IOP Conf. Series: Journal of Physics: Conf. Series **801** (2017) 012051 doi:10.1088/1742-6596/801/1/012051

Tropical Timber Identification using Backpropagation Neural Network

B Siregar[1], U Andayani[1], N Fatihah[1], L Hakim[2], F Fahmi[3]

[1] Faculty of Computer Science and Information Technology, University of Sumatera Utara, Medan-Indonesia
[2] Faculty of Forestry, University of Sumatera Utara, Medan-Indonesia
[3] Dept. Electrical Engineering, University of Sumatera Utara, Medan-Indonesia

Email: fahmimn@usu.ac.id

***Abstract*—** Each and every type of wood has different characteristics. Identifying the type of wood properly is important, especially for industries that need to know the type of timber specifically. However, it requires expertise in identifying the type of wood and only limited experts available. In addition, the manual identification even by experts is rather inefficient because it requires a lot of time and possibility of human errors. To overcome these problems, a digital image based method to identify the type of timber automatically is needed. In this study, backpropagation neural network is used as artificial intelligence component. Several stages were developed: a microscope image acquisition, pre-processing, feature extraction using gray level co-occurrence matrix and normalization of data extraction using decimal scaling features. The results showed that the proposed method was able to identify the timber with an accuracy of 94%.

1. Introduction

Wood is one of the commodities that can be used for multiple purposes, such as building materials, furniture, etc. Each type of wood has different characteristics so that it can affect the quality and price of the timber. Accordingly, the identification of the type of wood is important, especially for industries who need to know the type of timber precisely, so as to enable the parties concerned may use the appropriate timber. There are two ways that can be done to identify the type of wood that is by observing the general nature and properties of wood anatomy [1]. General nature of the timber that the physical properties of wood directly without the aid of a magnifying shadow. The physical properties of wood including color, texture, grain direction, image, weight, impression felt, the circle grows, smell and so forth. The nature of anatomy include the shape, structure and size of cells that can be observed with the aid of a magnifying shadow.

In identifying the type of wood there are obstacles that not everyone has the knowledge to be able to identify the type of wood properly. Identifying the type of wood to observe the general nature or anatomical properties of wood can be done by people who are experts and have a lot of experience. However, there is very limited experts available. In addition, the identification manually conducted by expert inefficient because it requires a lot of time.

Backpropagation is a learning algorithm on artificial neural network that can be done for pattern recognition. Neural network itself usually used in most image based analysis such as image reading [2], image differentiation [3] or in biometric [4]. Backpropagation can create balance in the network to train a network to be able to recognize a pattern in the training and can provide the right response to the input pattern similar to the pattern used on the training [5]. Risaldi et al. (2014) using the method of backpropagation to classify the quality of coconut timber by comparing the propagation neural network algorithms and libSVM [6].

In 2014, Mohan S. conduct research to identify the wood in India [7]. Wood image taken using a digital camera with high resolution. Image taken is the outer surface of the bark. This study uses feature extraction Grey Level Co-Occurrence Matrix to acquire the image of wood. Gunawan et al. (2011) conducted a study identifying timber in order to develop a system that can classify four types of timber traded in Indonesia [8]. Identification of timber is made using a microscopic image of wood. Image taken using a microscopic camera. The method used for image classification of wood is the support vector machine. While the method for image feature extraction is two-dimensional principal component analysis (2D-PCA).

In this study, backpropagation neural network was developed as a specific identification method for tropical timber identification.

2. Method and Material

Methods in this study consisted of several stages as follows: image acquisition using a microscope, pre-stage image processing consists of scaling and gray scaling; feature extraction stage of each image with a value of 5 Haralick features of Grey Level Co-Occurrence Matrix; normalization of the extracted features using decimal scaling; and image classification using artificial neural network backpropagation.

The general architecture of the research methodology can be seen in Figure 1.

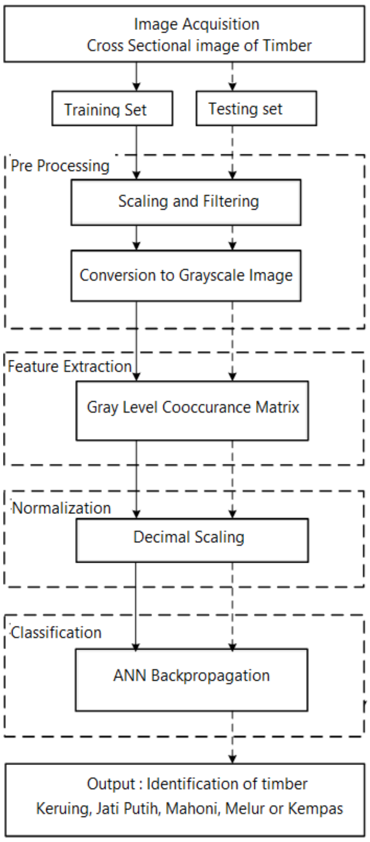

Figure 1. General Architecture

2.1 Image Acquisition
The acquisition of a cross-sectional image of tropical timber was taken using Digital Microscope Camera AxioCam with ERC 5s with a magnification of the microscope is 1:25 time and intensity of light is at 3200 K.

2.2 Data used
Type of wood used in this study is wood keruing oil (Dipterocarpus eurynchus), teak white (Gmelina arborea), mahogany (Swietenia mahagoni), wood jessamine (Dacrydium elatum) and wood kempas (Koompassia malaccensis) which can be seen in Figure 2.

Figure 2. (a) keruing minyak (b) Jati putih (c) Mahoni (d) Melur (e) Kempas

All types of wood in Figure 2 is made in the form of wooden blocks each of 5 pieces. The timber will be placed on top of the microscope to image is taken in the form of a block of wood measuring about 1x1x1 cm. This research will be done taking as many as 10 pieces of wood image on each block of wood so that each type of wood has 50 pieces of image data.

The image that has been collected will be divided into two groups of data that training data and test data. Training data amounted to 80% of the overall image data while the test data accounts for 20% of the overall image data so that in this research training data for each type of timber amounted to 40 units, while the test data for each type of timber amounted to 10 pieces.

2.3 Pre-Processing
Image pre-processing stage was done to produce a better image to be processed to the next stage of feature extraction phase. In this study, pre-processing the image taken was image scaling and the conversion of gray level image (gray scaling).

2.4 Feature Extraction
In this study, the method used for extraction of image features was the Gray Level Co-Occurrence Matrix (GLCM). GLCM is one of the second-order texture analysis methods. This method was introduced by Haralick et al in 1973 [13]. GLCM represents the relationship of two neighboring pixels in which two pixels associated has a certain intensity of gray and has a certain distance and direction between the two.

Calculation of statistical features can be made after the co-occurrence matrix had already been already normalized. In this study, some quantitative features of statistics obtained from the co-occurrence matrix were: Energy, Entropy, Contrast, Inverse Difference Moment, and Correlation.

2.5 Data Normalization
Normalization is a technique of pre-processing of data by transforming the value attribute of a dataset in a certain range, for example between 0 and 1. The normalization can be used in problems such as data classification and clustering neural network [11].

Data were normalized in advance before classification using backpropagation. In this study, normalization techniques used were decimal scaling. Decimal scaling was done by moving the decimal point of the value of an attribute. The size of the decimal point shifting was determined by the maximum absolute value of an attribute.

2.6 Classification Using Backpropagation Neural Network
Backpropagation is one method of supervised artificial neural network (supervised learning). Backpropagation requires the target as a reference in the training process, where the purpose of propagation is set so that the value of the error in the network becomes increasingly smaller, or in other words make the output value close to the target. The results of the training backpropagation is a set of weight value, where the final weight is a representation of knowledge of the learning process that carried out.

Backpropagation method consists of two phases: the propagation phase (feed forward) and backward direction phase (backward). This method modifies the value of weights in phase backward direction (backward) by using the error output. Advanced propagation phase (feed forward) must be passed first in order to be able to obtain the value of the error.

Determination of network architecture is done by determining the number of neurons in the input layer, hidden layer and output layer. In this study, the number of input neuron was determined by the number of feature extraction results (input neurons 20). While the number output neurons was 5, which is determined based on the target output of the number of types of wood that are classified.

3. Results

Tests were conducted to determine the ability of a propagation method in identifying five types of wood. The system's ability to identify types of wood depends on the backpropagation training process for generating weight that will be used in the testing phase. Parameters used in the backpropagation training phase can be seen in Table 1.

Table 1. Parameters of ANN *backpropagation*

No.	Parameter Backpropagation	Setting Value
1.	Hidden Neuron	40
2.	Activation Function	Sigmoid Binary
3.	Maximum Epoch	2000
4.	Minimum Error	0.1
5.	Learning Rate	0.8

The result of identifying the type of timber based on the final weight can be seen in Table 2 where the test images from every kind of timber was used.

Table 2. Test Result

No.	Image	Desired Output	Actual Output
1.	keruing-test (1).jpeg	Keruing	Keruing
2.	keruing-test (2).jpeg	Keruing	Keruing
3.	keruing-test (3).jpeg	Keruing	Keruing
4.	keruing-test (4).jpeg	Keruing	Keruing
5.	keruing-test (5).jpeg	Keruing	Keruing
6.	keruing-test (6).jpeg	Keruing	Keruing
7.	keruing-test (7).jpeg	Keruing	Keruing
8.	keruing-test (8).jpeg	Keruing	Keruing
9.	keruing-test (9).jpeg	Keruing	Keruing
10.	keruing-test (10).jpeg	Keruing	Keruing
11.	Jati-Putih-test (1).jpeg	Jati Putih	Kempas
12.	Jati-Putih-test (2).jpeg	Jati Putih	Jati Putih
13.	Jati-Putih-test (3).jpeg	Jati Putih	Jati Putih
14.	Jati-Putih-test (4).jpeg	Jati Putih	Jati Putih

15.	Jati-Putih-test (5).jpeg	Jati Putih	Jati Putih
16.	Jati-Putih-test (6).jpeg	Jati Putih	Jati Putih
17.	Jati-Putih-test (7).jpeg	Jati Putih	Jati Putih
18.	Jati-Putih-test (8).jpeg	Jati Putih	Jati Putih
19.	Jati-Putih-test (9).jpeg	Jati Putih	Jati Putih
20.	Jati-Putih-test (10).jpeg	Jati Putih	Jati Putih
21.	mahoni-test (1).jpeg	Mahoni	Mahoni
22.	mahoni-test (2).jpeg	Mahoni	Mahoni
23.	mahoni-test (3).jpeg	Mahoni	Mahoni
24.	mahoni-test (4).jpeg	Mahoni	Mahoni
25.	mahoni-test (5).jpeg	Mahoni	Mahoni
26.	mahoni-test (6).jpeg	Mahoni	Mahoni
27.	mahoni-test (7).jpeg	Mahoni	Mahoni
28.	mahoni-test (8).jpeg	Mahoni	Mahoni
29.	mahoni-test (9).jpeg	Mahoni	Mahoni
30.	mahoni-test (10).jpeg	Mahoni	Mahoni
31.	Melur-test (1).jpeg	Melur	Melur
32.	Melur-test (2).jpeg	Melur	Melur
33.	Melur-test (3).jpeg	Melur	Melur
34.	Melur-test (4).jpeg	Melur	Melur
35.	Melur-test (5).jpeg	Melur	Melur
36.	Melur-test (6).jpeg	Melur	Melur
37.	Melur-test (7).jpeg	Melur	Melur
38	Melur-test (8).jpeg	Melur	Melur
39.	Melur-test (9).jpeg	Melur	Melur
40.	Melur-test (10).jpeg	Melur	Melur
41.	Kempas-test (1).jpeg	Kempas	Jati Putih
42.	Kempas-test (2).jpeg	Kempas	Kempas
43.	Kempas-test (3).jpeg	Kempas	Kempas
44.	Kempas-test (4).jpeg	Kempas	Kempas
45.	Kempas-test (5).jpeg	Kempas	Kempas
46.	Kempas-test (6).jpeg	Kempas	Kempas
47.	Kempas-test (7).jpeg	Kempas	Kempas
48.	Kempas-test (8).jpeg	Kempas	Kempas
49.	Kempas-test (9).jpeg	Kempas	Kempas
50.	Kempas-test (10).jpeg	Kempas	Jati Putih

To calculate the accuracy of the test, the equation used is the following equation:

$$\text{Accuracy} = \frac{\text{Jumlah data uji yang benar}}{\text{Jumlah data uji keseluruhan}} \text{ x } 100$$

The accuracy of the test results in Table 2 can be seen in Table 3.

Table 3. Accuracy of system

No	Timber Type	Correct Identification	Accuracy
1.	Keruing	10	100%
2.	Jati Putih	9	90%
3.	Mahoni	10	100%
4.	Melur	10	100%
5.	Kempas	8	80%

$$\text{Average Accuracy} = \frac{(10 + 9 + 10 + 10 + 8)}{50} \text{ x } 100 \quad = 94\%$$

For further testing, we simulated the maximum parameter selection epoch in the training process. Epoch maximum parameter selection was done by the experiment performed using the same initial weight. The test results of 10 images per type of wood can be seen in Figure 3.

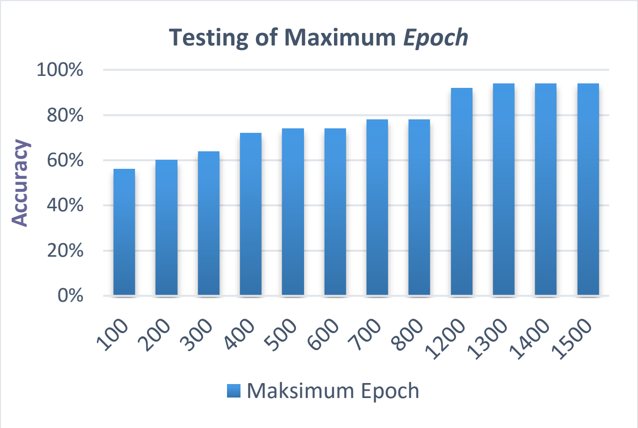

Figure 3. Testing of maximum *epoch*

Figure 3 shows the maximum epoch, the number of actual output in accordance with the desired output per type of wood as well as accuracy. The test results shows that the maximum epoch to 1300, the accuracy has reached 94%.

4. Discussion
Based on the tests performed, the identification of the type of wood can be done by using artificial neural networks backpropagation as a method of classification of types of wood according to predetermined targets with accuracy 94%. Propagation parameters such as the maximum value of the epoch has an influence on the accuracy of the test results. In testing the propagation parameters, the test gives an accuracy of 94% at the maximum value exceeds epoch 1300. The larger the value, the accuracy is increased. In a subsequent study is expected to develop by combining other methods to improve accuracy.

5. Conclusion
We have successfully develop a digital image based method to identify the type of timber automatically. In this study, backpropagation neural network is used as artificial intelligence component. Several stages were developed: a microscope image acquisition, pre-processing, feature extraction using gray level co-occurrence matrix and normalization of data extraction using decimal scaling features. The results showed that the proposed method was able to identify the timber with an accuracy of 94%

References
[1] Mandang YL and Pandit IKN 1997 *Pedoman Identifikasi Jenis Kayu di Lapangan.* Seri Manual. PROSEA: Bogor
[2] Triantoro T, Batubara FR and Fahmi F 2014 Image based water gauge reading developed with ANN Kohonen Proceedings of 2014 *Int. Conf. on Electrical Engineering and Computer Science, ICEECS Bali*
[3] Muhammadiy W and Fahmi F 2016 Mobile Application to differentiate flesh meat between beef and work *The 2016 IEEE International Conference on Computational Intelligence and Cybernetics* (CYBERNETICSCOM*)* Makassar
[4] Siswanto A, Tarigan P and Fahmi F 2013 Design of contactless hand biometric system with relative geometric parameters *Proc. of 2013 3rd Int. Conf. on Instrumentation, Communications,*

Information Technol., and Biomedical Engineering: Science and Technol. for Improvement of Health, Safety, and Environ., ICICI-BME Bandung

[5] Listia R and Harjoko A 2014 Klasifikasi massa pada citra mammogram berdasarkan grey level cooccurence matrix (GLCM). *Indonesian Journal of Computing and Cybernetics Systems* **8(1):** 59-68.

[6] Risaldi M, Purwanto and Himawan H 2014 Klasifikasi kualitas kayu kelapa menggunakan algoritma *neural network backpropagation. Jurnal Teknologi Informasi* **10(1)**: 69-78.

[7] Mohan SK, Venkatachalaphaty K and Sudhakar P 2014 An intelligent recognition system for identification of wood species. *Journal of Computer Science* **10(7)**: 1231-1237.

[8] Gunawan AAGR, Nurdiati S and Arkeman Y 2011. Identifikasi jenis kayu menggunakan *support vector machine based on image data. Jurnal Ilmu Komputer Agri-Informatika* **3(1)**: 1-8.

[9] Gadkari D 2004 Image quality analysis using GLCM. *Thesis under publication. University of Central Florida.Yang, X.S*. 2009.

[10] Ferguson JR 2007 Using the grey-level-co-occurrence matrix to segment and classify radar imagery. *Thesis under publication*. University of Nevada.

[11] Kadir A, Nugroho LE, Susanto A and Santosa PI 2011 Neural network application on foliage plant identification. Int. J. of Computer Applications **29(9)**: 15-22.

[12] Atomi WH 2012 The effect of data preprocessing on the performance of artificial neural networks techniques for classification problems. *Thesis under publication. University Tun Hussein Onn Malaysia.*

[13] Purnamasari RW 2013 Implementasi jaringan syaraf tiruan *backpropagation* sebagai sistem deteksi penyakit *tuberculosis* (TBC). *Thesis under publication. Universitas Negeri Semarang.*