IMPROVING THE CLASSIFICATION OF BANANA MATURITY LEVEL WITH HYBRID COMMITTEE OF ANN

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MAY 2008
“I hereby declared that I have read through this report 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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This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree Of Bachelor In Electrical Engineering (Power Electronic and Drives)

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May 2008
“I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references.”

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Bismillahirrahmanirrahim. In the name of ALLAH, who is the most Gracious and most Merciful. Firstly, I would like to express my sincere appreciation to my supervisor Mrs. Elia Erwani Hassan for her encouragement and guidance throughout this project. I also want to express my most infinite gratitude to my family and friends for the moral and spiritual support. Finally, I want to take this opportunity to express my appreciation to those that has directly or indirectly contributed during this project.
ABSTRACT

This project is to predict and improve the classification of banana maturity level using hybrid committee of Artificial Neural Network (ANN). The main objective of this project is to improve the accuracy of classification in identifying banana maturity level as an alternative way rather than press the banana. This accuracy depends on several ANN parameters such as number of hidden layers and nodes, learning rate, momentum rate and training function. The back propagation which consist of multi-layered perceptron make it possible to train the ANN training patterns. An array of seven neurons corresponds to the four indicator that related to each banana maturity’s level, average, standard deviation and variance of banana maturity’s level are the input for training phase. After passing through testing phase with the optimum training network, hybrid committee of two different networks give the best result in identifying then improving the classification of banana maturity’s level.
**ABSTRAK**

Projek ini adalah bagi meramalkan dan meningkatkan pengkelasaan tahap kematangan buah pisang dengan menggunakan kumpulan hibrid ANN. Objektif utama projek ini adalah untuk meningkatkan ketepatan pengkelasaan dalam menentukan tahap kematangan buah pisang sebagai jalan alternative selain memicit buah pisang tersebut. Ketepatan ini bergantung kepada beberapa parameter ANN seperti bilangan *hidden layers* dan *nodes*, *learning rate*, *momentum rate* dan *training function*. Rangkaian suap balik yang mengandungi perceptron pelbagai lapisan membolehkan ia mempelajari bentuk pelajaran ANN. Tatasusunan dari tujuh neuron yang terdiri daripada empat indikator yang relevan bagi setiap tahap kematangan pisang, purata, sisihan piawai dan varias adalah masukan untuk fasa pembelajaran. Setelah melalui fasa percubaan (testing) yang optimum, kumpulan hibrid yang terdiri daripada dua rangkaian yang berbeza memberikan ketepatan yang paling tinggi dalam menentukan seterusnya meningkatkan ketepatan pengkelasaan dalam menentukan tahap kematangan buah pisang.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td></td>
<td>ACKNOWLEDGEMENT</td>
<td>iii</td>
</tr>
<tr>
<td></td>
<td>ABSTRACT</td>
<td>iv</td>
</tr>
<tr>
<td></td>
<td>ABSTRAK</td>
<td>v</td>
</tr>
<tr>
<td></td>
<td>TABLE OF CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td></td>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td></td>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>LIST OF ABBREVIATION</td>
<td>xiii</td>
</tr>
<tr>
<td></td>
<td>LIST OF SYMBOLS</td>
<td>xiv</td>
</tr>
<tr>
<td></td>
<td>LIST OF APPENDIXES</td>
<td>xv</td>
</tr>
</tbody>
</table>

## 1 INTRODUCTION

1.1 Objectives
1.2 Scopes of work
1.3 Background
   1.3.1 Artificial Neural Network
   1.3.2 The Basic Component of ANN
   1.3.3 The Back Propagation Algorithm
1.4 Case Study
1.5 Motivation of Research

## 2 LITERATURE REVIEW

2.1 Introduction
2.2 Study of Similar System
   2.2.1 A Comparison between Single and Combined Back-propagation Neural Networks In The
Prediction of Turnover by T.Tchaban and J.P.Griffin

2.2.2 A Feed Forward Back Propagation Algorithm on Wood Recognition by Ahmad Athif, Mohd Syakirin, Mohd Sharieel and Mohd Afzan, UTM (2005)

2.2.3 A Prediction and Differentiating on Banana’s Maturity Level using Helical Antenna Neural Network By Sahazati Md Rozali (2003)

3 THEORY

3.1 Artificial Neural Network

3.1.1 Historical Summary of Artificial Neural Network

3.1.2 The Elements in ANN

3.1.3 The Basic Component of ANN

3.1.3.1 Inputs and Output

3.1.3.2 Weighting Factor

3.1.3.3 Neuron Function

3.1.3.4 Activation Function

3.1.3.5 Transfer Function

3.1.3.6 Learning Function

3.1.3.7 Combining Elements

3.1.3.8 Combining Layers

3.1.3.9 Connectivity Option

3.1.4 Single Layer Neural Network

3.1.5 Multi Layer Neural Network

3.2 Back Propagation Algorithm

3.2.1 Design Consideration

3.2.1.1 Selection of Inputs

3.2.1.2 Selection of Training Case

3.2.1.3 Number of Hidden Layers and Nodes

3.2.1.4 Learning Rate

3.2.1.5 Momentum Rate

3.2.2 Sigmoid Function
3.2.3 Back Propagation Step 32
3.2.4 Back Propagation Learning 34
3.2.4.1 Training Mode 36

4 EXPERIMENT PROCEDURE 38
4.1 Network Structure 38
4.2 Methodology 40
4.3 Flow Chart of Training Process in Identifying Banana’s Maturity Level 41
4.4 Flow Chart of Testing Process in Identifying Banana’s Maturity Level 43
4.4.1 Flow Chart of Singular Network of ANN 43
4.4.2 Flow Chart of Committee Network 45

5 RESULT AND ANALYSIS 47
5.1 Training Phase 47
5.1.1 Single Network 47
5.1.1.1 Without Indicator and One Output 48
5.1.1.2 With Indicator and One Output 54
5.1.2 Committee Networks 72
5.1.2.1 Two Different Single Network 72
5.1.2.2 Three Different Networks 77
5.2 Testing Phase 82
5.3.1 Single neural Network 82

6 CONCLUSION 94
6.1 Conclusion 94
6.2 Recommendation 95

REFERENCE 96

APPENDIXES A-I 98-154
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Errors in Percentage Term</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Binary set representation and their corresponding type of wood</td>
<td>11</td>
</tr>
<tr>
<td>2.3</td>
<td>Output of each banana’s maturity level</td>
<td>15</td>
</tr>
<tr>
<td>4.1</td>
<td>An Output Node of The ANN</td>
<td>39</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The Neurons</td>
<td>3</td>
</tr>
<tr>
<td>1.2</td>
<td>Basic Component of ANN</td>
<td>3</td>
</tr>
<tr>
<td>1.3</td>
<td>Banana</td>
<td>5</td>
</tr>
<tr>
<td>2.1</td>
<td>Sales line for actual sale and for a single and combined network</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Feed forward back-propagation neuron network</td>
<td>10</td>
</tr>
<tr>
<td>2.3</td>
<td>An Output Produce by HMLP of ANN</td>
<td>13</td>
</tr>
<tr>
<td>3.1</td>
<td>Simple summation function to determine the output</td>
<td>22</td>
</tr>
<tr>
<td>3.2</td>
<td>Summation function that is compared to the threshold to determine the output</td>
<td>22</td>
</tr>
<tr>
<td>3.3</td>
<td>Types of transfer function</td>
<td>24</td>
</tr>
<tr>
<td>3.4</td>
<td>The inputs connected to many nodes with various weight</td>
<td>25</td>
</tr>
<tr>
<td>3.5</td>
<td>Interconnection of several layers called input layer, hidden layer(s) and output layer</td>
<td>25</td>
</tr>
<tr>
<td>3.6</td>
<td>A single node with feedback itself</td>
<td>26</td>
</tr>
<tr>
<td>3.7</td>
<td>Network with feedback from previous mode</td>
<td>26</td>
</tr>
<tr>
<td>3.8</td>
<td>Single layer Neural Network</td>
<td>27</td>
</tr>
<tr>
<td>3.9</td>
<td>Multi-layer Neural Network</td>
<td>28</td>
</tr>
<tr>
<td>3.10</td>
<td>Back Propagation with one hidden layer</td>
<td>29</td>
</tr>
<tr>
<td>3.11</td>
<td>Sigmoid Function</td>
<td>31</td>
</tr>
<tr>
<td>3.12</td>
<td>Back Propagation training flow chart</td>
<td>35</td>
</tr>
<tr>
<td>4.1</td>
<td>Network structure of ANN in identifying banana maturity’s level</td>
<td>43</td>
</tr>
<tr>
<td>4.2</td>
<td>The Methodology</td>
<td>40</td>
</tr>
<tr>
<td>4.3</td>
<td>Flow Chart of Training Process in Identifying banana’s maturity level</td>
<td>42</td>
</tr>
</tbody>
</table>
4.4 Flow Chart of Testing Process in Identifying Banana”s Maturity Level 43
4.5 Flow Chart of Singular Network of ANN 44
4.6 Flow chart of hybrid committee of ANN 45
5.1 Training performance and regression graph for changes in momentum rate. 49
5.2 Training performance and regression graph for changes in learning rate 50
5.3 Training performance and regression graph for changes in training function 51
5.4 Training performance and regression graph for changes in hidden nodes 52
5.5 Training performance and regression graph for changes in goal 53
5.6 The graph for actual output compared with targeted output for one output without indicator 53
5.7 A single ANN with indicator (a) Training performance (b) Regression and (c) Actual versus desired output graph of banana maturity”s level classification 55
5.8 Regressions and actual versus desired output graphs for changes in hidden nodes. 59
5.9 Regressions and actual versus desired output graphs for changes in learning rate 61
5.10 Regressions and actual versus desired output graphs for changes in momentum rate 63
5.11 Regressions and actual versus desired output graphs for changes in epoch 65
5.12 Regressions and actual versus desired output graphs for changes in goal 67
5.13 Regressions and actual versus desired output graphs for changes in training functions 71
5.14 Regression and actual versus desired output graph for changes in learning rate 73
5.15 Regression and actual versus desired output graph for 74
changes in momentum rate.

5.16 Regression and actual versus desired output graph for changes in hidden nodes

5.17 Regression and actual versus desired output graph for changes in epoch

5.18 Regression and actual versus desired output graph for changes in goal

5.19 Regression and actual versus desired output graph for changes in momentum rate

5.20 Regression and actual versus desired output graph for changes in learning rate

5.21 Regression and actual versus desired output graph for changes in hidden nodes

5.22 Regression and actual versus desired output graph for changes in training function (traingdm, traingda & traingdx).

5.23 Regressions and actual versus desired output graphs for changes in hidden nodes

5.24 Regressions and actual versus desired output graphs for changes in learning rate

5.25 Regressions and actual versus desired output graphs for changes in momentum rate

5.26 Regressions and actual versus desired output graphs for changes in epoch

5.27 Regressions and actual versus desired output graphs for changes in training function
## LIST OF ABBREVIATION

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANN</td>
<td>Artificial Neural Network</td>
</tr>
<tr>
<td>MLP</td>
<td>Multi-Layer Perceptron</td>
</tr>
<tr>
<td>HMLP</td>
<td>Hybrid Multi-Layer Perceptron</td>
</tr>
</tbody>
</table>
LIST OF SYMBOLS

$I_1, \ldots, I_n = \text{inputs vector}$

$N = \text{number of layer(s)}$

$\eta = \text{learning rate}$

$\alpha = \text{momentum rate}$

$W_{ji} = \text{weights between input (i) and hidden layer (j)}$

$\text{net}_j = \text{the output signal to node j}$

$W_{kj} = \text{weights between hidden layer (j) and output layer (k)}$

$\theta_j = \text{bias on node j}$

$\text{net}_k = \text{the input signal to node k}$

$\theta_k = \text{bias on node k}$

$t_k = \text{actual output}$

$O_k = \text{desired output}$

$\delta = \text{the error gradient}$

$\Delta W(t) = \text{the previous weight}$

$n = \text{number of iteration(s)}$

$p = \text{number of input pattern(s)}$
**LIST OF APPENDIXES**

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Overall input data for banana maturity’s level</td>
<td>98</td>
</tr>
<tr>
<td>B</td>
<td>Banana Training Data</td>
<td>107</td>
</tr>
<tr>
<td>C</td>
<td>Example of training program for single neural network (without indicator and one output)</td>
<td>112</td>
</tr>
<tr>
<td>D</td>
<td>Example of training program for single neural network (with indicator and one output)</td>
<td>117</td>
</tr>
<tr>
<td>E</td>
<td>Example of training program for two different singular neural networks</td>
<td>122</td>
</tr>
<tr>
<td>F</td>
<td>Banana Testing Data</td>
<td>134</td>
</tr>
<tr>
<td>G</td>
<td>Example of testing program for single neural network</td>
<td>139</td>
</tr>
<tr>
<td>H</td>
<td>Example of testing program for two different networks</td>
<td>144</td>
</tr>
<tr>
<td>I</td>
<td>Testing Phase for Committee Network</td>
<td>150</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Objectives

The main objectives of this project are:

i. To improve the classification of banana maturity level by using Hybrid Committee of Artificial Neural Network (ANN).

ii. To predict banana maturity level as an alternative way rather than press it or look at the banana skin colour (especially for mass product).

iii. To compare the accuracy of ANNs in identifying the test data in two and three different ANNs structure.

1.2 Scopes of work

For improving classification problem, the Hybrid Committee of Artificial Neural Network (ANN) was introduced to see the effectiveness of prediction compared with a particular singular ANN. The performance and reliability of ANN depends on several factors which include the quality of training data, the initial weights used, the network structure and the activation function used.

This study will utilize available data on banana’s maturity level, to train and test the common feed forward ANN structure. The accuracy of this ANN in identifying the test data then compared with two different ANN structures. It is
expected that the accuracy of using Hybrid Committee of ANN is higher than the common singular feed forward ANN.

1.3 Background

1.3.1 Artificial Neural Network

An artificial neural network (ANN), often just called a "Neural Network" (NN), is an interconnected group of artificial neurons that uses a mathematical model or computational model for information processing based on a connectionist approach to computation [1]. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network. In more practical terms neural networks are non-linear statistical data modeling tools. They can be used to model complex relationships between inputs and outputs or to find patterns in data.

The original inspiration for the technique was from examination of the central nervous system and the neurons (and their axons, dendrites and synapses) which constitute one of its most significant information processing elements. In a neural network model, simple nodes (called variously "neurons", "neurodes", "PEs" (Processing Elements) or "units") are connected together to form a network of nodes and hence the term neural network. While a neural network does not have to be adaptive per se, its practical use comes with algorithms designed to alter the strength (weights) of the connections in the network to produce a desired signal flow [1].
These networks are also similar to the biological neural networks in the sense that functions are performed collectively and in parallel by the units, rather than there being a clear delineation of subtasks to which various units are assigned. Currently, the term Artificial Neural Network (ANN) tends to refer mostly to neural network models employed in statistics, cognitive psychology and artificial intelligence. Neural network models designed with emulation of the central nervous system (CNS) in mind are a subject of theoretical neuroscience [1].

1.3.1.1 The Basic Component of ANNs

The artificial neuron is called a processing element (PE). The node is represented by simple building block as a circle in Figure 1.1. The artificial neurons bear only a modest resemblance to the real thing. The PE handles several functions which it’s must evaluate the input signal and determine the strength of each one. Next, it must calculate a total number of the combined output signal and compare the total to some threshold level. Lastly, it must determine what the output should be.
1.3.1.2 The Back Propagation Algorithm

A method of adjusting the weight is needed to solve particular problem since the real uniqueness of the network exists in the values of the weights between neuron. The most common learning algorithm for this type of network is called Back Propagation (BP). A BP network learns by example using a learning set that consist of some input and the known-correct output for each case. These input-output pair is required to show the network what type of behavior is expected of it and the BP algorithm allows the network to adapt its weight.

The BP learning process works in small iterative steps: one of the example cases is applied to the network and the network produces some output based on the current state of its synaptic weights (initially, the output will be random). This output is compared to the known-good output and a mean-squared error signal is calculated. The error value is then propagated backwards through the network and small changes are made to the weights in each layer.

The weight changes are calculated to reduce the error signal for the case in question. The whole process is repeated for each of the example cases then back to the first case again and so on. The cycle is repeated until the overall error value drops below some predetermined threshold. At this point the network has learned the problem ‘well enough’. The network will never exactly learn the ideal function but rather it will asymptotically approach the ideal function.

1.4 Case Study

Banana is a long thick-skinned edible fruit that is yellow when ripe. The origin of bananas is traced back to the Malaysian jungles of Southeast Asia, where so many varieties and names for the banana are in that area [2]. Some horticulturists suspect that the banana was the earth's first fruit. Banana plants have been in cultivation since the time of recorded history. One of the first records of bananas dates back to Alexander the Great's conquest of India where he first discovered bananas in 327 B.C.[2].
1.5 **Motivation of Research**

Consumers usually detect banana’s maturity level by press it and looking at the colour of banana skin which cannot guarantee the accurate result. The method is not suitable for mass product and even can spoil the quality of banana. This project aims to provide an alternative way to inspect different level of banana’s maturity by utilising Artificial Neural Network. The sensitivity of each structure of neural network in differentiating maturity level will be scrutinized and compared. At the end of this project, the most effective neural network structure will be chosen. Thus the project implementation will provide for quick and harmless way to determine banana maturity level.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This project will focus on application of Artificial Neural Network to solve pattern recognition (classification) problem. A set of banana’s maturity level is chosen in a case of improving classification problem. The following studies were reviewed to gain an idea in doing this project.

2.2 Study of Similar System

2.2.1 A Comparison between Single and Combined Back-propagation Neural Networks In The Prediction of Turnover by T.Tchaban and J.P.Griffin, University College Chester (1997)

There were two main objectives pursued in this study. One was to ascertain whether a combination of neural networks would give better results than a single network, the other was to establish how the poor representation of data would affect the performance of the neural networks. In order to solve the problem area of forecasting and discuss issues concerning sales forecasting in business, a retail company planned to improve its performance by using neural networks to predict turnover and data used in the experiment was provided by the company. The study compares the performance of a combination of neural networks to that of a single neural network.
The values of turnover were supplied on a weekly basis for 1993/1994 and 1994/1995 financial years, and for 30 weeks of 1995/1996 financial year. This resulted in 134 patterns of data for each store and 2948 patterns in total. The data set was split into two parts: one for training and validation with data from 1993/1994 and 1994/1995 financial years, and another for testing which used the data from 1995/1996 financial year. Jacobs’s states that a combination of neural networks trained on different parts of a data set will perform as good as or better than a single network.

It was decided to split the data into 11 equal sets with 208 patterns in each. Eleven neural networks were trained, using sets 1 to 10 to train the first network, and set 11 to validate the performance of the network. Sets 1 to 9 and 11 were used to train the second network, and set 10 to validate it, sets 1 to 8 and 10 and 11 were used to train the third network, and set 9 to validate it, and so on. An important advantage of this approach is that the complete data set is used for training and validation of the combined model. It is impossible to achieve this using a single network.

The most popular algorithm used with Multi Layer Perceptrons (MLP) networks is back-propagation. It has been proven efficient and straightforward to use. The formula for standard back-propagation is:

\[ \Delta w_{ij}(t+1) = \eta \delta_j o_i \]

[Equation 2.1]

where \( \Delta w_{ij}(t+1) \) is a change in the weight between neurons \( i \) and \( j \) during the iteration \( t+1 \), \( \eta \) is a learning rate, \( \delta_j \) is an error of unit \( j \), \( o_i \) is the output of the preceding unit \( i \). There are also a number of variations of the back-propagation algorithm available. In this study the back-propagation with momentum term was used.