SHORT TERM LOAD FORECASTING WITH PERCEPTRON ARTIFICIAL NEURAL NETWORK

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A report submitted in partial fulfillment of the requirement for the degree of Electrical Engineering (Mechatronics)

" I hereby declare that I have read through this report entitle " Short term load forecasting with Perceptron Neural Network" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Mechatronics)"

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2010

I declare that this project entitle "short term load forecasting with artificial neural network" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not currently submitted in candidature of any other degree

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ABSTRACT

Short term load forecasting is important in predicting and analysis power distribution for a short period of time in many places. This project paper present the use of perceptron artificial neural network model for short term load forecasting in power distribution systems. Thus, this proposed project involves with case study and Matlab software implementation to come out with a model that can forecast future load for a week ahead. The expecting load forecast is to get minimum forecasting error of at least 1.5 percent. Furthermore, the suitability of the proposed approach is illustrated through an application to real load shapes provided utility of Malaysia. The data represent half hourly load data for 6 weeks in Peninsular Malaysia.

ABSTRAK

Ramalan beban Jangkaan Masa pendek adalah penting dalam membuat ramalan dan analisa terhadap penggunaan tenaga elektrik dalam satu tempoh masa yang singkat. Projek ini akan membincangkan tentang penggunaan Perceptron rangkaian saraf tiruan dalam menghasilkan satu model ramalan beban terhadap sistem pengedaran tenaga elektrik. Tambahan juga, projek ini melibatkan satu kajian lapangan terhadap konsep dan penggunaan sistem rangkaian saraf dan pengaplikasian pengetahuan dalam menggunakan perisian Matlab untuk menghasilkan satu model ramalan beban yang mampu meramal penggunaan tenaga elektrik pada masa seminggu akan datang. Model yang dihasilkan perlu mendapat perbezaan peratusan ralat kesalahan yang kurang daripada 1.5%. Tambahan juga, kesesuaian pendekatan digambarkan dengan menggunakan maklumat selama 6 minggu yang dibekalkan oleh syarikat pengelola tenaga elektrik di Malaysia. Selain itu, maklumat yang dibekalkan adalah setiap setengah jam selama 24 jam.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter will cover on objective, problem statement, scope and outline of the whole project. Furthermore, in this chapter, the information on the project will be stated clearly to enhance the understanding to achieve the project goal.

1.1 Problem statement

Nowadays, with the power system growth and the increase in their complexity, many factors have become influential in electrical power generation and consumption. With supply and demand fluctuating and the change of weather conditions and energy prices increasing by a factor of ten or more during peak situation, load forecasting is vitally important for utilities. The time factors including the hour of the daily historical load data are important load data on different weekdays also can behave differently.

Thus, to support power system operation and meet power requirement continually in the future, short term load forecasting have become more helpfully in developing an innovation of power supply strategy and electrical management in peninsular Malaysia.

Method that already been used to forecast load using different types of software and algorithm doesn't show high accuracy and good load forecasting structure. Thus, many types of load forecasting method came out with unexpected error and high error reading from

simulation that causes the load forecasting module cannot be used as a reference module in power utilities in peninsular Malaysia which is the mean absolute error produce by other different types of load forecasting module is more than 1.5%.

Therefore, In order to give the expected mean error, many methods can be applied in short term load forecasting such as regression method, time series, expert system method and fuzzy logic. But neural network is better than other because neural network have the ability to learn and construct a complex non linear mapping through a set of input and output. This shows that neural network can perform non linear and arrangement of bundle of input to be forecasting models. Most of researches have discovered that multi layer perceptron contributes to larger changes and accuracy through out load forecasting methodology. Therefore, a fine method and algorithm should be performed to get the best load forecasting model since utilities company in all over the world demand minimum error required to complete with the global recommendation and specs.

1.2 Objectives

1.2.1 To investigate and study load forecasting systems that has been used in optimizing the best load forecasting module.

1.2.2 To implement MATLAB software to develop the multilayer perceptron neural network model.

1.2.3 To evaluate the results in neural network simulation in getting minimum error at least 1.5 percent.

1.3 Scope

This project will also focus on implementation of Matlab software to forecast half hourly load data for a week ahead in peninsular Malaysia by using neural network

simulation method and evaluate the result to get minimum error which is below 1.5%. Thus, this project will use artificial neural network with perceptron algorithm to develop load forecasting module.

1.4 Outline

Based on this project, chapter 1 will be discussed on problem statement, objective and scope of the project. Furthermore, for chapter 2, it will discussed on literature review on related load forecasting system used to develop load forecasting module. Then, for chapter 3, it will be discussed on methodology of load forecasting system that will be used in this project. Then, for chapter 4, it will discuss on evaluation of result and analysis of result produce after neural network simulation using Matlab software. Lastly, in chapter 5, it will discussed on recommendation and conclusion of entire project in order to repair and upgrade previous load forecasting module that have been developed.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will cover on the overview of the project. This project will focus on using multilayer perceptron artificial neural network which produce the best load forecasting method in load distribution. Furthermore, this chapter will define load forecasting, artificial neural network, and other related topics in order to strengthen the knowledge on short term load forecasting using journals, seminars papers and etc.

2.1 Load forecasting

Load forecasting is vitally important for the electrical industry in the deregulated economy. It has many application including energy purchasing and generation, load switching, contract evaluation, and infrastructure development. Accurate models for electric power load forecasting are essential to be operation and planning of a utility company. Load forecasting helps an electric utility to make important decisions including on load switching, infrastructure development and etc. [1] Load forecasting can be divided into three categories which are short

term load forecasting that forecasts load hourly or weekly one hour to one week, medium term load forecast load monthly, and long term load forecasting that forecasts which load yearly.

Short term load forecasting is an essential function in electric power system operations and planning. Thus, short term load forecasting is basically aimed at predicting system load with a leading time of one hour to seven days, which is necessary for adequate scheduling and operation of power system. To achieve high forecasting accuracy and speed, which are the most important criteria; it is need to analyze the load characteristic and identity the main factors affecting the load. In electrical markets, in addition to the traditional load affecting factors such as season, day type and weather, electricity price, which are voluntary and may have a complicated relationship with system loa, is also becoming an important factor influencing the load [2].

In short term load forecasting, several factors should be considered, such as time factors, weather data, and possible customer classes [3]. There are important differences in load between weekdays and weekends. The load on different weekdays also can behave differently. For example, Monday and Friday that being adjacent to weekends, may have a structurally different loads than Tuesday through Thursday. Holidays are most difficult to forecasts than non-holiday because of their relative infrequent occurrence. Weather conditions influence the load. In fact, forecasts weather parameters are the most important factors in short term load forecasts. Various weather variables could be considered for load forecasting.

2.2 Artificial neural network

An artificial neural network is a system based on the operation of biological neural network, in other words, is an emulation of biological neural system. Artificial neural networks (ANN) are among the newest signal processing technologies in the engineer's toolbox. In engineering, neural network serve two important functions: as pattern classifiers

and as nonlinear system that learns to perform a function (an input / output map) from data. Adaptive means that the system parameters are changed during operation, normally called the training phase. After training phase the artificial neural network parameters are fixed and the system is deployed to solve the problem at testing phase.

The artificial neural network is built with systematic step by step procedure to optimize a performance criterion or to follow some implicit internal constraint, which is commonly referred to as the learning rule. The input / output training data are fundamental in neural network technology, because they convey the necessary information to obtain the optimal point [4]. Among others method, artificial neural network methods are particularly attractive, as they have the ability to handle nonlinear relationship between load and without having to select a given method [4].

Based on figure 2.1, in neural network architecture, implication of biological neurons and conceptual components for circuit are important to perform computational tasks. When creating a functional model of the biological neurons, there are three basic components of importance. First, the synapses of the neurons are modeled as weights. The strength of the connection between an input and a neuron is noted by the value if the weight. Negative weight values reflect inhibitory connections, while positive values designate excitatory connections [5]. The next two components model the actual activity within the neurons cell. An adder sums up all the input modified by their respective weights. This activity is referred to as linear combination. Finally, an activation function controls the amplitude of the output of the neurons.

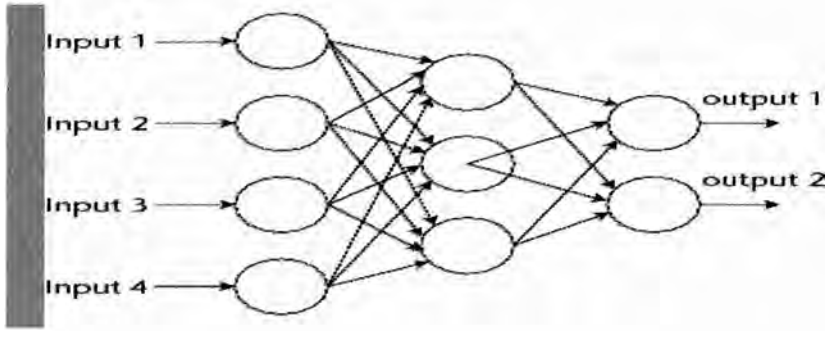

Figure 2.1: artificial neural network structure

2.3 Perceptron Neural network

The perceptron is a type of artificial neural network invented in 1957 at the Cornell Aeronautical Laboratory by Frank Rosenblatt. It ca be seen as the simplest kind of feed forward neural network: a linear classifier [5]. Rosenblatt created many variations of the perceptron. One of the simplest was a single layer network whose weights and biases could be trained to produce a correct target vector when presented with the corresponding input vector. The training technique used is called percptron learning rule. The perceptron generated great interest due its ability to generalize from its training vectors and learn initially randomly distributed connections.

Perceptron are especially suited for simple problems in pattern classification. They are fast and reliable network for the problem they can solve. In addition, an understanding of the operations of the perceptron provides a good basis for understanding more complex networks. The perceptron network consists of a single layer of S perceptron neurons connected to R input through a set of weights $w_{i,j}$ as shown in figure 2.1. as before, the network indices I and J indicate that $w_{i,j}$ is the strength of the connection from the jth input to the ith neurons.

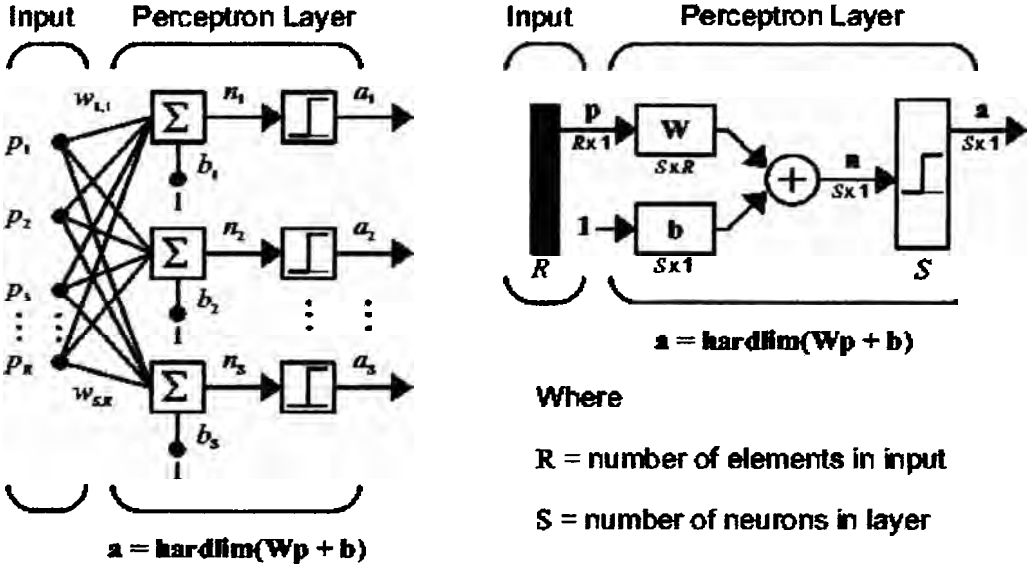

Figure 2.1: Perceptron single layer architecture

2.4 Multi-layer Perceptron (MLP)

MLP is a network of simple neurons called perceptrons. The basic concept of a single perceptron was introduced by Rosenblatt in 1958 [6]. A single perceptron is not very useful because of its limited mapping ability. No matter what activation function is used, the perceptron is only able to represent an oriented ridge-like function. The perceptrons can, however, be used as building blocks of a larger, much more practical structure MLP networks are typically used in supervised learning problems. This means that there is a training set of input-output pairs and the network must learn to model the dependency between them. The training here means adapting all the weights and biases.

The supervised learning problem of the MLP can be solved with the back-propagation algorithm. The algorithm consists of two steps. In the forward pass, the predicted outputs corresponding to the given inputs. In the backward pass, partial derivatives of the cost function with respect to the different parameters are propagated back through the network [6]. The chain rule of differentiation gives very similar computational rules for the backward pass as the ones in the forward pass. The network weights can then be adapted using any gradient-based optimization algorithm. The whole process is iterated until the weights have converged.

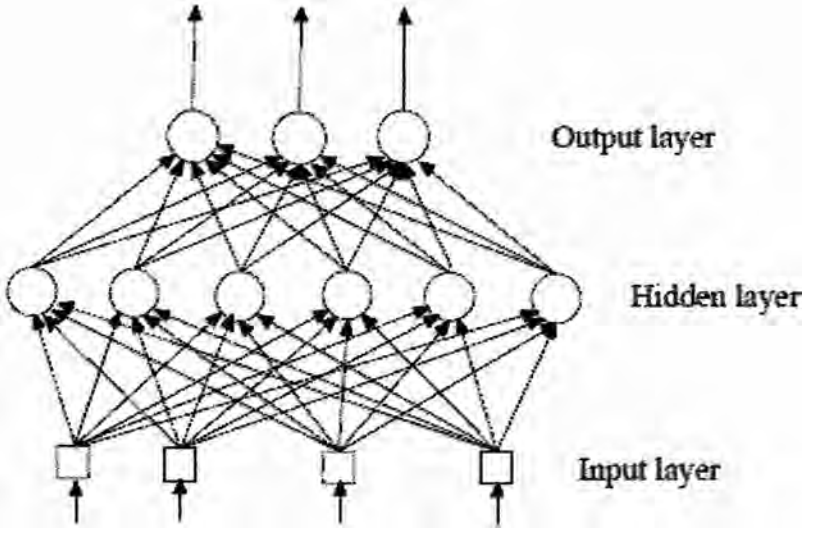

Figure: Multi-layer perceptron

The MLP network can also be used for unsupervised learning by using the so called auto-associative structure. This is done by setting the same values for both the inputs and the outputs of the network. The extracted sources emerge from the values of the hidden neurons. This approach is computationally rather intensive. The MLP network has to have at least three hidden layers for any reasonable representation and training such a network is a time consuming process [6].

2.5 Paper review

2.5.1 Project paper 1: artificial neural network approach for short term load forecasting for illam region [4].

The application of neural network was explored to study the design of short term load forecasting, STLF system for illam state that located in the west of Iran. One important architecture of neural network named multilayer perceptron (MLP) to model STLF system used. For developing the forecasting models, actual hourly electrical load data provided by the west electric company for the year 2004 through 2006 was used. Networks were trained for a fixed number of epochs. 17 neurons for hidden layer at 1000 epochs produce good results. Comparison of 24 hours ahead load forecasting with MLP and exact load was analyzed. Lastly, the results obtained clearly demonstrate that MLP method is reliable and accurate for a short term load forecasting. The mean absolute percentage error, MAPE is 0.18%.

2.5.2 Project paper 2: Kohonen neural network and wavelet transform based approach to short term load forecasting [3].

This paper presents Kohonen neural network and wavelet transform (WT) based technique provides a multi-scale, allowing a kind of time-scale analysis. Therefore, Kohonen neural network is based on the self-organization feature mapping (SOFM) that transforms input patterns into neurons on two-dimensional grid which are combined with WT for the purpose of establishing a composite forecasting model. The process of the short term load forecasting using kohonen neural network and WT were used when the historical seasonal load data classified into four patterns (Weekdays, Monday, Saturday and Sunday) by the SOFM and the Daubechies D2 (for winter analysis), D4 (spring and autumn analysis) and D10 (for summer analysis) WT's in order to forecasts the hourly load. The wavelet coefficient associated with certain frequency and time localization are adjusted using the conventional multiple regressions (MR) method and the component are reconstructed to predict the final loads through the five scale synthesis techniques. From the result provided, the yearly percentage error of 0.78% is experienced in spring, summer, autumn and winter time of 1995, respectively. The mean percentage error of Monday, Saturday and Sunday are obtained 1.51%.

2.5.3 Project paper 3: An efficient approach for short term load forecasting using artificial neural network [2].

In this paper, artificial neural network for short term load forecasting using real load and weather. In general, three types of variables are used as input: (a) hour and day indicator, (b) weather related inputs and (c) historical load. In hour indicator, load peak occurs twice a day, one is about 10.00 am and another is about 6.00pm. While for day indicator, load change from one day to another during week. In addition, there's no load history is used in this