TNB LOAD READING PREDICTION

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A STUDY ON
TNB LOAD READING PREDICTION

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"I hereby declared that I have read through this report entitle " A Study On TNB Load Reading Prediction" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic and Drives)"

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Date : 25/6/2012

Dedicated to my beloved Parents, my siblings

Lectures and all my friends

For their love and sacrifice.

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ABSTRACT

Nowadays there is a growing tendency towards improving the electricity system. Load forecasting is a process of predicting the future load demands. The growth of development in the country increases the demand on planning management and operations of the power system supply. As electricity is a product that cannot be stored, it demands must be forecasted in order to ensure enough supply being distributed to consumers while not generating load far exceeded that required. This project paper demonstrates the development of forecasting modeling by the application of Matlab software. It covers the load demand by the users in Penang. Hence, the load data from TNB has been used as input to forecast load and the temperature data from Malaysia Meteorology Department also had been used as forecasting factors. The forecasted load had been compared with actual load data to get the minimum forecasting error and better accuracy. The neural network modeling is able to make a prediction of what load would be in the next day. The modeling showed that neural network was used widely and accurately in load forecasting.

ABSTRAK

Sejak kebelakangan ini berlaku peningkatan ke arah penambahbaikan sistem elektrik. Ramalan beban adalah satu proses meramal permintaan tenaga elektrik di masa hadapan. Pertumbuhan pembangunan di negara ini meningkatkan lagi keperluan kepada pengurusan perancangan serta operasi sistem bekalan kuasa. Tenaga elektrik adalah produk yang tidak boleh disimpan, ia harus dianggarkan dalam usaha untuk memastikan bekalan yang mencukupi untuk dibekalkan kepada pengguna di samping tidak menjana tenaga elektrik yang jauh melebihi keperluan. Projek ini menghasilkan pembangunan model ramalan meggunakan aplikasi perisian Matlab. Ia meliputi permintaan tenaga elektrik oleh pengguna di Pulau Pinang. Oleh itu, data tenaga elektrik daripada TNB telah digunakan sebagai input untuk meramalkan tenaga dan data suhu daripada Jabatan Meteorologi Malaysia juga telah digunakan sebagai faktor ramalan. Beban ramalan telah dibandingkan dengan data beban sebenar untuk mendapatkan ralat ramalan minimum dan ketepatan yang lebih baik. Permodelan ini mampu untuk membuat ramalan beban yang akan digunakan di hari berikutnya. Permodelan menunjukkan bahawa rangkaian ini telah digunakan secara meluas dan tepat dalam ramalan beban.

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CHAPTER 1

INTRODUCTION

1.0 Background

Tenaga Nasional Berhad (TNB) is the largest of electricity utility company in Malaysia. Their core activities are in the generation, transmission and distribution of electricity. These activities ranging from system planning, evaluating, implementing and maintaining the systems. One of the requirements of the system planning is load forecasting. Load forecasting is a prediction of power demand. It is important for electricity planning and to ensuring that there would be enough supply of electricity, where and when that power must delivered. The accurate forecasting of energy requirement is one of the most important factors of energy management for the future development of the country like Malaysia. It can give a better planning such as budget planning, maintenance scheduling, the reliability evaluation of the power system and many more. Many factors are related to load forecasting such as weather changes, temperature, season, population, number of electricity consumers and others. Load forecast also can divides in three catogeries that is Long Term Load Forecast (LTLF), Medium Term Load Forecast (MTLF) and Short Term Load Forecast (STLF).

1.1 Problem Statements

Load forecasting is an important component in the operation and planning of electrical power generation conducted by Utilities Company. Many factors can influence the electricity usage. One of the factors is temperature changes and it made difficultly for TNB to predict power demand. It can affected the budget planning, maintenance and also electricity blackout. In order to overcome this problem a predicting model can be used based on history and forecast data. These data were analyzed to give better accuracy for future load demand. The electric utility company should have an appropriate model for load forecasting to ensure balance need among the utility and environment factors as well as minimizing the operating cost. For this project, an algorithm modeling will be developed to predict power demand based on temperature condition. A neural networks methods have been used to developed load forecasting modeling by using Matlab software. Hopefully this project will give some benefits to the utility of Malaysia in order to improve load forecasting in Malaysia.

1.2 Objectives

1.2.1 To develop an algorithm model to predict power demand based on temperature condition in Malaysia.

1.2.2 To investigate performance and accuracy of power demand prediction based on temperature condition.

1.3 Scopes of The Project

The project will focusing on developing an algorithm by using MATLAB software. It will be used to simulate and analyze forecasting load data. The result between forecasted load and actual load data will be compared to find forecasting error. The variables considered in this project are based on power demand and temperature changes data.The focusing area for this project is in Penang, so that the load demand data from TNB has been taken this area by a year which is from January to December 2011. The temperature data for this area also has been taken from Malaysia Meteorology Department.

CHAPTER 2

LITERATURE REVIEW

Load forecasting is very important to use in the system and market operators, transmission owners and any other market participants. It also can help an electric utility company such as Tenaga Nasional Berhad (TNB) to make decisions including on purchasing and generating electric power, load switching and infrastructure growth. Forecasting also can be divide into three categories that each category has a different time ranges. This is an important task to utility company for achieving the goal of optimal planning and operation of power system. The categories are Long Term Load Forecasting (LTLF), Medium Term Load Forecasting (MTLF) and Short Term Load Forecasting (STLF). Each category has a forecast method to development more accurate load forecasting.

2.1 Long Term Load Forecasting (LTLF)

The estimation may lead utility company to plan the generation and distribution schedule. It had been done for various lead times ranging from few seconds to more than a year. Long term load forecasting is an important issue in effective and efficient planning. Overestimation of power demand may lead to spending more money in building new power stations to supply this load. However, underestimation of load can cause troubles in supplying load from the available electric supplies, and produce a shortage in spinning reserve of the system that may lead to an insecure and defective system [2]. Long term load forecasting is the forecasting of future loads for a relatively large lead time (years ahead). It includes the forecasts on the population changes, economic development, industrial construction and technology development [1]. In fact, there have a few published paper can be found on the long term situation. The reason of this case because the long term forecasting requires years of economic and demographic data which may not be easy to gather or access. Even when data is accessible, it was complexes in the sense that it is affected by environmental, economical, political and social factors [2].

2.2 Medium Term Load Forecasting (MTLF)

Medium term load forecasting (MTLF) is also important to power system planning and operations system. It was important for utilities for maintenance scheduling, power demand management, purchasing planning and etc. The accurate MTLF can provide an advantage in negotiations and assist in the development of bilateral contracts [3]. The time range for MTLF to predict future load is from a few days to a year into the future. In these periods, an accurate forecast of a power demand factors such as a temperature is also important. Ignoring the ambient temperature forecasts and correlation among hourly loads may cause result in inaccurate prediction. Thus, more accurate MTLF methods are required. The end-use modeling, econometric modeling, and their combinations are the most often used methods for medium term load forecasting [1].

2.3 Short Term Load Forecasting (STLF)

Such as long and medium term load forecasting, this short term load forecasting is also important for real time operation and control power system. Short term forecasts are intended to be valid for only a few minutes to a few hours into the future and are needed by electric utility operators [4]. This is because the quality of the short term hourly load forecasting has a significant impact on the efficiency of operation. Many operational decisions such as economic scheduling of the generating capacity, scheduling of fuel purchase and system security assessment are based on such forecasts [5]. So, this kind of forecasting has been widely studied in the last decades because the represents of a great saving potential for economic and secure operation of power system. There are many methods for STLF which can be classified into four main categories; a) conventional methods including time series or regression models, b) fuzzy logic models, c) artificial neural network models, and d) expert system load forecasters. There are different approaches, architectures and algorithm within each category that may substantially impact performance [6]. To achieve high forecasting accuracy in STLF, load characteristics must be analyzed therefore the main factors affecting the load can be identified. Some factors of influencing the load that need to be considered in STLF are season, day type, weather and electric price [1].

2.4 Forecasting Methods

There are many methods can be used in forecasting such as time series method, fuzzy logic method, neural network method, regression method and others else. For this project, Neural Network method will be applied in order to give a faster and accurate result compared with other conventional method like Statistical, time series, perceptron. Matlab software is used to develop this neural network model.

2.4.1 Neural Network

Neural networks, or artificial neural networks (ANN) as they are often called, refer to a class of models inspired by biological nervous systems. The models are composed of many computing elements, usually denoted neurons, working in parallel. The elements are connected by synaptic weights, which are allowed to adapt through a learning process.

There are many types of neural network models, the common feature in them being the connection of the ideas to biological systems. The models can be categorized in many ways. One possibility is to classify them on the basis of the learning principle. A neural network uses either supervised or unsupervised learning. In supervised learning, the network is provided with example cases and desired responses. The network weights are then adapted in order to minimize the difference between network outputs and desired outputs. In unsupervised learning the network is given only input signals, and the network weights change through a predefined mechanism, which usually groups the data into clusters of similar data. The most common network type using supervised learning is a feed-forward (signal transfer) network. The network is given an input signal, which is transferred forward through the network. Eventually, an output signal is produced. The network can be understood as a mapping from the input space to the output space, and this mapping is defined by the free parameters of the model, which are the synaptic weights connecting the neurons [7,8].

2.4.2 Feed Forward Neural Network in Load Forecasting

Feed Forward Neural Network (FFNN) is the most popular neural network type and most of the reported neural network loads forecasting models are based on it. The idea behind the use of Feed Forward Neural Network models in load forecasting is simple: it is assumed that future load is dependent on past load and external factors like temperature, and the FFNN network is used to approximate this dependency. The inputs to the network consist of those temperature values and past load values, and the output is the target load values for example a load value of a certain hour, load values of many future hours, the peak load of a day, the total load of a day etc. Therefore, the building of a Feed Forward Neural Network model for load forecasting can be seen as a nonlinear system identification problem [9].

The determining of the model structure consists of selecting the input variables and deciding the network structure. The parameter estimation is carried out by training the network on load data of the history. This requires choices concerning the learning algorithm and appropriate training data. The model validation is carried out by testing on load data, which has not been used in training. However, the modeling with neural networks is different to modeling with linear system models. The nonlinearity and the great adaptability of the network models make it possible to use specific indicators as input variables. In the case of load forecasting, the hour of the day and day type of the target hour, for instance, can be included as binary codes in the network input [10].

The network model can be understood to be based on pattern recognition functions, where different input patterns are mapped in different ways. This makes the models very different to, for example, ARIMA models, which assume that the load time series can be made stationary such that invariant with respect to time with suitable filters. The handling of the special load conditions is easier for neural network models than for ARIMA models.

Another matter supporting neural network models is the relatively rapid changing of the characteristics in the load behavior. This is a problem with statistical models, because they cannot always keep up with the sudden changes in the dependencies of the load. For example, the beginnings of holiday seasons etc. can change the load behavior rapidly. As neural network models are in essence based on pattern recognition functions, they can in principle be hoped to recognize the changed conditions without re-estimating the parameters. This requires of course that conditions corresponding to the new situation have been used in training, and that network inputs contain the information necessary for recognizing the conditions. On the other hand, a problem with Feed Forward Neural Network models is the black-box like description of the dependencies of the future values on the past behavior. The understanding of the model is very difficult; the common sense can hardly be applied in order to see how the outputs depend on inputs. The responding of the model to an input pattern, which is very different to any experienced during the learning, can be unexpected. This can happen in new conditions, even if the model is validated with test data [11].

2.4.3 Component of Neural Network

2.4.3.1 Input and Output Factor

Selection of input is the most important part that has an impact on the desired output. Neurons in the input layer are not neurons in processing elements (PEs) sense; they act as simple fan out devices which passes the input to the various neurons in the next (hidden) layer without doing any processing. Therefore, the number of input layer neurons is fixed by the number of scalars in the input vector. As each neuron provides only a single output, the number of neurons required in the output layer will be equal to the number of scalars in the output vector. Improper selection of input will cause divergence, longer learning time and inaccuracy reading that is greater than 1.

2.4.3.2 Weighting factor

Relative weighting will be installing in each input and this weighting will affected the impact the input as shown in Figure 2.1. Weights determine the intensity of the input signal and are adaptive coefficients within the network. To various input, the initial weight for PE can be modified and according to the network's own rules for modification.

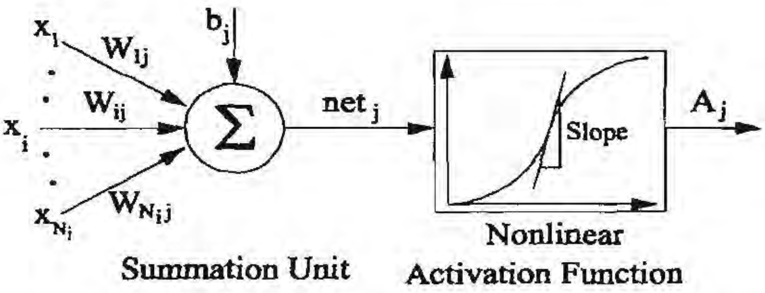

Figure 2.1: The model of neuron in hidden layer [6]

2.4.3.3 Neuron model

Fundamental processing element of a neural network is a neuron. The network usually consists of an input layer, some hidden layers and an output layer. The model of a neuron is shown in Figure 2.2

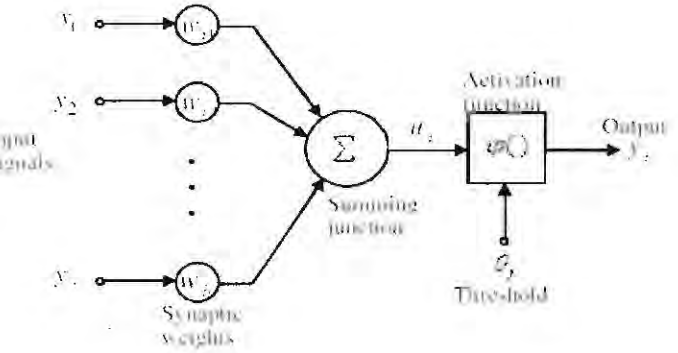

Figure 2.2 : non linear model of neuron [12]

2.4.3.4 Transfer function

There are a lot of transfer functions and basically the transfer function is a non-linear. A non-linear system is a system which is not linear, that is a system which does not satisfy the superposition principle, or whose output is notdirectly proportional to its input. The linear also known a straight line and the linear function is limited because the output is proportional to the input. Although, the output is depends upon whether the result of summation is negative or positive. The network output can be 1 and -1, or 1 and 0.

The hard limiter transfer function was used in perceptrons to create neurons that make classification decisions. For the linear transfer function, neurons of this type are used as linear approximates in linear filters. The sigmoid transfer function takes the input which can have any value between positive and negative infinity, and squashes the output into the range 0 to 1. Figure 2.3 show the type of transfer function.

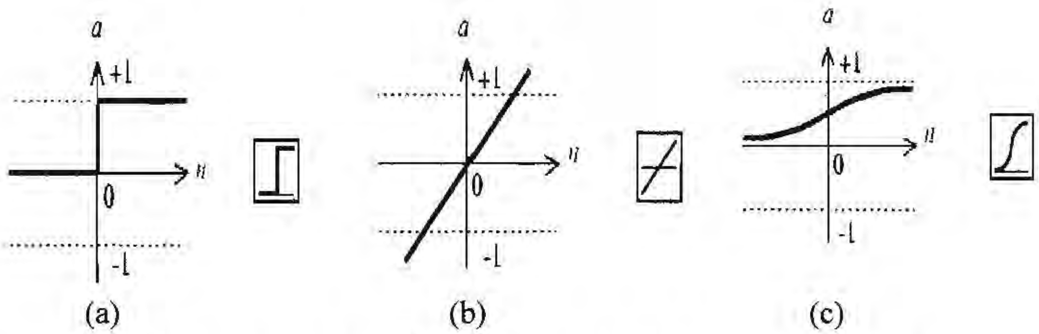

Figure 2.3: The types of transfer function. (a) Hard limiter (b) Linear function (c) Sigmoid function [12]

2.4.3.5 Single layer neural network

A single or one layer neural network do not have hidden layer and it is characterized by a layer of input neurons and a layer of output neurons interconnected to one another by weight to be determined in training process. This single layer neural network cannot give an accurate result in power system because these networks represent a linear system. Figure 2.4 show single layered neural network

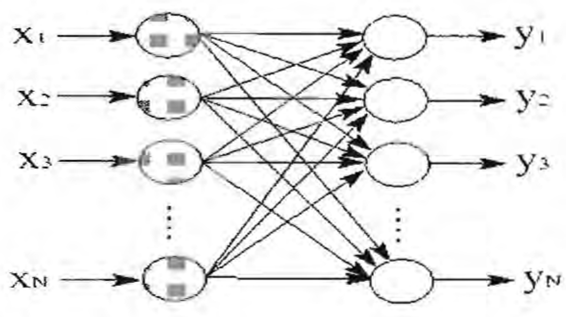

Figure 2.4: Single layered neural network [13]

2.4.3.6 Multi layered Neural Network

Multilayer neural network consist of an input layer, an output layer and hidden layer(s) between the input and output cell. This hidden layer interconnected with one another by weights to determine training process. Figure 2.5 show multilayered neural network.

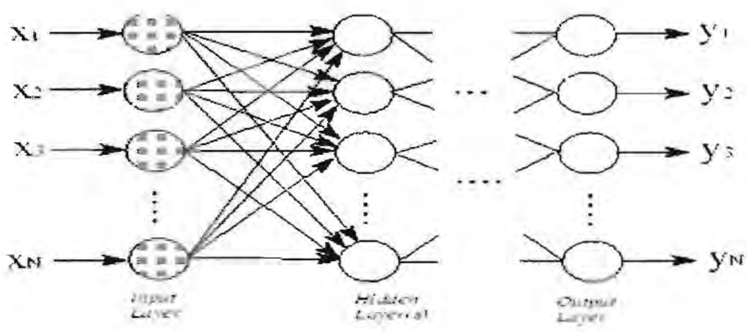

Figure 2.5: Multilayered neural network [13]

2.4.3.7 Hidden layer and node

In multi layer feed forward (MLFF) networks, one of the most important configuration issues is to select an optimal number of hidden layers. In MLFF networks one hidden layer is sufficient to compute arbitrary decision boundaries for the outputs and that two hidden layers are