

WOOD RECOGNITION SYSTEM
USING
NEURAL NETWORK

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ABSTRACT

Neural networks, as used in artificial intelligence, have traditionally been viewed as simplified models of neural processing in the brain. Automated visual inspection has been employed in various industries for decades to replace human dependent job with intelligent machines. Artificial intelligence techniques have been incorporated with image processing tools in the design of automated visual inspection systems. In this thesis, an automatic visual inspection system for recognition of tropical wood species based on neural network system has been proposed. In order to strengthen Malaysia's role as top exporter in wood products, wood recognition is needed to keep exporting wood products runs smoothly. Currently, there have been cases of wood species being misclassified, which cause problems to the wood industry. A solution is proposed to use the wood anatomy as a way to identify the species of the timber which in this thesis, the extract data base used in this project is provided by Central of Artificial Intelligence and robotic (CAIRO). The unique anatomy of the woods acts as a 'fingerprint' to each wood species. The objective of this research is to design a computer system that able to recognize several types of wood using neural network to replace the laborious manual task of wood identification performed by human. A multi-layer neural network based on the popular feed-forward algorithm has been used for classification. Besides using the conventional FF Neural network, the Multilayer network is also implemented in the simulations for further analysis on the efficiency of the network. The results obtained show a high rate of recognition accuracy proving that the techniques used are suitable to be implemented for commercial purposes.

ABSTRAK

Rangkaian Neural sebagaimana namanya dalam “Artificial Intelligence”, secara umumnya dinilai sebagai proses ringkas neuron dalam otak manusia. Percepsi Visual Maya Automasi telah diaplikasikan dalam pelbagai sektor industri sejak beberapa abad lalu untuk menyenangkan kerja manusia kepada mesin yang boleh berfikir dan bertindak. Teknik “Artificial Intelligence” telah digabungkan dengan pemrosesan imej dalam sistem Percepsi Visual Maya Automasi. Di dalam tesis ini, sistem “Wood Recognition” menggunakan rangkaian nural diperkenalkan. Bagi menguatkan lagi peranan Malaysia sebagai salah satu pengeksport utama dalam bahan kayu, satu system kenal-kayu perlu ada bagi melancarkan kerja-kerja pengeksportan produk-produk kayu itu. Satu jalan penyelesaian telah difikirkan dimana masalah ini boleh diatasi dengan menggunakan ekstrak kayu-kayuan yang akan digunakan dalam sistem “wood recognition” ini. Pengkalan data ekstrak untuk sistem ini dibekalkan oleh Central of Artificial Intelligence and robotic (CAIRO). Keunikan anatomi kayu akan bertindak sebagai “cap jari” kepada setiap jenis kayu. Objektif kajian ini adalah untuk merekabentuk satu sistem peririsan komputer yang boleh mengenalpasti beberapa jenis kayu dengan menggunakan rangkaian neural yang boleh menggantikan kerja manual makmal untuk mengenalpasti jenis kayu yang biasanya dikendalikan oleh manusia. Rangkaian nural pelbagai lapis berdasarkan algoritma “Feed-Forward” (FF) telah digunakan untuk diklasifikasikan. Selain menggunakan FF, rangkaian “Multilayer” atau berlapis-lapis sistem turut diperkenalkan dalam tesis ini

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LIST OF ABBREVIATIONS

JPM	-	Jabatan Perhutanan Malaysia
FF	-	Feed-Forward
VSDP	-	Vision System Development Platform
CAIRO	-	Central of Artificial Intelligence and Robotic
NNTool	-	Neural Network Toolbox
FRIM	-	Forest Research Institute of Malaysia
JKR	-	Jabatan Kerja Raya
MGR	-	Malaysia Grading Rule
MLP	-	Multilayer Perception
GLCM	-	Grey Level Co-occurrence matrices
ERTS	-	Earth Resource Technology Satellite
ASM	-	Angular second Moment
IDM	-	Inverse Different moment
RBF	-	Radial-Basis Function
ANN	-	Artificial Neural network
GD	-	Gradient descent
GUI	-	graphical user interface
GUIDE	-	GUI in Matlab
M-file	-	Matlab coding file

CHAPTER I

INTRODUCTION

1.1 Background

There are many types of trees in Malaysia tropical forest. Based on facts provided by Jabatan Perhutanan Malaysia (JPM), there are estimated 15,000 species of flowering plants, including 3,000 species of trees [1]. One major revenue income of this country is tropical forest wood products which are exported throughout the world. In order to strengthen Malaysia's role as a top exporter in wood products and also to further add value to the products, quality inspection is a necessity and it is also a stringent requirement by many wood product importers as well as the local authorities. It's really a big problem to Malaysia as one of big wood exporters to the world.

One of the many ways to improve the quality is to identify and verify the wood identification before the process starts. Automated visual identification of materials or products is necessary in any industry. It is needed for characterization and sorting of raw materials, for the control of the processes, and for determining the quality of the final products. Despite the high degree of automation on the production lines, the surface identification tasks mostly rely on human visual inspection which is not practical. Artificial intelligence technologies have been incorporated with image processing methods to provide solutions to problems as a way to substitute humans.

Developing an automated visual identification system is not trivial. The lack of flexibility of the existing design strategies, the lack of established performance characterization methods and the lack of case studies complicate the development of automated visual identification system. Besides that, the identification tasks are often more complex than expected, many identification problems require considerable visual abilities especially for problems which are stochastic in nature.

Regardless of this, the development of an automated visual identification or recognition system is always greatly anticipated looking at the tremendous benefits generated from the availability of such systems. In this thesis, the identification of wood is based on its macroscopic anatomy images which are usually done visually by certified inspectors or professionals. Research in designing wood recognition systems is rather limited. In order to design an automated wood recognition system, mathematical techniques, image processing, feature extraction, texture analysis, neural networks, pattern learning, optimization algorithms and machine vision hardware such as camera, interfaces, PC, lighting and others are required. But in this thesis, the design data based recognition will be using neural network perception method with popular feed-forward (FF) method as an early prototype to this project.

1.2 Objectives of the Thesis

The primary objective of this thesis is to explore the possibility of developing a system which is able to perform automated wood recognition based on wood anatomy using a newly developed image processing software; Vision System Development Platform (VSDP) which is provide by Central of Artificial Intelligence and Robotics (CAIRO) and artificial neural networks [2]. In this thesis, only a small number of samples for each species are used due to the fact that there is no standard wood anatomy database for recognition, unlike face, fingerprint and handwriting recognition, where there are already established sets of database for researchers. This thesis is expected to achieve three goals:

- To design a computer system that able to recognize several wood types using neural network.
- All simulations performed using Matlab/Neural Network Toolbox (NNTool).
- To improve the current wood identification process.

1.3 Problem statements

When trees in the wood have been chopped down, the characteristics of the wood is not same as before. This would lead to wrong selection of wood when categorizations have been made. It can be only recognized by professional who is expert in knowing about woods. Wood should be clearly categorized as a standardization measure in determining the wood classifications. For example, in order to build a reliable roof truss, only woods with acceptable strength can be used. When suppliers deliver woods in mixed piles, appropriate requirements may not be met. In years to come, somebody would have to face the consequence of roof collapse or any other probable accidents and several such cases have already happened in Malaysia.

Customs needs to know whether logs, timbers, or wood products are correctly labeled so that tariffs can be properly assessed and trade regulation enforced. Technical methods which act like “fingerprinting” methods can be used to identify commercial timber and its origin may help to set up better controlling systems which can be used by public agencies from exporting as well as importing countries and by the private sector as one element against illegal logging and related trade. This will help to prevent from illegal loggings that have been a big problem in Malaysia right now [2].

Restorers of historical building prefer to use the same type of wood as used originally, and hence requires identification of the original wood fragments remain. Wood recognition can also be used for forensic purposes by determining whether

wooden fragments at a crime scene match of those taken from the belongings of a suspect and helps to solve part of the case [2].

Nowadays, there's only trained identifiers that can identify woods. To train someone who is qualify to identify woods takes a long time. This is why mankind really needs some kind of technology to support human workers. So, to build this wood identification software is a great idea in first place.

1.4 Scope of work

The scope of this thesis involves the design of a wood recognition system based on the following:

- Types of woods used in this project as described in [2].
- The classification system developed is based on grey scale images of wood samples due to the fact that macroscopic wood classification does not rely much on the wood color.
- All simulations are performed using Matlab/NNTool.

1.5 Synopsis of methodology

This project is designed to identify the type of woods using a PC-based wood classification. A good methodology must be used to complete this thesis. So, in order to do that, the right software will be choosing to solve the problems. Neural network in Matlab software is one of easy method in order to fulfill the objectives of this thesis. After that, an appropriate data of wood extract will be classified. With help from Central of Artificial Intelligence & Robotic (CAIRO), the suitable data based for wood extract have been found. This includes the preprocessing data which classifying all the good data and the bad data that need to be used.

The whole methodology is like Figure 1.1. The first thing need to be done is to select the suitable methods of Neural Network system. This is important because it will be the root of the whole system recognition. Follow by training the network which includes the selecting suitable bias and weight to be used. And finally, to test the output with test data to estimated the accuracy of the system.

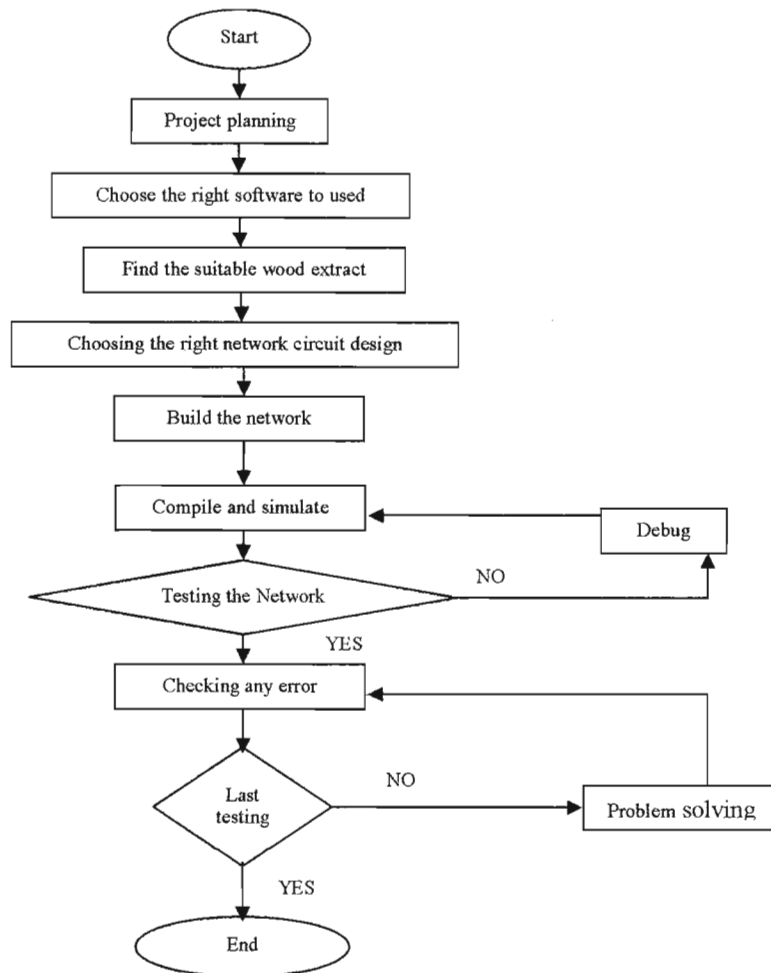


Figure 1.1 Synopsis methodology of the project

1.6 Thesis Outlines

The thesis is divided into five chapters. Chapter One, discussion some introduction on wood identification based on wood anatomy, the motivation for the research, the aim and scope of work. Chapter Two includes the classification of Malaysian timbers, general structure of the wood, and state of the art in wood

recognition based on the anatomical features and the current method of examination of wood for identification. Chapter Three explained the software design of the wood recognition system from the pre-processing of the image, feature extraction and pattern recognition.

Chapter Four followed with the simulation results. In this chapter also describe whether the objectives of project are achieved or not. Chapter Five on concludes the wood recognition system and summarizes what has been achieved in this research. Further works based on the findings of this thesis are suggested.

CHAPTER II

LITERATURE REVIEW

2.1 Perspectives and methods of previous wood identification

2.1.1 Current techniques in wood identification

Wood is a hard, fibrous, lignified structural tissue produced as secondary xylem in the stems of woody plants, notably trees but also shrubs. This tissue conducts water to the leaves and other growing tissues and has a support function, enabling plants to reach large sizes. Wood may also refer to other plant materials and tissues with comparable properties. The structure of wood is differing from every type. It has its own characteristic which is similar to fingerprints conditions. Even though, there are professionals who work with these woods everyday, but sometimes they are not fully aware of their characteristics. Wood identification is useful in a few contexts such as commercial, forensic, archeological and paleontological [2].

Sometimes an easy task could be difficult to be done. It's the same with wood identification. It's an easy task to recognize what type of tree for the people that have experience in wood as everyday they handling them. But, in certain cases, when the tree has felled, the physical of the wood (appearance) which identify them, has changed. The only ways left to identify them are by the wood structure and physical wood properties (extracts). By looking at the macro and micro levels of the woods, it

will show the identity of the woods. It also will reveal the essential information of the woods like the behavior of the timber itself.

In Malaysia, Wood Identification based on the anatomy of the wood is done by only very few certified personnel are authorized by the Forest Research Institute of Malaysia (FRIM). The process of training up experience personnel in performing the job is a difficult one, due to the fact that there are about more than 1,000 wood species in Malaysian jungle [2]. Furthermore, subjective evaluations by these personnel's may not necessary give same results which are bias, unreliable at times, etc. For example in order to build a reliable roof truss, only woods with acceptable strength can be used. When suppliers deliver woods in mixed piles, appropriate requirements may not be met this could result in causing roof to collapse. This issue has become a concern to Jabatan Kerja Raya (JKR) [1]. Thus there is a need to have quality control on the types of wood to be used.

Another example is for exporting woods and furniture productions. To ensure the right type of woods are exported (including raw wood and other wood products such as furniture); a good wood classification method must be used (Figure 2.1 and Figure 2.2). With wood identifiers also, people can avoid wrong species of wood being sent to importers [3].



Figure 2.1 newspaper cut shows wood projects approved in Malaysia are in big budget [4].



Figure 2.2 newspaper cut shows furniture export growing in Malaysia [5].