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The Comparison of Classification Accuracy on the Teak Wood Image Processing using Support Vector Machine (SVM) and Artificial Neural Network (ANN)

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ABSTRACT
Tropical climate in Indonesia resulted this country having the largest and most tropical rainforests. Numerous types or varieties of tress grow, however not all types have sale value. Teak wood among other types of wood is the top commodities due to its high-value. In general, the identification of wood types in Indonesia depends on the subjectivity of human's eyes thus the process is slow and inaccurate. Therefore, technology is used to overcome human limitations in observing or analyzing the classification or grouping according to the wood types. This study aims to compare Classification Accuracy on Teak Wood Image Processing using Support Vector Machine (SVM) and Artificial Neural Network (ANN) with 3 data varieties namely semarangan, blora, and Sulawesi. Based on the results of tests and analyses carried out, it can be concluded that classification method ANN obtained higher accuracy with 76.0% accuracy value compared to SVM with 72.0% accuracy value.

Keywords
Teakwood; SVM; ANN; Classification; Digital Image

1. INTRODUCTION
Indonesia with its tropical climate provides opportunities for biodiversity, one of which is the largest and most tropical forests as well as flora and fauna that make up the ecosystem. The main component of the forest itself is a forest stand providing life so as to create a fairly complex ecosystem. This diversity makes Indonesia a key producing country of tropical and sawn timber, plywood and other wood products, as well as pulp for papermaking. More than half of Indonesia's forests, nearly 54 million hectares, are allocated for timber production (although not all are being actively logged), and another 2 million ha of industrial plantations have been established [5].

There are many types of wood in Indonesia, such as jackfruit, bengkirai, teak and others. Among the woods that are widely grown in Indonesia, teak is the most commercial tress due to its high-value [5]. Thus, teakwood (Tectona grandis L. f.) is desirable for cultivation [3], wood from natural forest has better basic properties than timber from plantation forest. In 1950, teak plantations in Java covered an area of 824.000 ha [7].

There are several types or varieties of teak wood that will be discussed in this journal as learning data,
namely semarang, blora and Sulawesi. Each type of teakwood has its own properties: texture, specific gravity, color and many others. Because the grains or textures is almost identical, it is difficult for humans to recognize it because it depends on the subjectivity of their eyes. The process identification becomes the major concern for manufacturing companies in order to maintain the quality manufactured product, sorting teakwood is a priority.

Observing using the naked eye becomes its own limitations because it is less sensitive to recognize small changes that occur gradually. Therefore, technology is utilized to overcome human limitations in observing or analyzing wood texture. The technology also helps the efficiency of existing observations as well as becomes faster and more accurate, compared to the observations by human eye and sensitivity. This study will analyze image texture using Support Vector Machine (SVM) and Artificial Neural Network (ANN).

The application of the Support Vector Machine (SVM) and Artificial Neural Network (ANN) methods has been compared to their effectiveness in research [11] by comparing the image processing of Tuna fish eyes. The study concluded that the k-NN classification method is the best classification method that can be used to predict tuna freshness based on tuna eyes images with a correlation coefficient of 0.83 and RMSE 3.75%. The further research based [10] on the comparison of the accuracy of teak image classification using the Naive Bayes and k-Nearest Neighbor (k-NN) methods where in general the k-NN method is better at classifying 3 types of teak wood, namely semarangan, blora and sulawesi with a high level of accuracy over 70%. However, the best classification for Sulawesi teakwood species is the Naive Bayes Method with an accuracy rate of 82.7%.

Based on the findings of several studies above, this study was conducted to make another comparison using the Support Vector Machine (SVM) and Artificial Neural Network (ANN) Methods for Teak Wood Image Processing with 3 data varieties; Semarang, Blora and Sulawesi. The study aims to find a method with the best accuracy results for classifying the teak wood varieties.

2. LITERATURE REVIEW

2.1 Support Vector Machine (SVM)
Support Vector Machine (SVM), proposed by Boser, Guyon, Vapnik, is a supervised learning method that can be used for classification and regression. SVM is trained with a learning algorithms based on optimization theory by implementing a learning bias derived from statistical learning theory [4]. The basic concept of SVM is actually a harmonious combination of computational theories that have existed for decades before, such as the hyperplane margin (Duda& Hart 1973, Cover 1965, Vapnik 1964) SVM is capable of doing linear and nonlinear classification and regression.

SVM is used to find the optimal hyperplane by maximizing the margin between classes. While hyperplane itself is a function that can be used to perform separation between classes. Unlike what is done by neural network strategy which find a separating line (hyperplane) between classes, SVM will try to find the optimal hyperplane in the input space.
SVM is the most widely used and developed method. SVM can give good results if the existing data set has a relatively higher dimension. SVM uses a kernel technique that will map the data from initial space to a new higher-dimensional space. Another advantage of SVM is that not all training data is involved in the training [6].

2.2 Artificial Neural Network (ANN)

ANN was designed based on the complex learning system of the human biological brain where the brain network works with the help of neurons to complete complex tasks such as grouping and understanding pila. This Artificial Neural Network or ANN is easily inspired by how the neurons in the brain with the ability to stimulate, process end output. The data or knowledge collection is performed by detecting patterns that occur and a relationship in the training data based on experiences (Figure 1).
The implementation of ANN is mostly used to make predictions, pattern recognition, optimization and stimulation. ANN is capable of learning using large amount of data sets with additional attributes. ANN has the potential ability to accurately predict and classify student academic performance in higher institutions, especially by considering the Correct Classification Rate (CCR) value.
In this training method, the Forward Pass occurs where the input will be propagated to the output layer and the results of the predicted output will be compared with the outcomes, using a function called Loss Function.

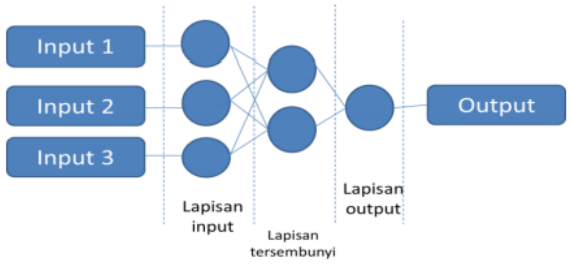


Figure 1. Example of a simple ANN

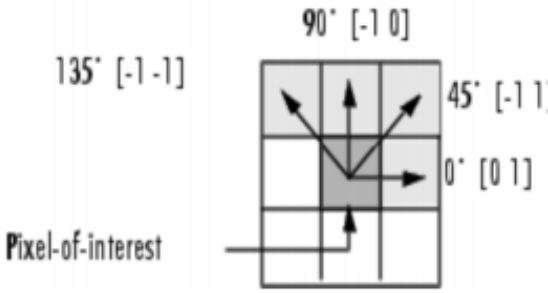
The Loss Function is used to measure how well the neural network performs in predicting the outcomes. There are many types of the Loss Function, but the most commonly used regression loss function is Squared Loss (L2 Loss) while Cross Entropy for classification. Loss formula in Equation 1

$$Loss = (Target - Prediction)^2 \quad (1)$$

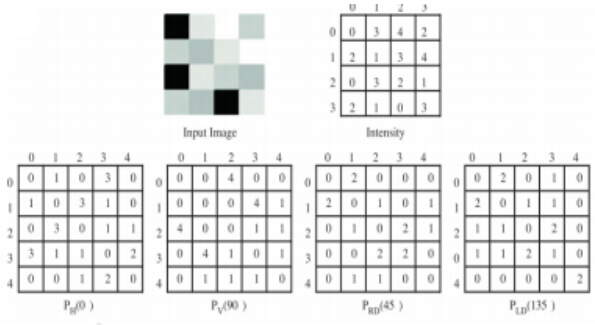
The network begins with a small random value except 0 which is assigned to each connection weight in the ANN. The datasets with the same size as the input layer will be applied to the network one by one and then the model produces several outputs and the error is calculated through the difference between the
outputs produced by the actual output in the dataset). The network then tries to reduce the errors that occur by adjusting the weights for each connection that occurs based upon the error value measured which is calculated through a process called Back Propagation or Backward Pass.
The Back Propagation process is intended to make adjustments to each weight and bias based on the errors obtained within the forward pass.

2.3 Gray Level Co-occurrence Matrix (GLCM)

GLCM is a technique used for analyzing a texture in a digital image by presenting the relationship between 2 neighboring pixels with grayscale intensity, distance and angle. GLCM first proposed by Haralick in 1973 with 28 features to explain spatial patterns [2]. The GLCM is a statistical method that calculates gray-level distribution (histogram) by measuring the level of contrast, granularity, and roughness of an area from the neighboring relationship between pixels in the image.
To perform image analysis based on the statistical distribution of the pixel intensity, it can be done by extracting texture features [13]. The angle formed from the pixel values of the GLCM image is 0º, 45 º, 90 º, 145 º [1] (Figure 2).



(a)



(b)

Figure 2. (a) Pixel from different angles (b) llustration of a co-occurrence matrix Source: (Eleyan&Demirel 2011)

2.4 Confusion Matrix

The comparison between the Support Vector Machine (SVM) and Artificial Neural Network (ANN) method is carried out by analyzing the comparison of Confusion Matrix or also known as error matrix. This comparison method works by comparing the results of training image with test results to obtain a Confusion Matrix in the form of a matrix table that describes the performance of the classification model on a series of test data whose actual values are known. Confusion Matrix is needed to determine how good the model we create. Figure 3 shows the Confusion Matrix with 4 different combinations of predicted and actual values.

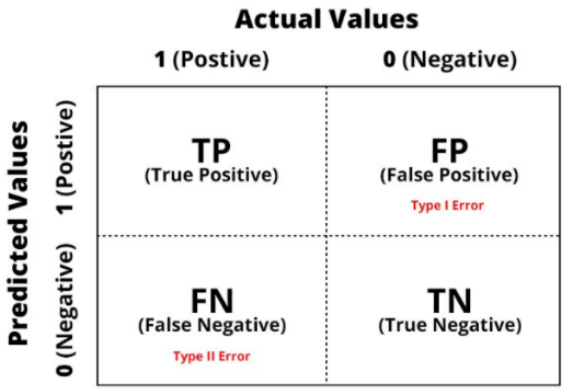


Figure 3. Confusion Matrix with 4 different combinations of predicted and actual values

The output of the Confusion Matrix classification is represented by 4 terms, namely

- True Positive (TP) is positive data that is predicted to be true. The actual value of the original class is true/1 and the value of the predicted class is also true/1.
- True Negative (TN) is negative data that is predicted to be true. The actual value of the original class is false/0 and the predicted class value is also false/0.
- False Positive (FP) – Type I Error is negative data but predicted as positive data. The actual original class value is false/0 and the predicted class value is opposite, i.e., true/1.
- False Negative (FN) – Type II Error is positive data but predicted as negative data. The actual value of the original class is true/1 and the value of the predicted class is the opposite, i.e., false/0.

The recall, accuracy and precision values will be obtained from the Confusion Matrix to be used as a benchmark for the performance of the model that has been developed.

Accuracy will provide data or a description of how accurately the model is able to classify correctly. Thus, accuracy is the ratio of number of correct predictions to all available data or the degree of proximity of a predicted value to its actual or value. The accuracy value is calculated by Equation 2.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (2)$$

Precision provides a degree of accuracy between the requested data and the prediction results provided by the model. Thus, precision is the ratio of number of positive correct predictions to the overall positive predicted outcome. The precision value is calculated by Equation 3.

$$Precision = \frac{TP}{TP + FP} \quad (3)$$

Recall or Sensitivity (True Positive Rate) provides data about the success of a model in finding information. Thus, recall is the ratio of number of true positive predictions to all true positive data. The recall value is calculated by Equation 4.

$$Recall = \frac{TP}{TP + FN} \quad (4)$$

F1 Score is the weighted average of precision and recall. F1 Score can be calculated using Equation 5.

$$F1\ Score = \frac{2 \times (Recall \times Precision)}{(Recall + Precision)} \quad (5)$$

2.5 Teakwood

Teakwood (Tectona grandis L. f.) is a popular timber used by the community for building materials and furniture that has strength and high value due to its beauty and durability. Teakwood in Java has a class of its own against the company since the Dutch colonial era, where teak wood began to be planted and used. There are many advantages of teakwood, making it one of the most popular woods in the world [9].

There has been a lot of research on teak wood, especially technological research to improve the quality or added value of teak wood. One of them is the tissue culture method in which the propagation of teak seedlings, which only relied on using seeds, can be developed using tissue culture. The purpose of tissue culture is to produce seeds quickly, in large numbers of plant seeds with good and superior properties [12].

3. METHODOLOGY

3.1 Research Materials and Tools

The materials used in this study were teak wood digital image (Tectona grandis L. f.) with a variety of Semarangan teak wood (from Semarang City), Sulawesi (from Southeast Sulawesi), and Blora (from Blora Regency). The digital image data used was from teak wood that has been cut and unprocessed such as raw teakwood, thus there is no teak wood modification for the accuracy of image or data. Image retrieval using digital microscope camera. Other supporting tools used in this research for digutal image data processing are as follows:

1. Laptop Intel Core i5 processor 8th Gen (64 bit) RAM 8GB
2. Operating System Windows 10 (64 bit)
3. Software Mathlab, Jupyter Notebook.

3.2 Research Procedures

The stages of research procedures can be seen in Figure 4 below.

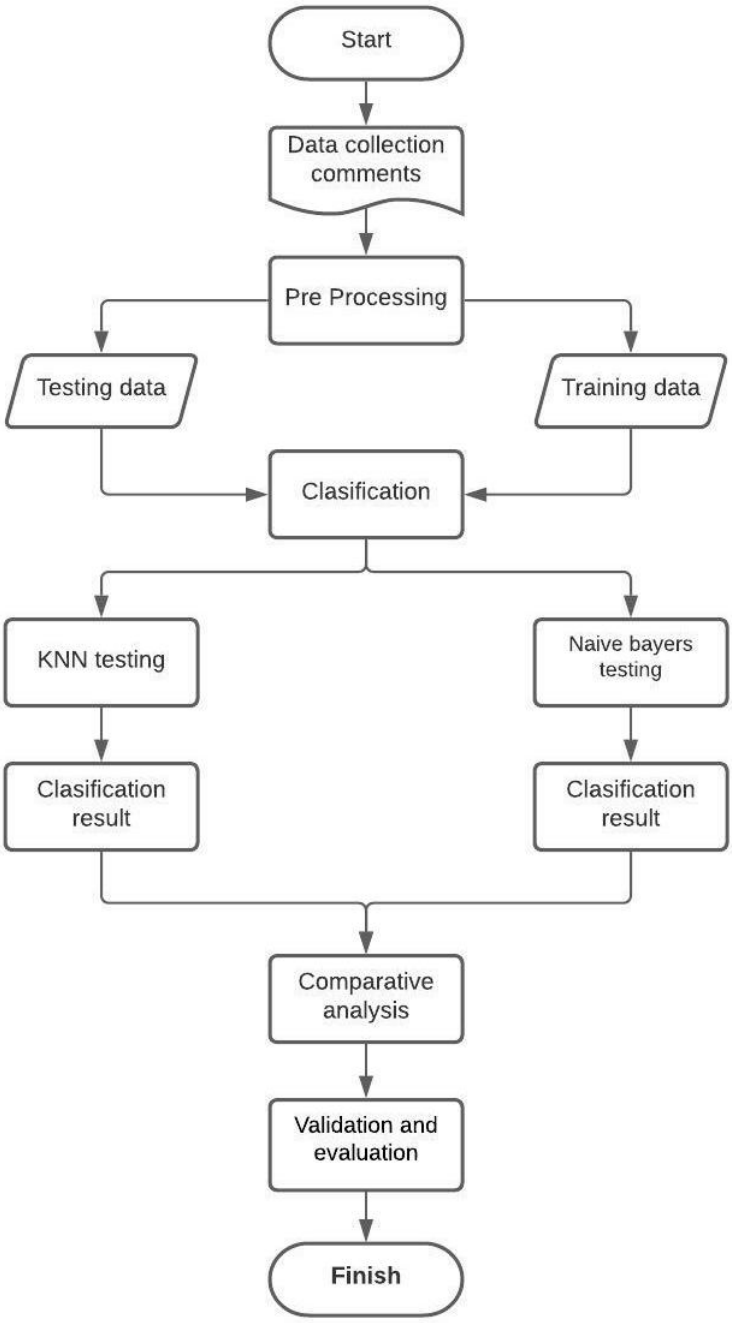


Figure 4. Research Procedures

The procedures used in this research was Digital Image Processing method. The prepared teakwood (already cut and raw) was taken its image using digital microscope camera. Digital image data used or taken was a variety of semarangan teakwood, Blora, and Sulawesi. The taken teakwood image was still in the form of Red, GreeN, Blue (RGB) images and then converted into gray/grayscale (texture feature extraction) with values from 0-255. The conversion or processing is performed using Mathlab software. The results of the sample image of teak wood are converted to the form of a gray level to obtain GLCM

4. RESULTS AND DISCUSSION

From the image data (Figure 5), the parameter values extracted using GLCM. Furthermore, feature extraction can be carried out after converting from RGB to grayscale using GLCM to produce 4 parameters in the form of Contrast, Energy, Homogeneity and Corellation which are used for texture analysis (Figure 8). The parameter values generated from feature extraction are then analyzed for sensitivity by using regression testing.

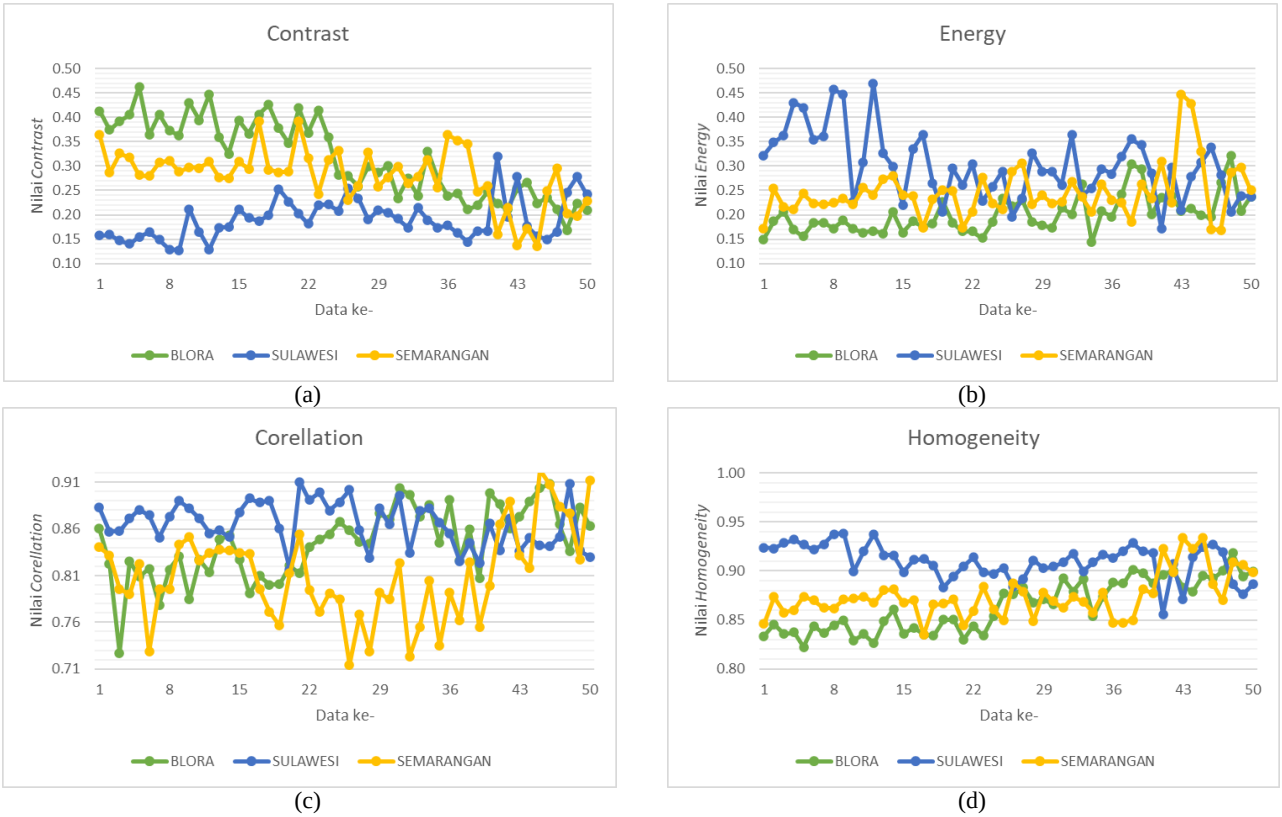


Figure 5. Parameter values extracted using GLCM
(a) Contrast, (b) Energy, (c) Corellation, (d) Homogenity

The dataset was then prepared to be loaded using pandas and divided into training data and test data with 67% and 33% settings, respectively. The loaded data is tested for two classification methods, namely SVM and ANN.

Figure 6 and 7 below shows how the graph of the movement of the accuracy value (acc) and the loss value (loss) uses the ANN method. The blue line indicates the movement of the data train or training data. The loss model graph shows the training data for the loss value obtained which continues to drop until the 140th epoch. While the accuracy model graph shows the accuracy value of the iteration results generated for both training data which increases to the 140th epoch

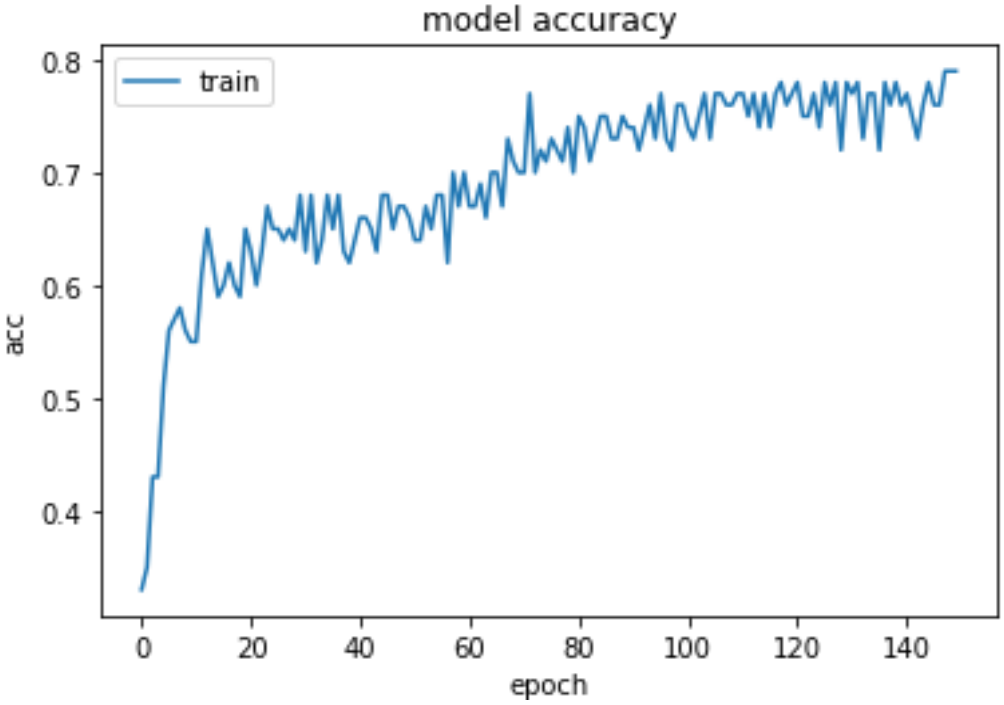


Figure 6. The Graph of Accuracy / acc value movement graph for ANN Iteration Results

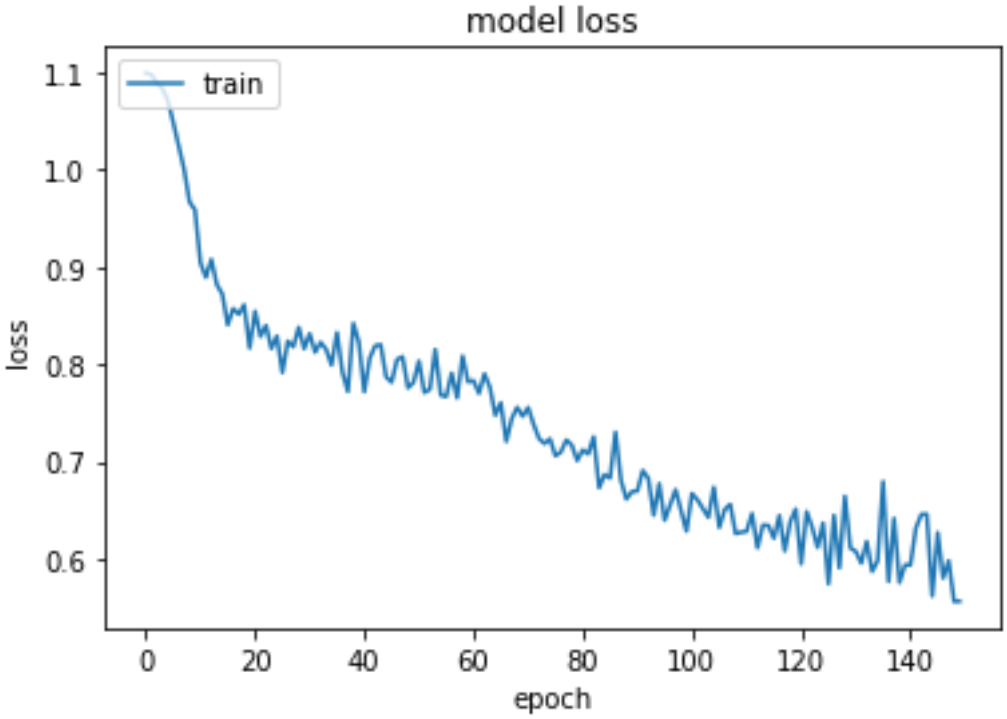
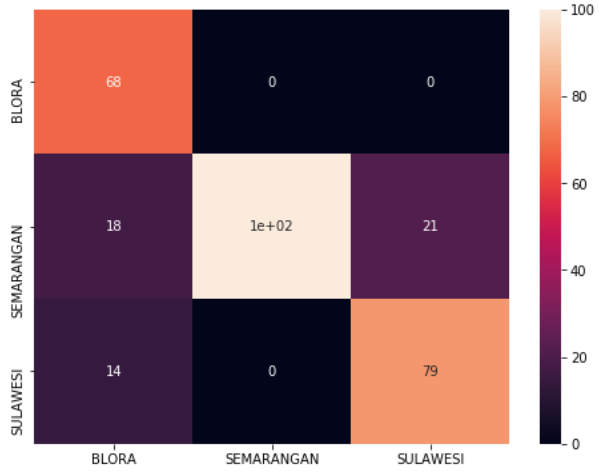


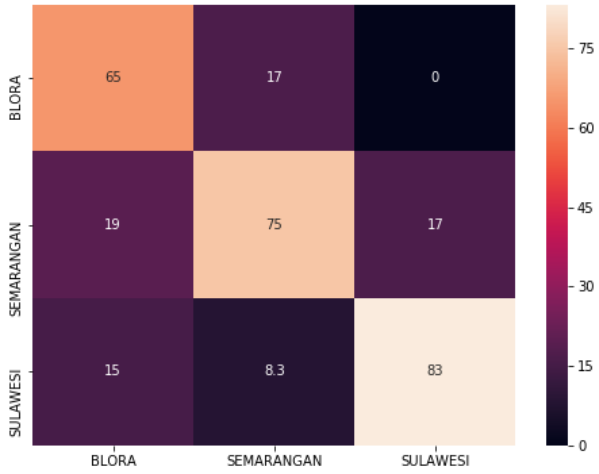
Figure 7. The Graph of Loss movement graph for ANN Iteration Results

ANN performs better than SVM Classifier with the ability to generalize learned data and predict according to neural processing. The ANN configuration is set to a short AutoEncoder which has 30 Layered Dense, then 70 Layered Dense and followed by a 100 Layered Dense network to emulate the encoding part. The decoding part is continued in reverse order with 70 & 30 Layered Dense layers, all with ReLU (A Rectified Linear Unit) Activation. The output layer has 3 nodes (in 3 classes to predict) applied with the softmax activation function, trained with categorical crossentropy and rmsprop optimizer.

The results of the confusion metrics of 3 teakwood varieties (Blora, Semarang and Sulawesi) using the SVM and ANN methods are shown in Figure 8.



(a)



(b)

Figure 8. Confusion Matrix Model
(a) ANN, (b) SVM

SVM classifiers are trained on pre-prepared pipelined datasets to achieve faster results. The performance of ANN and SVM metrics are shown in Figure 9 and Figure 10, respectively.

```
Perc. Score 76.0%
F1 Score 74.99%
Recall 0.7444
Precision 0.76
Class  0 --ROC---> 0.16
Class  1 --ROC---> 0.57
Class  2 --ROC---> 0.81
```

Figure 9. The results of ANN performance on teak wood images

```
Perc. Score 72.0%
F1 Score 71.5%
Recall 0.708
Precision 0.72
Class  0 --ROC---> 0.18
Class  1 --ROC---> 0.58
Class  2 --ROC---> 0.78
```

Figure 10. The results of SVM performance on teak wood images

From the results of the ANN performance above, the accuracy rate of 76.0% and the accuracy rate of SVM performance is 72.0%. The ANN method has a higher accuracy than the SVM method, and is still relatively high compared to the previous study by [10] using k-NN, but still lower than the study [10] using the Naïve Bayes method for Sulawesi teak.

For prediction results using machine learning classification, the results of the ANN method have a higher running rate (S) of 2.82450 than the SVM method with a value of 0.13963 as shown in Table 1 below. The ANN method is a better classification method than SVM because it has the ability to learn data in general by imitating the behavior of the brain and perform better overall performance.

Table 1. Prediction results using machine learning classification

Algorithm model	Running Rate (S)
Support Vector Machine (SVM)	0,13963
Artificial Neural Network (ANN)	2,82450

5. CONCLUSION

Based on the results of the tests and analyses carried out, it can be concluded that the ANN classification method is the optimal classification method compared to SVM with an accuracy rate of 76.0% while SVM has an accuracy rate of 72.0%. Specifically, the resultshas a difference of ~4%.

ANN is better classification method compared to SVM because it has the ability to learn data in general by imitating the behavior of the brain and perform better overall performance. The layered neural network architecture also allows ANNs to be trained in parallel through other processing units such as GPUs to speed up training. The trained model does not require a large space to store information because it is stored in the network connection weights.In further research, it is necessary to develop an image capture using a microscopic camera that has a higher magnification capability so that a quality dataset can be produced.

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