Wood Texture Detection with Conjugate Gradient Neural Network Algorithm

Setyawan Widyarto[1)], I Nyoman Suryasa[2)] , OttoFajarianto[2)]
[1, 2)]Program Magister Ilmu Komputer
Universitas Budi Luhur
Jakarta Selatan, 12260, Indonesia
[2)]swidyarto@unisel.edu.my

Khairul Annuar bin Abdullah
[2)]Department of Computing
Universiti Selangor
Selangor, Malaysia

Mohd Shafry Mohd Rahim
Faculty of Computing, Universiti Teknologi Malaysia,
UTM Skudai, 81310, Johor Bahru, Malaysia

Gigih Priyandoko[3)], Gilang Anggit Budaya[4)]
[3)]Fakulti Kejuruteraan Mekanikal, Universiti Malaysia Pahang, Pekan,Pahang 26600, Malaysia
[4)]Alumni Fakultas Kehutanan, Universitas Gajah Mada, Yogyakarta, Indonesia

***Abstract*— This project explored fundamental methods to find the factors that can be used in classifying and detecting the type of wood. Whereas, the literatures have been reviewed to determine the algorithms developed. Some experiments have been conducted to analyze the model and system. The experiments are based on artificial neural network (ANN) algorithm that used back propagation and conjugate gradient method of training function in the process of identification. The experiments carried out to be more accurate than the ANN system, the result is about 96% accuracy. It is expected the method can be used and applied for the detection of the type and classification of wood in the industrial sector, especially agriculture.**

Keywords— Neural Networks; Back propagation; Edge Detection; Image Processing; Texture Detection.

I. INTRODUCTION

There are many knowledge based approaches to segment an image and can be classified as intensity, discontinuity, similarity, clustering, graph, pixels based methods and hybrid of them, Khan et.al [1], the system of intelligent wood species recognition based on a variety of feature extraction techniques and several pattern classifiers such support vector machine (SVM) and other artificial neural network paradigms to further improve the classification of the wood species has been investigated. The popular multilayer perceptron (MLP) artificial neural network (ANN) trained using the backpropagation (BP) algorithm had been used to classify the wood species.

An alternative description of images, based on a multifractal characterization of the signal, can be used instead of the classical approach that involves smoothing of the discrete data in order to compute local extrema, Vehel et.al [2].

Fundamental Research Grant Scheme (FRGS/1/2016/STG07/) – Pure and Applied Science..

Problem Statement

Nowadays, quantification of material texture has not accomplished yet. Some of its works have been carrying out for the wood texture orientation with artificial neural networks implementation. However, the accuracy of recognition system using neural network but was difficult to improve. Most of the detection methods enhance the classical algorithm and apply massive artificial neural network but fractal characterization has not included.

The images processed are images of wood that is cut horizontally, so we get the pore structure of the wood.

II. RELATED WORKS

A. General Nature and Anatomy of Wood

Most of the detection methods enhance the classical algorithm and some have applied massive artificial neural network. The accuracy of artificial neural network implementation in the performance of the intelligent wood species recognition system [3] achieved the level that was difficult to improve the accuracy further and the experiments stopped upon achieving such accuracy rate. According to Bond and Hamner [4], anatomical characteristics of a tree can be seen in cross-section surface of the wood cells by cutting with perpendicularly direction.

There are two characteristics that are used in the classification of wood types. Common trait is a characteristic that can be observed directly through the five senses, both sight, smell, touch without the use of tools such as a magnifying glass, common characteristics include, among others, color, pattern, texture, grain direction, gloss, tactile surface, the smell of wood and violence.

978-1-5386-0549-3/17/$31.00 ©2017 IEEE

The hallmark anatomical features that include composition, shape, and size of the cells or tissue constituent that can only be seen with the help of tools such as microscopes and magnifying glass.

Bond and Hammer perform classification of wooden surfaces into three categories geometric reference plane, the cross section, radial section, and tangential section as shown in the figure below [1]:

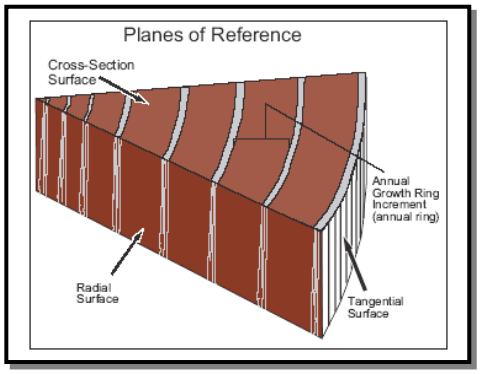


Fig. 1. Cross section wood surface (Courtesy: Bond B. and Hamner P, 2002)

B. *Artificial Neural Network (ANN)*

Artificial Neural Network (ANN) is a method of computing systems that mimic biological neural networks. This method uses a non-linear element calculation base called neurons that are organized as a network of interconnected, so similar to human nerve tissue. ANN was created to solve a specific problem such as the imposition of a pattern or a classification for the learning process.

Artificial neural networks, like humans, learn from an example because it has characteristics that can adaptively learn from previous data and recognize patterns of data that is always changing. In addition, the artificial neural network is a system that is not programmed, meaning that all outputs or conclusions drawn by the network based on his experience during the process of learning / training.

It is to be achieved by training artificial neural networks is to achieve a balance between the ability of memorizing the Neural Network capabilities to take back perfectly a pattern that has been studied and the generalization ability of Artificial Neural Network to produce the usual response is received on the input patterns similar (but not identical) to the patterns that have previously been studied.

Artificial neural networks have been implemented in wood recognition system using neural network [5], in wooden surfaces classification with modular structure of neural networks using PLC Industrial Implementation [6], low-cost wood species classification and identification system [7] but fractal characterization has not included.

This is very useful if at some time in the Artificial Neural Network fed new information that has not been studied, then the neural network will still be able to give a good response, providing the closest output.

Generally, Neural Network has four main components and will determine the characteristics of artificial neural networks, namely:

1) Neurons

Neuron is a processing unit that became the basis of information in the operation of artificial neural networks. Neurons work by impulses or signals given in the neurons. Neurons will transform information (input) signals passing between neurons transmitted through the liaison. Connections between neurons pick weights that store information on a particular value. Number, structure and pattern of relationships between these neurons will define the network architecture (network model which is formed). Ultimately, they will form a pattern of relationships between neurons (Architecture Network) that is a place of information processors.

2) Layer

Layer refers to a layer in the network. ANN structure used in this study is one input layer, one hidden layer with 10 neurons and one output layer.

3) Weight

Each connection has a weight liaison between corresponding layers [8]. The connector has a different weight, the weight of which will amplify a signal is positive and negative weight is to weaken many signals. There are various methods for determining the connection weights (called methods of training / learning / algorithms).

Training method used in this project is a method of propagation. In the methods of propagation, there are several algorithms to optimize the method of propagation. A method of conjugate training algorithm **backpropagation gradient with fletcher-reeves** (*traincgf* in MATLAB®).

4) Activation Function

Each neuron activation function will apply the weighted sum of signals coming to him to determine the output signals. Activation function used in this study is the binary sigmoid activation function (*logsig* in MATLAB®). This is preferred because the function has a range of outputs 0-1 logsig, this can be seen in the characteristic curves for logsig function. Logsig function selection which has a range of output values 0-1 as the target output value is also 0 and 1. The following figure shows the characteristic curves for the binary sigmoid function.

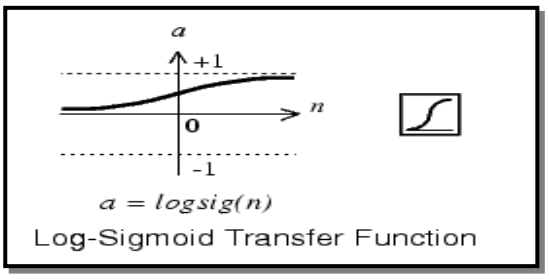


Fig. 2. Binary Sigmoid Curve *(Source: MATLAB® Documentation)*

Constituent layers of artificial neural networks can be divided into three, namely:

a) Input layer

The units in the input layer are called input units and input units that receive data from the external. Meanwhile input patterns describe the problem.

b) Hidden layer

The units in the hidden layer are called hidden units, where the output cannot be directly observed.

c) Output layer

The units in the output layer are called output units. The output of this layer is a neural network solution to a problem. Figure below shows the representation of artificial neural system consisting of 3 layers: one input layer, one hidden layer and one output layer.

The Figure below shows the representation of artificial neural system consisting of 3 layers: one input layer, one hidden layer and one output layer.

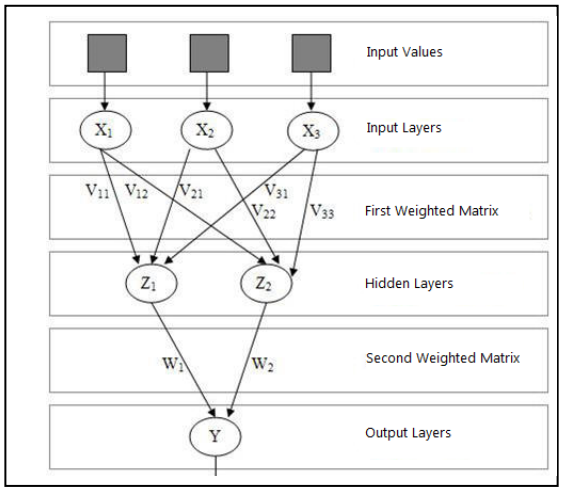


Fig. 3. Multilayers Neural Network Architecture

Some advantages of ANN are:

1. The ability to acquire knowledge even in conditions of no disturbances or uncertainties. This is because the neural network capable of generalization, abstraction and extraction of the statistical properties of the data.
2. Ability of representing knowledge, a flexible artificial neural network to create its own representation through self-regulation or the ability to learn (self-organizing).
3. Ability to tolerate or a distortion, in which small perturbations in the data can be considered only as a mere shock.
4. The ability to efficiently process knowledge for wearing a parallel system, so that the time required for the operation becomes shorter.

4. SYSTEM OVERVIEW

The methodology used in the whole project can be grouped in three main concerns but this paper expose on neural networks implementation. *The first* is classical image processing as conducted for texture identification and recognition [9, 10]. *The second* is neural networks implementation in the wood identification and species recognition that have been initiated and discussed in this paper. *The third* will be enhanced with fractal fundamental in image segmentation inclusion. The research is still running and will end in 2018. Fractal dimension is an efficient and effective way to deal with texture, since different fractal methods lead to high classification as microscopic crowd model [11, 12, 13) and the fractal dimension [14] can be estimated. Fractal descriptors approaches are based on the idea of calculating the fractal dimension of an object at different scales to emphasize patterns and irregularities. The main idea underlying fractal descriptors is to use the function to describe an object.
In this ANN project, a set of wood texture images are used as input system as shown in the block diagram.

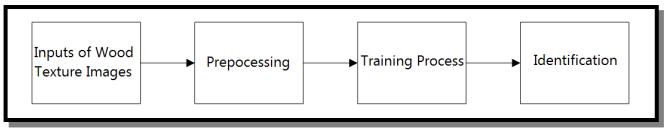


Fig. 4. Overall System

1. Input image is an image horizontally piece of wood image is then performed either by using a digitizing scanner or digital camera.
2. The image preprocessing in the form of the initial process before the image can be processed in the training process, while the preprocessing is Grayscale, Noise Reduction, Threshold, Edge Detection, Resize, Binary, reshape.
3. Training process is a learning process image of the database that will be used in the identification process; the image is done in this phase of the training process by using of back propagation algorithm with conjugate gradient training function.
4. Identification is the final process system, where the system can recognize objects enter the calculation results based on comparison with the training database.

5. DISCUSSION

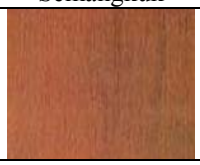
The total images were used as many as 56 pictures with 148 x 84 true color (TABLE I). The parameters of neural networks that were used as the following:

- Hidden layer: 200
- Training function: *traincgf*
- Performance function: *mse*
- Training ratio: 0:05
- Show command: 5
- Epoch: 100
- Goal performance: 0001
- Learning rate: 0.2

- Transfer function L1: *logsig*
- Transfer function L2: *logsig*

TABLE I. INPUT IMAGES

 Agatis	 Agava	 Alan Bunga
 Babai	 Bagkirai	 Balau Merah
 Balau	 Bayur	 Bekak
 Belian	 Berangan	 Bitangor
 Bitis	 Chengal	 Damar Minyak
 Dedali	 Derum	 Durian
 Eboni	 Entahpuloh	 Geronggang

 Gerutu	 Giam	 Jati Doreng
 Jati Mata Mati	 Jati mata Sehat	 Jati Putih Sedikit
 Jati Serat Halus	 Jadi Serat Mahkota	 Kamper
 Kapur	 Karet	 Kedongdong
 Kelapa	 Kembang Semangkuk	 Kempas
 Keruning	 Kulim	 Mahoni
 Malam	Mata Ulat	Medang
Meranti Merah	Meranti	Merapuh
Merbau	Nyantoh	Oak

Experimental results obtained has indicated that by using Artificial Neural Network with Back propagation method and conjugate gradient training functions, it can improve the accuracy of the process up to 96.4286% seen in TABLE II, with the optimal 0.2 Learning Rate, Hidden Layer 200, then the value obtained 0.00638237 performance approaching 0001, with 568 697 the second time.

TABLE II. RESULTS TRAINING PROSES

Learning Rate	Hidden Layer	Epoch	Total Data	Total Data (True)	Total Data (False)	Percentage right (%)
0.1	10	100	56	9	47	16.0714%
		4000	56	7	49	12.5000%
	100	100	56	54	2	96.4286%
	200	100	56	54	2	96.4286%
0.2	100	100	56	54	2	96.4286%
	200	100	56	54	2	96.4286%

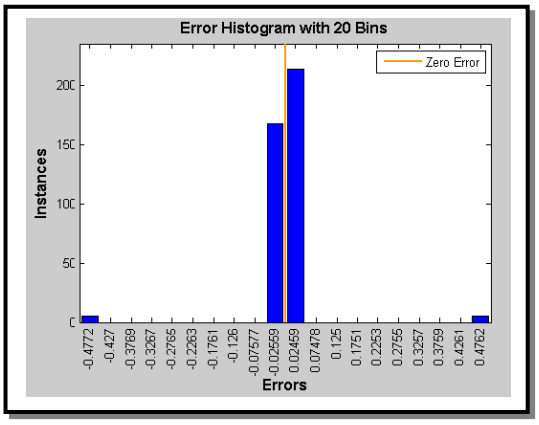


Fig. 5. Histogram Display Result

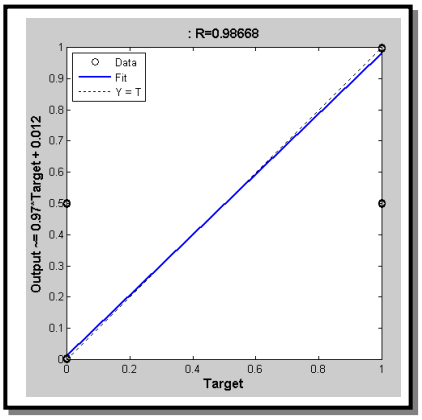


Fig. 6. Regression Result Display

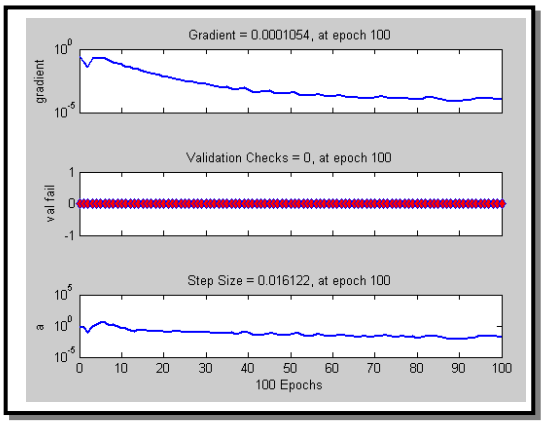


Fig. 7. The State Training Result Display

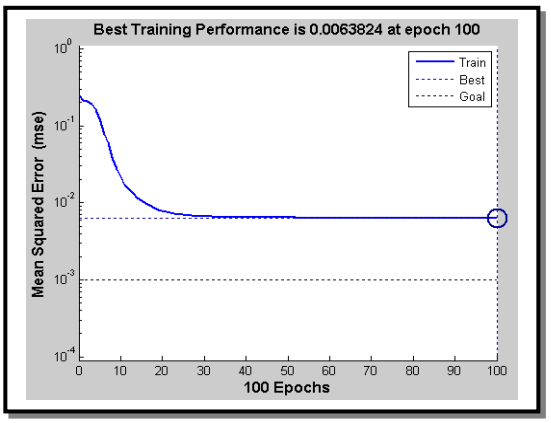


Fig. 8. Result Display Performance

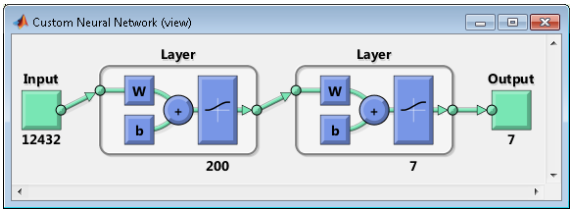


Fig. 9. Result Display Structure Neural Network

6. CONCLUSION

Artificial Neural Network (ANN) with Back propagation method and conjugate gradient training functions can improve the accuracy in identification. It is expected that the results of this study may be useful to improve the work process, with the result that the process is better than ever, and can be applied to the industrial field.

ACKNOWLEDGMENT

This research is on-going research and funded by Ministry of Higher Education (MoHE), Department of Higher Education (JPT), Institutions of Higher Education Excellence Planning Division (BPKI), Wood Texture Detection with Conjugate Gradient Neural Network Algorithm, Fundamental Research Grant Scheme (FRGS/1/2016/STG07/) – Pure and Applied Science.

REFERENCES

[1] A. M. Khan and Ravi. S, "Image Segmentation Methods: A Comparative Study" International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-4, September 2013

[2] Vehel, Jacques Levy, and Pascal Mignot. "Multifractal segmentation of images." Fractals 2.03 (1994): 371-377.

[3] Rubiyah Yusof, Uswah Khairuddin, Marzuki Khalid, "A new mutation operation for faster convergence in genetic algorithm feature selection", International Journal of Innovative Computing, Information and Control Volume 8, Number 10(B), October 2012.

[4] Bond B. and Hamner P, "Wood Identification for Hardwood and Softwood Species Native to Tennessee ", Agricultural Extension Service, The University of Tennessee 2002.

[5] Saiful Nizam, Mohd Padzil (2008) Wood Recognition System Using Neural Network. Project Report. UTeM, Melaka,Malaysia.

[6] Topalova, I., Tzokev, A., "Modular Structure of Neural Networks for Classification of Wooden Surfaces with PLC Industrial Implementation", The Seventh International Conference on Autonomic and Autonomous Systems ICAS 2011, ISSN 978-1-61208-006-, pp. 13 - 17 May 2011, Venice, Italy

[7] S. Mohan, K. Venkatachalapathy, Ashok Kumar Rai "Wood Species Classification and Identification System" International Journal of Engineering Sciences & Research Technology, 3(6): June, 2014. 847-853.

[8] Kusumadewi,Sri.Purnomo,Hari.,"Aplikasi Logika Fuzzy untuk Pendukung Keputusan".Yogyakarta: GRAHA ILMU,2004

[9] Yoga Prihastomo, Setyawan Widyarto, 2012, 'Image Search: A Vienna Classification and ContentBased Image Retrieval Approach', Journal of Technology of Information and Communication (TICOM). 09/2012; 1(11): 15.

[10] Setyawan Widyarto, Angga Kusuma Nugraha, Nurmalia Sumali, Riskiana Wulan and Shintya Yulianti, Attendance System with Face Identification using Gabor Wavelet Method, UNISEL Journal of Sciences, Engineering and Technology Vol.1, No.1 (2014)

[11] Setyawan Widyarto, Muhammad Shafie Abdul Latiff. Fractals Study and AgroBiotechnology Application. The 1st International Symposium on BioInspired Computing [BIC 05] 5-7 September, 2005 Johor Bahru Malaysia.

[12] Setyawan Widyarto, and Muhammad Shafie Abdul Latiff, A Microscopic Swarm Model Simulation and Fractal Approach towards Swarm Agent Behaviour, International Journal of Computer Science and Network Security (IJCSNS), Vol.6 No.7A, July 2006, pp.6474

[13] Setyawan Widyarto, Muhammad Shafie Abd. Latiff, Fractal, a Microscopic Crowd Model, Fractals, Vol. 16, No. 4 (Dec, 2008) 1–16, Journal: Fractals Complex Geometry, Patterns, and Scaling in Nature and Society World Scientific Publishing Company.

[14] K.J. Falconer , The Geometry of Fractal Sets, Cambridge University Press, Cambridge, UK, 1985.