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Classification of Traditional Batik Motifs in Central Java using Gabor Filter and Backpropagation Neural Network

Laily Muntasiroh[1], R.Rizal Isnanto[2], Aris Triwiyatno[3]

[1,2,3]Department of Electrical and Electronic Engineering, Diponegoro University, Semarang, Indonesia
Email: [1]lailymuntasiroh@students.undip.ac.id, [2]rizal_isnanto@yahoo.com,
[3]aristriwiyatno@live.undip.ac.id

Abstract

Batik has a variety of varied motifs, each region in Indonesia has certain characteristics on batik motifs. Based on literature studies the use of backpropagation neural network methods to recognize complex patterns has a satisfactory rate of success. The purpose of this research is to develop and apply neural networks that are fast, precise and accurate to classify batik designs and patterns. Types of batik motifs typical of Central Java that are used include; Truntum from Solo, Warak Ngendhog from Semarang, Sekar Jagad from Lasem, Burnt from Pati, and Jlamprang from Pekalongan. The image first undergoes RGB color feature extraction based on mean values of R, G, and B, and Gabor filter texture characteristics. The tests were carried out using 90 batik images, 60 batik images for training data and 30 batik images for testing data. The results of the study concluded that the best parameter settings were, the number of hidden layer 30 neurons in the first layer and 15 in the second layer, with 6 input layers and 5 output layers. Gabor filter with 90º orientation angle and wavelength 4 become the best combination in this study. From the results of training and testing results obtained an average accuracy of 93.3% in all batik classes in Central Java.

Keywords: Backpropagation, Gabor, Batik, Extraction, Patterns

1. INTRODUCTION

Batik is an ancient method of textile decoration which has been practiced in many places all over Asia since prehistoric times. It’s one of the world’s cultural heritages with various decorative pattern [1-2] In Java, Indonesia the technique was developed more than anywhere else. Batik is a cultural heritage not because of the batik itself but because of the art in making the batik [3].

There are several past research addressing the same problem of batik patterns classification. In[4] the authors explored the color-based clustering algorithm, contrast-based algorithm, and other mask and shape-based feature extractors. Further discussion on feature extraction methods can be found in[5] where the authors compared the performance of Gabor filters [6], canny edge detectors, and gray level co-occurrence matrix (GLCM) in several testing scenarios. Similar to [2] and [7], the authors [5] of also found that the GLCM features have the best accuracy for batik classification. Other features such as scale-invariant feature transform (SIFT) [8] local binary pattern [9] had already been explored. For the classification model, several approaches have been proposed such as using decision tree [3], fuzzy neural network [1], backpropagation neural network [10], k-nearest neighbor [11], and support machine [6,8].

Based on literature studies the use of backpropagation neural network methods as a training model for recognizing complex patterns of success rates for recognizing a pattern of an object is very good. For example, research "Batik Classification with Artificial Neural Networks Based on Texture-Shape Features of Main Ornament" with the accuracy is 70.84% [10] . In a previous research by Suhartono, Sutikno and Priyo Sidik Sasongko "Modeling Identification of Batik Motifs Using the Method of Backpropagation Artificial Neural Networks and Template Matching Algorithms" with the accuracy is 60% [12].

Batik motifs have vast variations, which is very difficult to identify for people. There have been many studies to identify or classify batik motifs in general for the identification process [12]. The feature extraction process uses a combination of Gray Level Co-occurrence Matrix (GLCM) and statistical color RGB [10]. A combination of Bag of Features (BOF) and Scale-Invariant Feature Transform (SIFT) [13], content based batik image classification using wavelet transform and fuzzy neural network, texture feature extraction using co-occurrence matrices of sub-band batik image for image classification [14] , automatic batik motifs classification using various combinations of properties features moments and k-Nearest Neighbor [11], batik motif classification using color-texture-based feature extraction and neural backpropagation network [15], fast discrete curvelet transform and HSV color features for batik image classification [16], application of an artificial neural network for modeling the mechanical behavior or carbonate soils [17], based on these previous works, researchers need to build the model classification of motifs using the method of backpropagation artificial neural network using a Gabor filter.

The research entitled [10] "Batik Classification with Artificial Neural Networks Based on Texture-Shape Features of Main Ornament" classifies batik motifs by processing digital images of batik motifs using the feature selection pattern recognition method. The results of this study are models for the classification of batik motifs with artificial neural networks based on selected features from a combination of texture features and ornamental shape features.

Research entitled [12] "Modeling Identification of Batik Motifs Using the Method of Backpropagation Artificial Neural Networks and Template Matching Algorithms" This model was built based on artificial neural network methods and template matching algorithms. The model is to identify the type of motif.

Computational results using the backpropagation method, artificial neural networks are able to identify 9 types of motives with an accuracy of 60%. Based on the results of calculations using an android smartphone to identify motifs using a template matching algorithm, able to recognize 9 types of motifs with an accuracy of 56%. The results of this test are to determine the level of success of the application to recognize batik motifs from the input image. By taking 35 tested data, the system is able to recognize 21 data tests or 60% succeed. Identification of batik motifs using templates that match those implemented on Android-based smart phone features.

2. METHODS

The discussion of a system that is able to classify batik in a typical part of central Java using a backpropagation neural network using MATLAB 2017a. This simulation uses the image processing of the input image before the image is inserted into the artificial neural network. The image first undergoes feature extraction which is the RGB color feature based on the average values of R, G, and B, and the Gabor filter texture characteristic based on the mean (average), entropy, and variance of the magnitude image. Gabor patterns are defined as the product of a sinusoid function and a Gaussian envelope and are commonly used in visual and attentional research due to their ability to selectively stimulate the primary visual cortex [18].

The training process is a system development process that aims to train artificial neural networks to be able to recognize and classify batik typical of Central Java. The training process uses 60 training data. After the neural network is well trained in the training process, this network is ready for use in the classification process. Pre-processing is the initial process that is carried out in image processing before the data is processed using artificial neural networks in order to obtain clearer object characteristics. In this step the size of the batik image from the digital camera and mobile camera is converted to an image of 256x256 pixels. This change of mind aims to reduce computing time so that the workload of the computer can be reduced.

Batik is the art of crafting cloth that has high artistic value and has been a part of Indonesian (especially Javanese) culture for a long time. This research builds a model to classify batik typical of Central Java such as, Pekalongan, Solo, Semarang, Lasem and Pati using a backpropagation artificial neural network. This model is to classify 5 motifs, as shown in Table 1**.**

Table 1. Batik Motif Types

No	Batik motif image	Batik motif type
1.		Batik Bakaran Pati
2.		Batik Jlamprang Pekalongan
3.		Batik Sekar Jagad Lasem
4.		Batik Warak Ngendhog-Semarang
5.		Batik Truntum-Solo

The next process is extracting the RGB color features to take the value of each RGB component. Researching images by paying attention to color content is a widely used technique. In general, color feature extraction only pays attention to the pixels in the image without regard to the size or position of the image.

Figure 1 is the stage of the process for all system. The feature extraction method used in this study is the Gabor filter Feature Extraction. The Gabor filter is a new filtering method [19-21]. The Gabor texture analysis algorithm is useful for extracting different features from each region and classifying them based on existing patterns. Gabor filter has two order calculations to get the six parameters needed in this study. In the first-order Gabor filter, Gabor filter will calculate the formula for the form irregularity (entropy) directly based on the image histogram value. Gabor filters can be calculated using the angle (θ) and distance (d). There are 4 angles on the Gabor filter namely 0˚, 45˚, 90˚ and 135˚ and with a distance of 1,2,3 and 4. However in this system the best combination is the 90˚ angle with a distance of 4.

The network architecture used by the backpropagation algorithm is a multilayer forward propagation network, to construct a forward propagation network newff instruction is used:

Net = newff (PR, [S1 S2 ... SN1], {TF1 TF2 ... TFN1}, BTF, BLF, PF.

PR is a matrix containing input and target variables. Si is the number of neurons in the *i* layer and TF is the *i* layer activation function, with *i* = 1, 2, ..., N1. BTF is a network training function, BLF is a weight training function, and PF is a performance function. Forward propagation networks have default functions that will be automatically used by the network if these functions are not set up when building the network.
In this research, the Lavenberg-Marquardt (trainlm) network training function is used. In addition to being the default advanced propagation training function, the trainlm is used for approach problem functions whose network has a weights of less than one hundred and the approach must be very accurate. But trainlm requires a large memory during the training process. Detail stage of the process for all system is shown in Figure 1.

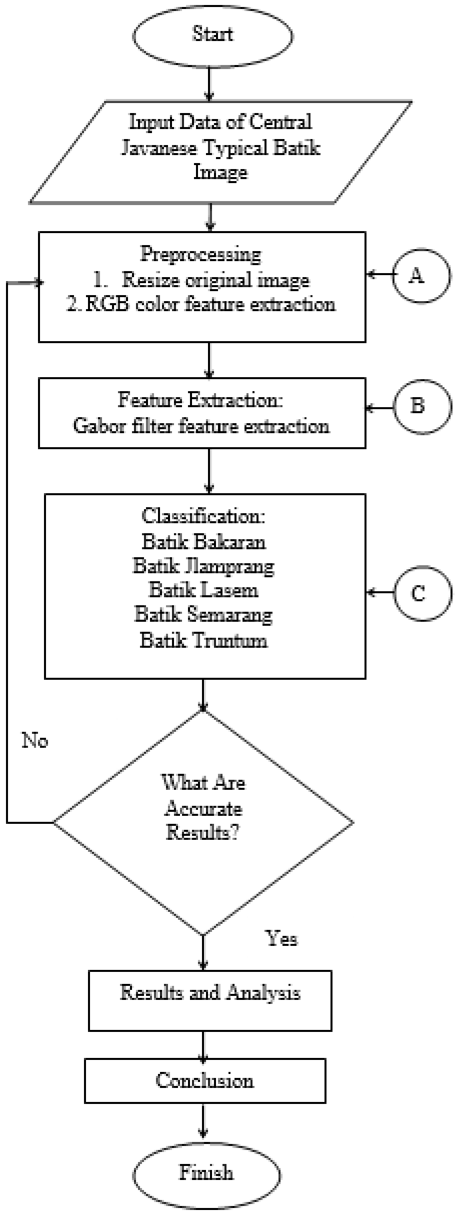

Figure 1. Stage of the process

The training parameters that exist in artificial neural networks with the Lavenberg-Marquardt network training function (trainlm), which need to be set before conducting training in order to obtain optimal training results as shown in Table 2.

An artificial neural network architecture design consisting of 6 inputs consisting of R, G, B, entropy, average, variance, 2 hidden layers and 5 outputs consisting of the Bakaran batik class, Jlamprang batik, Sekar Jagad batik, Warak Ngendhog batik and Truntum batik. Hidden layer 1 totaling 30 neurons using the activation function 37 tansig, hidden layer 2 totaling 15 neurons using the activation function. The output layer uses the purelin activation function with neurons total of 5 neurons.

Table 2. The Design Of Artificial Neural Network Architecture

Characteristics	**Specification**
Number of Input Layer Neurons	6
Number of hidden layer neurons Layer 1	30
Number of hidden layer neurons Layer 2	15
Number of Output Layer Neurons	5
Activation Function	*Tansig-logsig-purelin*
Algoritma *Training*	*Trainlm*
Error Tolerance	10^{-5}
Set *Epoch* Maksimum	10000
Learning Rate	0.5
Value *Mu*	0.7
Gradient Minimum	10^{-8}
Set *Max* Momentum Unit	10^{13}
Momentum unit *decrease*	0.1
Momentum unit *increase*	10

3. RESULT AND DISCUSSION

This section will explain the stages of the results and analysis of the system. The testing results with the best settings are using a variation of parameters where the number of hidden layer 30 neurons in the first layer and 15 in the second layer, with parameters 6 input layer and 5 output layer. In this research Gabor Filter with 90º orientation angle and wavelength 4 become the best combination. Resulting in an accuracy of 93.3%, as shown in Table 3.

Table 3. Scenario training and testing combination

Gabor fillter		Training and testing	Accuracy	
θ	(º)	periode (s)	Training (%)	Testing (%)
2	45	6.728	100	83.3
3	45	3.392	100	80
4	45	6.247	100	83.3

5	45	5.021	100	83.3
6	45	4.874	100	80
7	45	4.596	100	80
2	90	4.633	100	90
3	90	4.184	100	90
4	90	4.155	100	93.3
5	90	4.562	100	90
6	90	5.304	100	90
7	90	3.430	100	90
2	135	5.205	100	83.3
5	90	4.562	100	90
3	135	6.122	100	83.3
4	135	5.857	100	80
5	135	4.896	100	80
6	135	4.344	100	83.3
7	135	5.990	100	76.7

TESTING RESULTS

Tests carried out using 30 data with each category of 6 data. This data is data that has never been used in the network training process. The purpose of testing is to find out whether the network that has been trained can produce output following the target such as during training if the network is given other input data and the data has never been used as a network input.

The test is carried out with various combinations of Gabor filter parameters namely by changing the wavelength and orientation of the angles to get the best combination, which is shown in Table 2 of the test combination scenario. This is done to determine the extent to which this network recognizes input data.

The second test image of batik following the level classification uses 30 typical Central Javanese batik images consisting of 6 burnt batik class images from Pati, 6 Pekalongan Jlamprang batik class images, 6 batik Sekar Jagad class images from Lasem, 6 batik class images from the Warak Ngendhog from Semarang, and 6 images of Truntum batik from Solo. There are two images from 30 images that cannot be classified according to the target class determined by the backpropagation network that was built because the images in several classes have similar values, causing the network that has been built to be less than the maximum. Truntum Solo and Warak Ngendhog batik classes and are not legible as batik images, this is because the images used have a resolution that is not the same as the training data. It could also be because the image used does not have a feature extraction value that is similar in any class.

Table 4. Results

Batik Image	Results
Batik Image 1-1	Recognized

Batik Image 1-2	Recognized
Batik Image 1-3	Recognized
Batik Image 1-4	Recognized
Batik Image 1-5	Recognized
Batik Image 1-6	Recognized
Batik Image 2-1	Recognized
Batik Image 2-2	Recognized
Batik Image 2-3	Recognized
Batik Image 2-4	Recognized
Batik Image 2-5	Recognized
Batik Image 2-6	Recognized
Batik Image 3-1	Recognized
Batik Image 3-2	Recognized
Batik Image 3-3	Recognized
Batik Image 3-4	Recognized
Batik Image 3-5	Recognized
Batik Image 3-6	Recognized
Batik Image 4-1	Recognized
Batik Image 4-2	Not Recognized
Batik Image 4-3	Recognized
Batik Image 4-4	Recognized
Batik Image 4-5	Recognized
Batik Image 4-6	Recognized
Batik Image 5-1	Recognized
Batik Image 5-2	Recognized
Batik Image 5-3	Not Recognized
Batik Image 5-4	Recognized
Batik Image 5-5	Recognized
Batik Image 5-6	Recognized

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Validation values in the ninth test are:

$$\text{Validation} = \frac{28}{30} \text{ x } 100\ \% = 93.3\%$$

The validation value is obtained from the number of images successfully classified divided by the number of test images multiplied by 100%. Of the total tests 18 times each time the testing process is different and if the average time used is 4.1 seconds using the train. Training and testing were carried out 18 times based on Table 2.

In the testing process there are 30 batik images, which the batik is not included in the training data. From the variation of test parameters, the results shown in Table 4.

4. CONCLUSION

From this study it was concluded that by using the image processing process of color feature extraction, can be implemented to classify well. With the maximum number of training iterations (epochs) is set to a maximum of 1000 but only up to 10 epochs of the system are accurate. By using an orientation angle of 90º and wavelength 2 on the Gabor 1 order filter and building a backpropagation network with the number of hidden layers 30 and 15. The proposed artificial neural network with the average values of R, G, and B as well as Gabor filter texture feature extraction can be used for batik image classification with the accuracy 93.3% accuracy.

5. REFERENCES

[1] Kasim, A. A., & Harjoko, A. (2014, June). Klasifikasi citra batik menggunakan jaringan syaraf tiruan berdasarkan gray level co-occurrence matrices (GLCM). In *Seminar Nasional Aplikasi Teknologi Informasi (SNATI)* (Vol. 1, No. 1).

[2] Kasim, A. A., Wardoyo, R., & Harjoko, A. (2017). Batik classification with artificial neural network based on texture-shape feature of main ornament. *International Journal of Intelligent Systems and Applications*, *11*(6), 55.

[3] Rangkuti, A. H., Rasjid, Z. E., & Santoso, D. J. (2015). Batik image classification using treeval and treefit as decision tree function in optimizing content based batik image retrieval. *Procedia Computer Science*, *59*, 577-583.

[4] Moertini, V. S., & Sitohang, B. (2005). Algorithms of clustering and classifying batik images based on color, contrast and motif. *Journal of Engineering and Technological Sciences*, *37*(2), 141-160.

[5] Nurhaida, I., Manurung, R., & Arymurthy, A. M. (2012, December). Performance comparison analysis features extraction methods for batik recognition. In *2012 International Conference on Advanced Computer Science and Information Systems (ICACSIS)* (pp. 207-212). IEEE.

[6] Lahmiri, S., & Boukadoum, M. (2013). Hybrid discrete wavelet transform and Gabor filter banks processing for features extraction from biomedical images. *Journal of medical engineering*, *2013*.

[7] Handhayani, T. (2016, July). Batik Lasem images classification using voting feature intervals 5 and statistical features selection approach. In *2016 International Seminar on Intelligent Technology and Its Applications (ISITIA)* (pp. 13-16). IEEE.

[8] Azhar, R., Tuwohingide, D., Kamudi, D., & Suciati, N. (2015). Batik image classification using SIFT feature extraction, bag of features and support vector machine. *Procedia Computer Science*, *72*, 24-30.

[9] Nurhaida, I., Wei, H., Zen, R. A., Manurung, R., & Arymurthy, A. M.

(2016). Texture fusion for batik motif retrieval system. *International Journal of Electrical and Computer Engineering (IJECE)*, *6*(6), 3174-3187.
[10] Aditya, C. S. K., Hani'ah, M., Bintana, R. R., & Suciati, N. (2015, September). Batik classification using neural network with gray level co-occurence matrix and statistical color feature extraction. In *2015 International Conference on Information & Communication Technology and Systems (ICTS)* (pp. 163-168). IEEE.
[11] Setyawan, I., Timotius, I. K., & Kalvin, M. (2015, October). Automatic batik motifs classification using various combinations of SIFT features moments and k-Nearest Neighbor. In *2015 7th International Conference on Information Technology and Electrical Engineering (ICITEE)* (pp. 269-274). IEEE.
[12] Suhartono, S., & Sasongko, P. S. (2017). Modeling Identification of Batik Motif Using the Method of Back-propagation Artificial Neural Network and Template Matching Algorithm. *Applied Mathematical Sciences*, *11*(63), 3129-3139.
[13] Azhar, R., Tuwohingide, D., Kamudi, D., & Suciati, N. (2015). Batik image classification using SIFT feature extraction, bag of features and support vector machine. *Procedia Computer Science*, *72*, 24-30.
[14] Minarno, A. E., Munarko, Y., Kurniawardhani, A., Bimantoro, F., & Suciati, N. (2014, May). Texture feature extraction using co-occurrence matrices of sub-band image for batik image classification. In *2014 2nd International Conference on Information and Communication Technology (ICoICT)* (pp. 249-254). IEEE.
[15] Suciati, N., Pratomo, W. A., & Purwitasari, D. (2014, September). Batik motif classification using color-texture-based feature extraction and backpropagation neural network. In *2014 IIAI 3rd International Conference on Advanced Applied Informatics* (pp. 517-521). IEEE.
[16] Suciati, N., Kridanto, A., Naufal, M. F., Machmud, M., & Wicaksono, A. Y. (2015, September). Fast discrete curvelet transform and HSV color features for batik image clansificotlon. In *2015 International Conference on Information & Communication Technology and Systems (ICTS)* (pp. 99-104). IEEE..
[17] Vahid, R. & Hassanlourad, M., (2014), Application of an Artificial Neural Network for Modeling the Mechanical Behavior of Carbonate Soils, *International Jurnal of Geomechanic*, pp. 142–150.
[18] Caballero-Puntiverio, M., Prichardt, S., Klem, L., Bundesen, C., Vangkilde, S., & Andreasen, J. T. (2020). Gabor patterns as stimuli in a rodent visual attention task. *Neuroscience Letters*, 134970.
[19] Nazarkevych, M., & Nazarkevych, H. (2019). Ateb-Gabor Filtering Method in Fingerprint Recognition. *Procedia Computer Science*, *160*, 30-37.
[20] Nazarkevych, M., Klyujnyk, I., Maslanych, I., Havrysh, B., & Nazarkevych, H. (2018, April). Image filtration using the Ateb-Gabor

filter in the biometric security systems. In *2018 XIV-th International Conference on Perspective Technologies and Methods in MEMS Design (MEMSTECH)* (pp. 276-279). IEEE. [21] Khaleefah, S. H., Mostafa, S. A., Mustapha, A., & Nasrudin, M. F. (2019). The ideal effect of Gabor filters and Uniform Local Binary Pattern combinations on deformed scanned paper images. *Journal of King Saud University-Computer and Information Sciences.*