid-term forecast (a few months to years ahead) (iii) long-term forecasts (up to twenty years ahead). All model applied to forecast short, medium and long-term load are greatly influenced by the characteristics of the past load observation. So a fair comparison of an old one and new one method would have to be based on response error when applied to the same year as data selected [3]. In order to predict long term load forecasting two Artificial Neural Network (ANN), a Recurrent Neural Network (RNN) and three layers feed forward Back Propagation (BP) applied and prediction were done for twenty one years (1975 to 1995) in Japan [4]. The first step to make a proper load forecast is to identify factors that would affect load pattern and relation among corresponding factors [5]. There are some economic factors like population, no of households, GDP, Consumer price index (CPI), Electricity consumption, IIP, Temperature and Electricity price are selected as input of forecasting model [6]. Many approaches are applied to predict the load forecast [7]. It has been a challenging problem due to its spatial diversity and sensitivity to land usage and customer habit [8]. One major AI technique used for LTLF is based on ANN. Hence ANN is flexible and accurate method for non-linear system. To get better performance new forecasting method by combining of ANN and grey prediction is applied and to be more superior to any method alone [9]. We apply the regression and ANN method as two possible. Regression is a classical method and applied only for linear data. It is not accurate in forecast. Thus for getting more accurate result ANN method is applied [10]. It gives better accuracy and also can handle nonlinear system. ANN can yield satisfactory result with limited information.

II. LOAD FORECASTING

Prediction of future events and conditions is called forecasts, and the act of making such predictions is called forecasting. Load forecasting means estimating active load at various load buses ahead of actual load occurrence. Load forecasting helps an electric utility to make important decisions including decisions on purchasing and generating electric power, load switching, and infrastructure development. As we see, a large variety of mathematical methods and ideas have been used for load forecasting. The development and improvements of appropriate mathematical tools will lead to the development of more accurate load forecasting techniques.

2.1 Regression Methods

Linear regression is a technique which examines the dependent variable to specified independent. The future value of the dependent variable can be estimated. Essentially, regression analysis attempts to measure the degree of correlation between the dependent and independent variables. Regression is the one of most widely used statistical techniques. For electric load forecasting, regression methods are usually used to model the relationship of load consumption

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and other factors such as weather, day type, and customer class. Regression is used for forecasting by establishing a mathematical relationship between two or more variables. The simplest form of regression is linear regression.

Linear Regression is a mathematical technique that relates one variable, called an independent variable, to another, the dependent variable, in the form of an equation for a straight line. A linear equation has the following general form:

$$y = a + bx$$

where

y = the dependent variable
a = the intercept
b = the slope of the line
x = the independent variable

Because we want to use linear regression as a forecasting model for demand, the dependent variable, *y*, represents demand, and *x* is an independent variable that causes demand to behave in a linear manner.

2.2 Artificial Neural Network

Artificial Neural Network (ANN) is a machine learning approach inspired by the way in which the brain performs a particular learning task. ANN is modeled on human brain and consists of a number of artificial neurons. Each neuron in ANN receives a number of inputs. A function called activation function is applied to these inputs which result in activation level of neuron. The ANN is designed by using the Multilayer Percptron (MLP) and Back Propagation (BP) learning technique. The three layers connect to feed forward back propagation, there includes one input layer, one hidden layer and one output layer. Designing an ANN model for loading has always been a challenge because the problems mainly consist of selecting the input variable, model structure and training data. The data used in ANN learning algorithm are separated in two parts: the first part is to perform the training called training data set; and other part is to measure the network performance called the testing set. The multiple layer feed forward, trained in a supervised and back propagation, are used as the training method.

The procedures setting up the input for ANN are:

1. Select input and define output variable
2. Determine the no. of layers and the neurons in hidden layers
3. Train the network from historical data. At this step, the network learned by adjusting the weight to input in order to minimize the less error based.
4. After the training is complete, the network is tested by using the testing data which contains historical data that the network has never learned.

Multi-Layer Perceptron

Multi-Layer Perceptron network is a class of neural networks which consists of a set of sensory units that constitute the input layer and one or more hidden layer of computation nodes and output layer of computation nodes. In general MLPs are trained with the back propagation algorithm to develop successful classification and regression system.

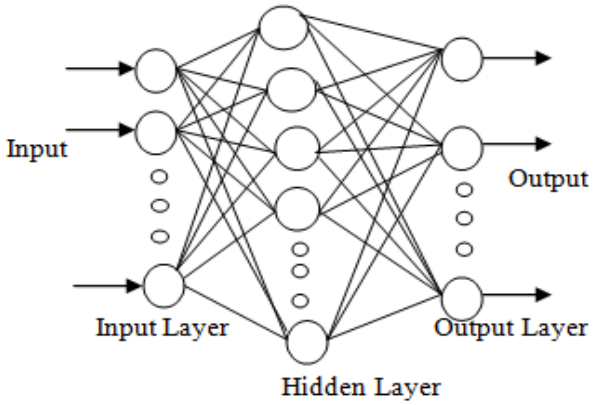

Fig.2: Multilayer feed forward network

A Back Propagation network consists of at least three layers of units:

1. An input layer,
2. At least one intermediate hidden layer, and
3. An output layer.

Typically, units are connected in a feed-forward fashion with input units fully connected to units in the hidden layer and hidden units fully connected to units in the output layer. When a back-propagation network is cycled, an input pattern is propagated forward the output units through the intervening input-to-hidden and hidden-to-output weights. The output of back-propagation is interpreted as a classification decision. With Back-propagation network, learning occurs during a training phase.

III. METHODOLOGY

The data can be preprocessed to improve the quality of data and thereby improve the prediction result. To solve the forecasting problem various and nonlinear model were analyzed and applied to a real case with information from Haryana state. A flow chart is drawn in fig.3.1

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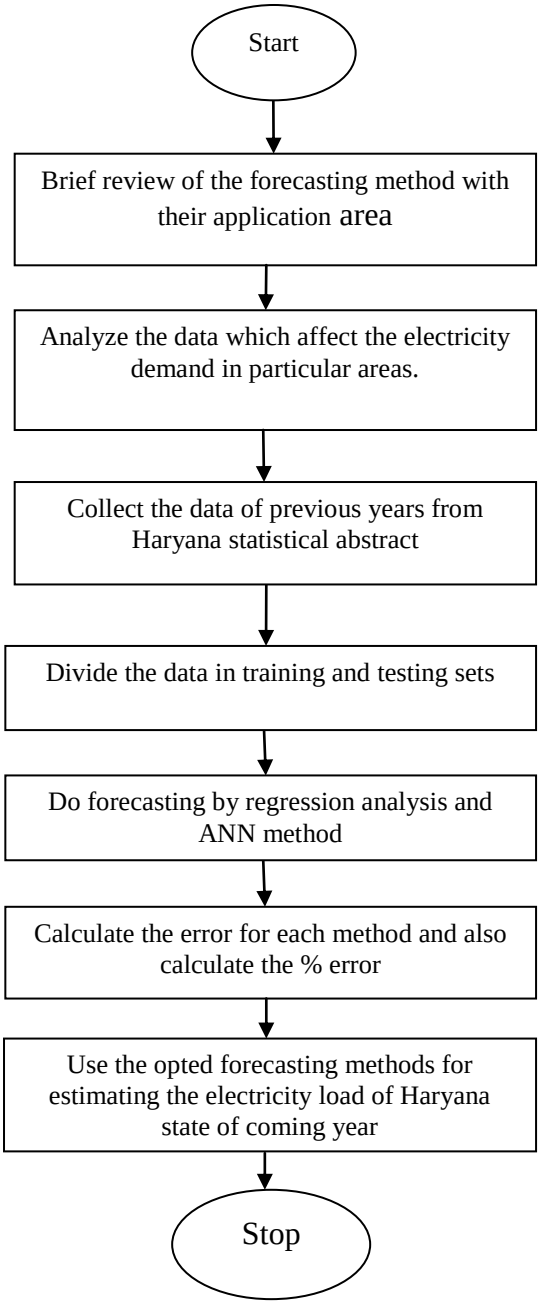

Fig 3. A general flow chart representing the steps involving in developed model

This represents the steps involved in the forecasting model. Firstly various methods are studied with their application area. Many factors which affect to the load forecasting are taken as an input to do forecasting. These data are collected from statistical abstract from Haryana. Whole data are divided in training and testing sets. Training set is used to build the model and testing set is used to evaluate the model and create the forecasting model using Regression and ANN method. Both method does not give the accurate result thus errors are obtained from these two method are calculated. By comparing the result of methods it is concludes that ANN is better than regression method.

IV. CASE ANALYSIS

Electric load is predicted using both regression and neural network. The error in both the models is presented below

Table 1: comparison of Regression and ANN

Model	MSE	MAPE (%)	MAX APE (%)
Regression	5.58	4.36	11.36
Neural Network	3.56	1.72	8.31

From this table it can be observed that NN gives a better performance than Regression analysis.

Fig 4.1 and fig 4.2 show the performance of both models

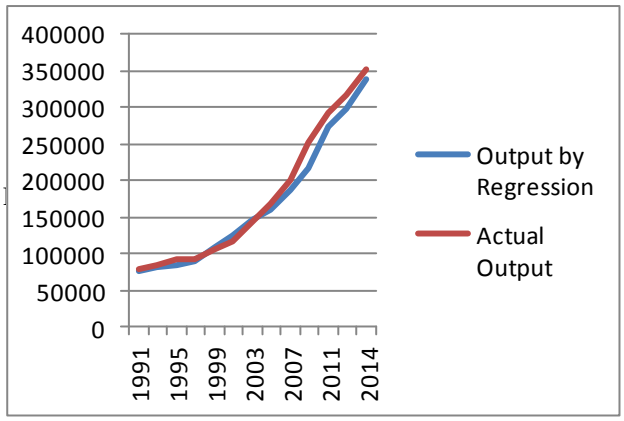

Fig 4.1: Actual output and output by Regression analysis

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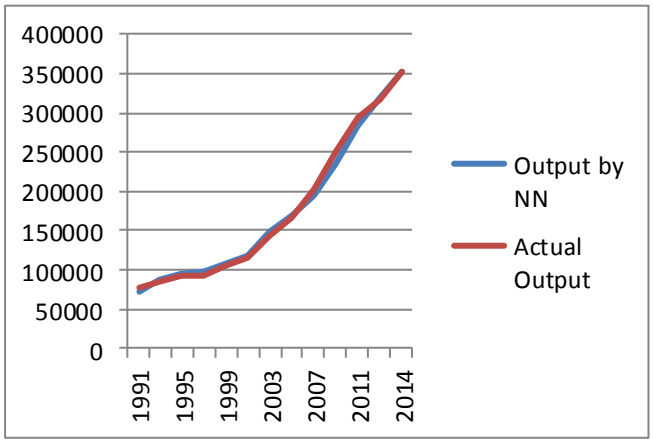

Fig 4.2 Actual output and output by NN model

V. CONCLUSION

In order to provide a high quality and reliable service to the customers, it is essential for electric power distribution companies to carry out projections regarding anticipated Electric Peak load demand in the future. In this paper two models were proposed for LTLF. The first one is based on Regression and In order to provide a high quality and reliable service to the customers, it is essential for electric power second one is based on ANN method. The regression wasn't successful in accurate forecast. Results showed that ANN had a better performance in LTLF because of its flexibility in handling nonlinear system, and ability to learn from historical data and generalize the solution based on input data. This result indicated that the proposed model has more efficiency to forecast future load for next several years.

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