Modeling Identification of Batik Motif Using the Method of Back-propagation Artificial Neural Network and Template Matching Algorithm

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Abstract

Batik has a vast variety of motifs and colors. Aside from its popularity as being part of Indonesian culture, it has become the source of Indonesia’s income. Batik was more promising in the past years for the business opportunities. Batik has economic and high export value as the commodity. Batik has become the main part of national culture, however there is a lack of understanding for many people, as they are still unaware about batik motifs and patterns. Therefore, it is needed for building a model to identify batik motifs. The model is constructed based on the method of artificial neural network back-propagation and template matching algorithm. The model is to identify the type of pattern motifs. Computational results using artificial neural network back-propagation method is capable to identify 9 types of motifs with 60% accuracy. Based on the results of the computation using the android smartphone to identify motifs using template matching algorithm, it is capable to recognize 9 kinds of motifs with 56% accuracy.

Keywords: batik, back-propagation, template-matching, modeling, identification

1. Introduction

Batik has a vast variety of motifs and colors. Aside from its popularity as being part of Indonesian culture, it has become the source of Indonesia’s income. Batik was more promising in the past years for the business opportunities. Batik has econo-
mic and high export value as the commodity. Batik has become the main part of national culture, however there is a lack of understanding for many people, as they are still unaware about batik motifs and patterns. Batik, as a painted-cloth and a cultural heritage from Indonesian ancestor, needs to be preserved. Batik business has several advantages: the welfare of society can be fulfilled, both in the field of financial economy and the needs of a spiritual nature. Unemployment can be reduced by providing training to batik communities.

Batik motifs have vast variations, which is very difficult to identify for people. There have been many studies to identify batik motifs in general for the identification process. The feature extraction process uses a combination of Gray Level Co-occurrence Matrix (GLCM) and statistical color RGB (Aditya, 2016), A combination of Bag of Features (BOF) and Scale-Invariant Feature Transform (SIFT) (Azhar, 2015), Discrete wavelet transform (DWT) (Budiman, 2016), Content based batik image classification using wavelet transform and fuzzy neural network (Rangkuti, 2014), Texture feature extraction using co-occurrence matrices of sub-band batik image for image classification (Minarno, 2014), Katakana letter Classification with template matching method (Sustenance T, 2014), Design of Ergonomic Stool for Batik Crafters-No. (Shabila, 2013), Automatic batik motifs classification using various combinations of properties features moments and k-Nearest Neighbor (Setyawan I, 2016), Batik motif classification using color-texture-based feature extraction and neural back-propagation network (Suciati N., 2014), Fast discrete curvelet transform and HSV color features for batik image classification (Suciati N, 2015), The performance of the Neural Network Model of Back-propagation Neural Network, Regression and General to identify the types of beef. (Nugroho, 2011), Application of an artificial Neural Network for Modeling the Mechanical Behavior or Carbonate Soils. (Rashidian, 2013 ), Use of Artificial Neural Networks for Prediction of Convective Heat Transfer in Evaporative Units (Romero MR, 2013). Object Detection Based on Template Matching through Use of Best -So-Far ABC. (Tanathong, 2014). Object Recognition using Template Matching with the help of Features extraction method (Amanpreet Kaur, 2015). Based on these previous works, researchers need to build the model identification of motifs using the method of back-propagation artificial neural network and template matching algorithm.

2. Research Methodology

2.1. Data Collection

The collected data includes data of batik production, about various batik motifs from their origin city. The input includes 5 batik-producing cities where each has 9 types of images and motifs. Combining iterative training with Back-propagation Artificial Neural Network method with the pictures and batik motif (formed as photos), a batik motifs pattern recognition models is produced, which will be tested later.
2.2. **Understanding Artificial Neural Network**

Artificial neural network (ANN) is an information processing system that has characteristics similar to biological neural networks. Artificial neural network is formed as generalizations of mathematical models for human neural networks. Artificial neural network is determined by 3 aspects: the network architecture, method for determining the connection weights, and the activation function. Some research has been tested with back-propagation methods, such as fingerprint recognition, face recognition, et cetera. (Nugroho, 2011)

### 2.3. ANN Back-propagation architecture

ANN Back-propagation Architecture used in this system consists of 3 layers, namely: input layer, hidden layer, and output layer. The input layer consists of 13 units of neurons, matching to the number of symptom data and the collected risk factors. The hidden layer consists of p neuron unit, where p is the control variable. The output layer consists only of 1 neuron unit as the output batik identification. (Romero MR, 2013)

The back-propagation training algorithm is as follows: (Sutikno, Indra, & B Nurdin, 2016)

**Step 0:** Initialize all weights with small random numbers, determine the rate ($\alpha$), specify the number of units in the hidden layer (p) and specify the termination conditions. The termination conditions are maximum max epoch and target error.

**Step 1:** If $\text{epoch} \neq \text{max epoch}$ and $\text{target error} < MSE$, do step 2-9.

**Step 2:** For each pair of training data (1 to $a$, $a$ is the amount of training data), do step 3-8.

#### Phase I: Forward Propagation

**Step 3:** Each input unit receiving a signal and passes to a hidden unit above it.

**Step 4:** Calculate all outputs in hidden units $z_j$ ($j = 1, 2, ..., p$)

$$z_{-\text{net}}_j = v_j0 + \sum_{i=1}^{n} x_i v_{ji}$$

$$z_j = f(z_{-\text{net}}_j) = \frac{1}{1 + e^{-z_{-\text{net}}_j}}$$

**Step 5:** Calculate all network outputs in unit $y_k$ ($k = 1, 2, ..., m$)

$$y_{-\text{net}}_k = w_k0 + \sum_{j=1}^{p} z_j w_{kj}$$

$$y_k = f(y_{-\text{net}}_k) = \frac{1}{1 + e^{-y_{-\text{net}}_k}}$$

#### Phase II: Back- Propagation

**Step 6:** Calculate the $\delta$ output unit base factor on the error factor in each unit of output $y_k$

$$\delta_k = (t_k - y_k)f'(y_{-\text{net}}_k) = (t_k - y_k)y_k(1 - y_k)$$

Calculate the weight change rate
with acceleration rate $\alpha$

$$\Delta w_{kj} = \alpha \delta_k z_j ; \quad k = 1, 2, ..., m ; \quad j = 0, 1, ..., p$$

Step 7: Calculate $\delta$ hidden unit factor based on error in hidden unity unit $z_j$ (j = 1, 2 p)

$$\delta_{-\text{net}j} = \sum_{k=1}^{m} \delta_k w_{kj} \delta_j = \delta_{-\text{net}j} f'(z_{-\text{net}j}) = \delta_{-\text{net}j} z_j(1-z_j)$$

Calculate the weight change rate $v_{ji}$ with acceleration rate $\alpha$

$$\Delta v_{ji} = \alpha \delta_j x_i ; \quad j = 1, 2, ..., p ; \quad i = 0, 1, ..., n$$

Phase III: Weight Change

Step 8: Calculate all weight changes

- The weight change of the line leading to the output unit

$$w_{kj}(\text{new}) = w_{kj}(\text{now}) + \Delta w_{kj} ; \quad k = 1, 2, ..., m ; \quad j = 0, 1, ..., p$$

- The weight change of the line leading to the hidden unit:

$$v_{kj}(\text{new}) = v_{kj}(\text{now}) + \Delta v_{ji} ; \quad j = 1, 2, ..., p ; \quad i = 0, 1, ..., n$$

g. Step 9: Update the epoch value $\text{epoch} = \text{epoch} + 1$

and calculate the mean square error (MSE): $MSE = \frac{1}{a} \sum_{k=1}^{a} (t_k - y_k)^2$

Template Matching Method

Template Matching is a technique in computer vision used for finding a sub-image of a target image which matches a template image. It is used in object detection fields such as surveillance, vehicle tracking, robotics, medical imaging and manufacturing. Generally, template matching is categorized into two groups, the first based on the histogram level method and the second based on the feature extraction method. (Tanathong, 2014)

Feature extraction method is used for recognition of particular object from group of objects. Template Matching is used to create a template with the help of possible object identification. Template is mainly a sub-part of an object to match with different objects. (Amanpreet Kaur, 2015)

3. Results and Discussion

The identification research of batik motif is using 2 algorithms: back-propagation artificial neural network and template matching.

3.1. Identification with Back-propagation Artificial Neural Network.

3.1.1. System Description

This research builds a model to identify batik motifs using back-propagation artificial neural network. This model is to identify 9 motifs, as shown in Table 1.
### Tables 1 Types of batik motif

<table>
<thead>
<tr>
<th>No</th>
<th>Batik Motif Type</th>
<th>Batik Motif Image</th>
<th>No</th>
<th>Batik Motif Type</th>
<th>Batik Motif Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Truntun Sogan</td>
<td><img src="image1" alt="Truntun Sogan" /></td>
<td>6</td>
<td>Nithik Cakar</td>
<td><img src="image2" alt="Nithik Cakar" /></td>
</tr>
<tr>
<td>2</td>
<td>Anyaman Sogan</td>
<td><img src="image3" alt="Anyaman Sogan" /></td>
<td>7</td>
<td>Kawung Prabu Sogan</td>
<td><img src="image4" alt="Kawung Prabu Sogan" /></td>
</tr>
<tr>
<td>3</td>
<td>Kembang Tanjung Gede</td>
<td><img src="image5" alt="Kembang Tanjung Gede" /></td>
<td>8</td>
<td>Ceplok Bunga</td>
<td><img src="image6" alt="Ceplok Bunga" /></td>
</tr>
<tr>
<td>4</td>
<td>Kawung Prabu Titik</td>
<td><img src="image7" alt="Kawung Prabu Titik" /></td>
<td>9</td>
<td>Kawung Banji</td>
<td><img src="image8" alt="Kawung Banji" /></td>
</tr>
<tr>
<td>5</td>
<td>Ceplok Kembang Kecil</td>
<td><img src="image9" alt="Ceplok Kembang Kecil" /></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3.1.2. Process Design

In this process design there are 3 main processes: training data input, training, and testing. Each process can be described in the form of a flowchart below.

a. Process of training data input

Training data input is shown in Figure 1.

![Fig. 1 Training Data Input Flowchart](image10)
b. The Training Process
The training process is shown in Figure 2.

![Training Process Flowchart](image)

Fig. 2 Training Process Flowchart

c. Testing Process
Figure 3 shows a flowchart for the testing process.

![Testing Process Flowchart](image)

Fig. 3 Testing Process Flowchart
3.1.3. Testing System

In this research, testing system conducts 2 tests: training algorithm testing and performance algorithm testing.

a. Training algorithm Testing
The data in this research is using 20x20 pixel image. There are 90 data for training, consisting of 10 types of batik motifs. The image for the training is shown in Table 2.

The training process of artificial neural network is using variable input limit epoch 40000, error limit of 0.00001 and alpha value of 0.2. The training process stops at epoch 1075. The result of this training is the layer input of network weights to the hidden layer and the hidden layer to the output layer.

b. Performance testing system
Performance testing system aims to measure system performance, especially for the algorithm. The input of this testing process is the network weights generated from the previous training process and the data to be tested is 20x20 pixel image. The result of the test is to determine the success rate of application for recognizing the batik motif of the input image. By taking the tested data amounted to 35 data, the system is able to recognize 21 data testing or 60% successful.

3.2. Identification of Batik Motifs with Template Matching

Identification of batik motif by using template matching to the implemented features on android-based smart-phone. Some difficulties during to identify batik motifs:
(Amanpreet Kaur, 2015)
- The main complexity during identification is lighting condition
- Factor object may be visible in any rotated form
- Similar object may be present
- The problem of mirroring objects
- Large number of objects may be a difficulty for finding the required object

3.2.1. System with Template Matching Algorithm
Template Matching Algorithm is a simple method and can be used as a tool to recognize patterns in an image. In this research, this application is capable to identify batik motif in digital image by using Template Matching Algorithm. (Amanpreet Kaur, 2015). This application is used to identify 9 batik motifs batik and shown in Table 3.4.

3.2.2. Testing
Template Matching Algorithm test is done by using 27 data test, as shown in Table 2. From this test, 15 test data is produced or 56% are identified correctly and the rest of the data is incorrect.

For the testing with incorrect identification, it consists of 5 incompatibilities with data testing and 7 unidentified tests.
Tables 2. Testing result to identify the batik motif by template matching.

<table>
<thead>
<tr>
<th>No</th>
<th>Batik Motif Type</th>
<th>Batik Name</th>
<th>Image</th>
<th>Identification Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kawung Banji</td>
<td>Kawung Banji-09</td>
<td><img src="image1" alt="Image" /></td>
<td>Kawung Prabu Sogan</td>
</tr>
<tr>
<td>2</td>
<td>Kawung Banji</td>
<td>Kawung Banji-06</td>
<td><img src="image2" alt="Image" /></td>
<td>Kawung Prabu Titik</td>
</tr>
<tr>
<td>3</td>
<td>Kawung Baban banji</td>
<td>Kawung Banji-02</td>
<td><img src="image3" alt="Image" /></td>
<td>Kawung Banji</td>
</tr>
<tr>
<td>4</td>
<td>Ceplok Bunga</td>
<td>Ceplok Bunga-08</td>
<td><img src="image4" alt="Image" /></td>
<td>Unidentified</td>
</tr>
<tr>
<td>5</td>
<td>Ceplok Bunga</td>
<td>Ceplok Bunga-04</td>
<td><img src="image5" alt="Image" /></td>
<td>Unidentified</td>
</tr>
<tr>
<td>6</td>
<td>Ceplok Bunga</td>
<td>Ceplok Bunga-01</td>
<td><img src="image6" alt="Image" /></td>
<td>Unidentified</td>
</tr>
<tr>
<td>7</td>
<td>Kawung Prabu Sogan</td>
<td>Kawung Prabu Sogan-09</td>
<td><img src="image7" alt="Image" /></td>
<td>Kawung Prabu Sogan</td>
</tr>
<tr>
<td>8</td>
<td>Kawung Prabu Sogan</td>
<td>Kawung Prabu Sogan-06</td>
<td><img src="image8" alt="Image" /></td>
<td>Kawung Banji</td>
</tr>
<tr>
<td>9</td>
<td>Kawung Prabu Sogan</td>
<td>Kawung Prabu Sogan-03</td>
<td><img src="image9" alt="Image" /></td>
<td>Kawung Prabu Titik</td>
</tr>
<tr>
<td>10</td>
<td>Nithik Cakar</td>
<td>Nithik Cakar-07</td>
<td><img src="image10" alt="Image" /></td>
<td>Tidak Teridentifikasi</td>
</tr>
<tr>
<td>11</td>
<td>Nithik Cakar</td>
<td>Nithik Cakar-04</td>
<td><img src="image11" alt="Image" /></td>
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<tr>
<td>12</td>
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<td><img src="image12" alt="Image" /></td>
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<td><img src="image14" alt="Image" /></td>
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</table>
Tables 2. (Continued): Testing result to identify the batik motif by template matching.

<table>
<thead>
<tr>
<th></th>
<th>Ceplok Kembang Kecil</th>
<th>Ceplok Kembang Kecil-01</th>
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</thead>
<tbody>
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<tr>
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<td>25</td>
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<td>Kawung Prabu Titik</td>
<td>Kawung Prabu Titik-04</td>
<td>Kawung Prabu Titik</td>
</tr>
</tbody>
</table>

4. Conclusion

The conclusion from this research is:
1. The use of back-propagation artificial neural network is able to identify 9 types of batik motif with 63% accuracy.
2. Android smart-phone-based applications in identifying batik motifs using matching template algorithm, is capable to recognize the motifs with 56% success rate.

References


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