HASIL CEK_Murinto_IMAGE SEGMENTATION USING HIDDEN MARKOV TREE METHODS IN RECOGNIZING MOTIF OF BATIK

by Murinto Image Segmentation Using Hidden Markov Tree Metho

Submission date: 22-Sep-2023 09:30AM (UTC+0700)
Submission ID: 2173213087
File name: HASIL_CEK_Murinto_Aribowo_Batik_Image_HMTSeg_Texture.pdf (1.28M)
Word count: 3799
Character count: 20148

Journal of Theoretical and Applied Information Technology
10th March 2016. Vol.85. No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

IMAGE SEGMENTATION USING HIDDEN MARKOV TREE METHODS IN RECOGNIZING MOTIF OF BATIK

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ABSTRACT

Batik is one of the inherited high-valued artwork. Batik is a way of making clothes using fabric coloring technique. This technique uses 'malam' to avoid staining unintended parts of the fabric. The term 'Batik' can also be referred to a cloth that is made with coloring technique, possesses certain motifs as well as special characteristic. Batik's motif pattern recognition requires initial image processing step called as image segmentation. The purpose of image segmentation is to divide the image into several regions based on feature similarity including grayscale level, texture, color, and motion. In this research multiscale segmentation methods, HMTSeg, is used to recognize the pattern of batik's motif. Images of Batik that have been used in this work are images of Batik originated from Jambi region, Pekalongan region, and Yogyakarta region. Batik's motif pattern recognition steps include image pre-processing, image segmentation, and pattern recognition using Euclidean distance based method. Result shows that this method gained 80% of accuracy in recognizing batik's motif. In conclusion, HMTSeg is a good segmentation method to recognize pattern of batik based on the texture.

Keywords: *Batik Image, Hidden Markov Tree (HMTSeg), Image Segmentation, Pattern Recognition, Texture*

1. INTRODUCTION

Batik is one of Indonesia's cultural heritage which has been recognized by UNESCO as Masterpieces of the Oral and Intangible Heritage of Humanity. Batik is a way of making clothes that uses fabric coloring technique. This technique uses 'malam' to prevent staining unintended part of the fabric. The term 'Batik' can also be referred to a cloth that is made with coloring technique, possesses certain motifs as well as special characteristic. There are three kinds of Batik, hand-drawn batik, cap batik and painted batik. In hand-drawn batik, a piece of cloth is decorated with texture and batik pattern using hand drawing [1]. In cap batik, a piece of cloth is decorated with texture and batik patterns using cap, a kind of stample. While in painted batik, the pattern is directly painted into a white cloth. Indonesian batik consists of different types including palace batik, coastal batik and inland batik. Palace batik includes batik of Yogyakarta palace and batik of Solo palace. Coastal batik includes Batik of Pekalongan, batik of Indramayu , batik of Cirebon , batik of Garut, batik of Lasem and batik of Madura . While batik inland includes the following styles: batik of Jambi, batik of Bali, batik of Lampung, batik of Abepura, etc. There are plenty kinds of batik's patterns in Indonesia, including the abovementioned.

In its development, batik fabric texture pattern makes rapid progress such that various kinds of new texture patterns appear; including both which totally different from the existing textures or patterns that come from mixed existing patterns to become a new pattern. Batik is a part of the textile industry. If a certain batik image is obtained from a specific coloring technique, then this batik image will be different from the image of natural color, in which the image of textile (batik) has very different feature, generally there is a dominant color in batik. In the textile industry (batik), designers combine different colors, thickness, and density to produce visual suppression from other colors (color mixing techniques in textile printing). The structure of the yarn, texture noise will have a strong influence on the textile image color appearance, hence it makes the color image segmentation of the textiles is a very difficult job [2].

Journal of Theoretical and Applied Information Technology
10th March 2016. Vol.85. No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Image segmentation has been and remains an important area of research in image processing, because this process is an important process for further process that is the image analysis. Image analysis includes image recognition process of a particular input image. The main function of image segmentation is to divide the image into regions that has similar features: texture, color, shape, and so forth. Image segmentation and classification are often an initial step in the process of acquisition or an image analysis. Applications in the field of machine vision, face recognition, medical image analysis ,textile industry (batik), etc.[3]-[5].

In a certain application, for example, the introduction of certain batik pattern, initial activity to perform is the segmentation process using a model that is suitable with the characteristics of the image. Through an appropriate segmentation model, the recognition process will be able to get a satisfying result. Here the ultimate goal of the segmentation process is to gain a region based on partition of batik image in different areas (in different classes), where each region is characterized by special specification. The model used in image segmentation includes active contour model and probabilistic model [6]. A probabilistic model includes the Markov Model (Hidden Markov Tree/HMT, Markov Random Field/MRF).

In this research,Hidden Markov Tree (HMT) model are based on discrete wavelet transform (DWT) of the image used to image segmentation. Models capture dependencies that exist between wavelet coefficients at different scale in the image [7]. The main goal of this research is to get a higher accuracy value of batik cloth pattern recognition. In this research we uses HMTSeg algorithm to image segmentation batik image.

2. LITERATUR REVIEW

A. Discrete Wavelet Transform (DWT)

Wavelet Transform is a multiresolution technique through signals (1D and 2 D) that can be transformed into spatial domain and frequency domain.Some previous research on Domain Wavelet Hidden Markov tree (DWHMT) used the simplest Haar wavelet transform because it is orthogonal as well as linear. Wavelet transform is used to transform the image into a multiscale representation with the frequency and spatial characteristics that eases multiscale image analysis. Texture analysis based on wavelet is built using multiscale of energy, the mean deviation, first-order and second -order statistics of the wavelet coefficients. The main reason of using Wavelet transform is that the discrete wavelet transform (DWT) is more representative in building the image processing technique and image modeling efficiently.

B. Hidden Markov Tree (HMT)

Hidden Markov Tree (HMT) is used to capture the clustering properties between scales (interscale clustering) and persistence between the scales (interscale persistence) in the wavelet domain. Clustering between scales denotes that a certain wavelet coefficient corresponds to the nearest neighbor that has same hidden state. While the persistence of interscale states wavelet coefficient tends to be maintained at the same state along the scales. The most important correlation between wavelet coefficients is a parent-child interaction due to the property of interscale persistence.

A probabilistic Markov graph is directly used to connect the hidden state variables, to capture inter scale properties. In the research a transition probability is used $\varepsilon_{i,m}^{p(i),m}$ to represent the probability for w_i to be large/small when $w_{p(i)}$ is large / small.

HMT Model is shown in the following equation:

$$\theta_{HMT}^{b} = \left\{ p_0^b(m), \epsilon_{i,m}^{v(i),m}, \sigma_{i,m}^2 | b \in HL, LH, HH \right\} \quad (1)$$

Where the complete wavelet HMT model consists of three HMTs (one for each wavelet subband), assuming that each subband is independent, the overall 2D HMT model can be written as follows:

$$f(W|\theta) = f(w^{LH}|\theta^{LH}) f(w^{HL}|\theta^{HL}) f(w^{HH}|\theta^{HH}) \quad (2)$$

A Bayesian segmentation algorithm based on different context introduced by Choi and Baraniuk (1999) [8], where the model context context is characterized by a context vector v^n which is derived from a set of neighborhood samples on the next coarse scale. To capture the properties of each image region to be segmented, both large and small scale behavior must be utilized to perform the segmentation, the homogeneity of regions and the boundary region details.In that study a dyadic square (blocks) is used for the implementation of classification with different window size. Given an initial square of image, x, from $n = 2^{2J}$ pixels of

Journal of Theoretical and Applied Information Technology
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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

$2^J x\ 2^J$ size, the block is obtained simply by dividing the image recursively into four square sub-images of the same size.

Model parameter is trained using expectation minimization (EM) algorithm. Conditional likelihood $\beta_m^{p(i)}(m)$ of the sub tree T_i^b to θ_{HMT}^b is then calculated for the HMT model which the state of hidden variable is given in state m.

$$\beta_i^b(m) = f(T_i^b | s_i^b = m, \theta_{HMT}^b) \quad (3)$$

Then conditional likelihood of the sub tree $\beta_i^{p(i)}$ from sub tree T_i^b to θ_{HMT}^b is calculated for which the parent is given in state m

$$\beta_m^{p(i)}(m) = \sum_{n=0,1} \varepsilon_i^{p(i)}(n,m)\beta_i(n) \quad (4)$$

Conditional likelihood of the coarse level is then written as follows:

$$\beta_{p(i)} = f(w_{p(i)} | m, \theta_{HMT}) \prod_{j \in C(p(i))} \beta_j^{p(j)}(m) \quad (5)$$

Assuming the independency of sub-tree and through the equation (2), likelihood of wavelet coefficient $f(W|\theta)$ is derived. Based on this likelihood, the equation of classification is given as follows:

$$\hat{c}_i^{ML} = \text{argmax}_{c \in \{1,2,..,N_c\}} f(w_i | \theta_{HMT}) \quad (6)$$

C. Motif of Batik

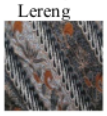
Batik is a result of the cultural art creation which possesses visual beauty and contains philosophical message in each motif produced. A strand of traditional batik, both in terms of motifs, patterns and colors show us where the batik was originated. Batik motifs change in time, place, and the surrounding events [1]. Some of Yogyakarta batik motifs used in this work is shown in Table. 1.

D. Accuracy of Batik Pattern Recognition

Accuracy is obtained from the comparison of manual results with the results obtained through model implementation in segmentation system of batik pattern recognition. The level of accuracy obtained by the formula [5] :

Accuracy (%) = (Number of correct test image / Total Image Test) x 100 %

Table 1. Motif of Yogyakarta Batik

Motif Name	Description of Motif
Gurda 	The word 'Gurda" is derived from Garuda. As is known, the eagle is a great bird. In the Java community point of view, an eagle has a very important position. Gurda motif consists of two wings (lar) and in between the wings; there are a body and a tail.
Meru 	The word 'Meru' comes from Mahameru mountain. The mountain is considered as a residence of the Tri Murti, namely Sang Hyang Vishnu, Sang Hyang Brahma, and Sang Hyang Shiva. Tri Murti is denoted as the source of life, the source of prosperity, and the source of life happiness in the world. Therefore, Meru is used as a motif such that the one who wears always get prosperity and happiness.
Parang Lereng 	Parang Lereng Batik is originally used only by "Sentono Dalem" (the children of the queen). The word 'Lereng' comes from 'mereng' which means hillside. History of this motif begins when the royal family escaped from Kartasura Palace. The royal family was hiding in the mountains to avoid dangers. This motif also means 'tapa brata' (a kind of meditation) of the king which was done in the hillsides to achieve holly message.
Parang Rusak Barong 	The name of this motif comes from the word 'batu karang' (karang stone) and 'barong' (lion). Parang baron is the biggest parang motif, and is great. Due to its holiness, this motif is only used by the king, especially during religious ceremony or meditation.
Sidomukti 	This motif implies prosperity. To the Javanese, the desired value of life other than virtue, speech, and action, of course, is the achievement of 'mukti' or prosperity, both in the world and in the hereafter.

3. RESEARCH METHOD

In this work, image data of Batik of Jambi, Batik of Pekalongan and Batik of Yogyakarta are used. The research framework in general can be seen in Figure 1. Batik pattern recognition takes two sets of image data namely the training data and test data.

Journal of Theoretical and Applied Information Technology
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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

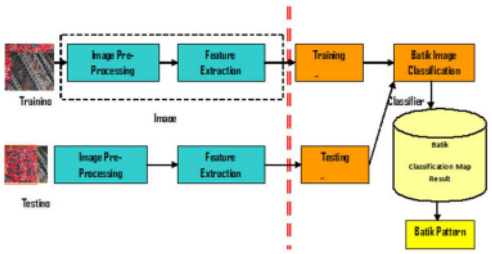


Figure 1: Research Framework of Batik Images PatternRecognition

Image Data. Image data includes training and testing images. Batik images used in this research are taken with normal lighting. Images are taken from the front surface. Batik images a8 devided into two categories, 25 images are used as training data and 25 images are used as the testing data. Batik images that are used in this study consist of 4 motifs from Yogyakarta namely Gurda motif, Meru motif, Parang Lereng motif, and Parang Rusak Barong motif. Three motifs from Pekalongan are used in this study, including Buketan motif, Sampek Eng motif, and Jlamprang motif. Moreover, three motifs from Jambi are used in this study including Pauh motif, Melati motif, and Kapal Sangat motif.

Image Segmentation. The segmentation process includes two activities, namely: Pre - Processing and Feature Extraction image . This process is preliminary process to get the texture features that used later for further analysis process: classification and pattern recognition . The method used is the segmentation algorithm Hidden Markov Tree (HMT)

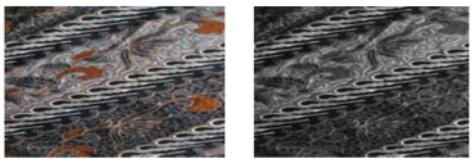
Image Preprocessing. The original image's size is changed by resizing the image. The original image's size is changed into 256x256 pixels. Initially the images generated from digital camera are in the format of true color. Images need to be converted into grayscale images to facilitate the subsequent image processing. Images are in .BMP file format. Once the resizing process is done, the results are then used as input for the process of converting true color images into grayscale images.

Feature Extraction. The final result of feature extraction is batik texture characteristics, which are mean and en4y of each images resulted from segmentation using wavelet-hidden Markov Tree (HMT).

Image Classification. After the image segmentation process is done, the next step is to perform image classification process. Classification is conducted to obtain homogeneous regions grouped into one class. In this research, the classification is done in batik texture pattern classification system. The results of classification are regions with certain class labels. This model involves multispectral image data as an input, which is transformed into a color channel and texture features. This also involves a probability model, which describes the relationship between patterns of batik texture and the image pixels included in the obtained type. In the pattern recognition process, the distance measurement uses Euclidean distance method. The distance measurement is done by calculating distance between training images and testing images .The shortest distance is an image that is similar to the training image. The result of pattern recognition is the final result of the whole process in the system involving images. Testing images which has passed the classification process and decision making process are then identified as a certain type of batik.

4. RESULT AND ANALYSIS

In this study the ten motifs from Batik of Jambi, Batik of Pekalongan and Batik of Yogyakarta are shown. Batik image size is 25 8 x 256 pixels. Total of 50 images are used for training data and 20 images are used for 8sting. Out of these numbers, 25 images are used as training data and 20 images are used for testing data. The original image of batik in RGB format is then converted into a gray scale image to facilitate the segmentation process and pattern recognition. Figure 2 shows the results of image conversion of Parang Lereng Batik into its grayscale image.



(a) (b)

Figure 2: RGB Images of Parang Lereng Batik (a) Grayscale image of Parang Lereng Batik(b)

Image segmentation is done after the pre-processing of the images (resize and conversion of gray scale). Image segmentation process is performed on the gray- scale batik image using Hidden Markov Tree (HMTSeg) algorithms (Crouse et al, 1998)[9]. The results of segmentation process using HMTSeg are shown in Figure 3.

Journal of Theoretical and Applied Information Technology
10th March 2016. Vol.85. No.1

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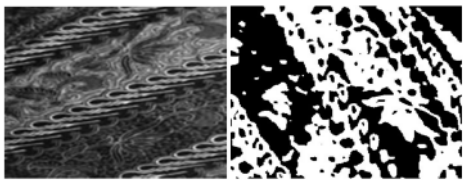

(a) (b)

Figure 3: Grayscale image of Parang Lereng Batik (a) Image basic segmentation of Parang Lereng Batik

After the segmentation process is completed and homogeneous regions presented in the image of batik are obtained, then feature extraction is performed to obtain parameters that will be used for testing of the image data. Training of the image data is done firstly. The extracted parameters include: mean, standard deviation and the energy of each training image data. Texture feature parameters are obtained from the probability density approaches of the appearance intensity level of the image segmentation result histogram. Database uses 50 images from the texture of batik images using energy, mean and standard deviation calculation. The curve of characteristic parameter calculation for 10 textures of batik's motif consisting of 50 images, where 5 images are taken from each motif can be seen in Figure 4.

The interface of batik pattern recognition main program is developed using Matlab R2010 . While the database as statistical calculation data storage of texture characteristic images that are used as a benchmark for testing the image is created earlier so that it can obtain the output of the test. The database is stored in a table of *.mat format, the standard format for workspace on Matlab programming. After all parameter values are known, the next step is to find the average value of each parameter of the 10 different motifs . Table 1 shows the results of calculation of the average for each parameter that become the range of Batik's Motif Texture Characteristic.

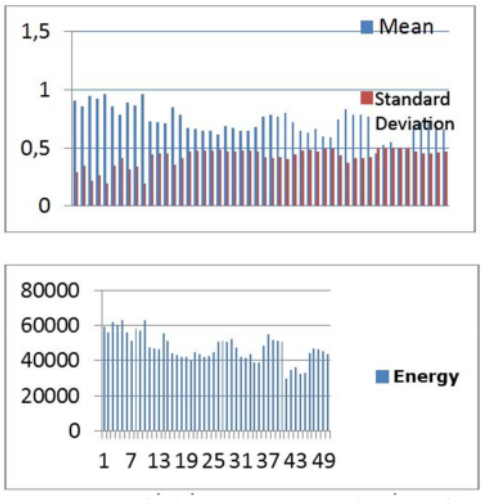

Figure 4 : Standard Deviation, Mean and Energy of 50 Different Batik Images

In Table 1 and the average for each texture features of batik's motif is calculated. This average value is then used as a reference to the batik pattern recognition. Batik pattern recognition performed comparisons between test images and training images. The method used is the Euclidean distance. In this research testing phase is performed by processing 20 images of * .bmp file extension. From these 20 images, standard deviation, mean, and energy are calculated. Two batik images of each motif are taken into account. Those motifs include parang lereng, barong rusak, meru, gurdo, buketan alas, jlamprang, sam pek eng tai, melati, pauh and kapal sangat.

In the testing phase, the images of batik with BMP format are converted to gray scale and then the images are segmented. Furthermore the characteristic parameters (rmean, standard deviation, and energy) of the segmentation result of each image are calculated.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 1: Range of Batik's Motif Texture Characteristic Parameter Values

Range	Batik's Motif Texture Characteristic Parameter			
	Mean	Standar Dev.	Energy	Type of Batik's Motif
Average	0.919130	0.264200	60236	Buketan Alas
Min	0.856476	0.197086	56130	
Max	0.959518	0.350607	62883	
Avegare	0.872310	0.320930	57168	Jlamprang
Min	0.783661	0.927240	51358	
Max	0.961365	0.411748	63004	
Avegare	0.758360	0.423220	49700	Sam Pek Eng Tai
Min	0.711777	0.356586	46647	
Max	0.850494	0.452936	55738	
Avegare	0.647450	0.477260	42431	Kapal Sangat
Min	0.611465	0.4688856	40073	
Max	0.673706	0.487417	44152	
Avegare	0.665670	0.471450	43625	Melati
Min	0.644211	0.464977	42219	
Max	0.683838	0.478752	42592	
Avegare	0.665670	0.420190	50423	Gurdo
Min	0.644211	0.400150	47422	
Max	0.683838	0.447216	52417	
Avegare	0.769390	0.482900	41057	Meru
Min	0.593887	0.472349	38921	
Max	0.646378	0.491106	43514	
Avegare	0.784280	0.409570	51399	Parang Lereng
Min	0.741241	0.369986	48578	
Max	0.836319	0.437953	54809	
Avegare	0.504820	0.498870	33084	Rusak Barong
Min	0.452530	0.497358	29657	
Max	0.551331	0.499992	36132	
Avegare	0.693010	0.460870	45417	Pauh
Min	0.678360	0.451001	43962	
Max	0.715866	0.469920	46915	

Table 2 shows the result of batik pattern recognition based on texture, using HMTSeg segmentation method, where n is the number of batik images to test, namely 20 images consisting of two images of each motif where there are 10 different motifs. The accuracy is calculated as follows.

Accuracy(%)

$$= \frac{number\ of\ correct\ test\ images}{n}\ X\ 100\% = \frac{16}{20} = 80\%$$

Table 2: Motif of Batik Test Data

Test Image Data	Result	
	Correct	Incorrect
BuketanAlas01	-	V
BuketanAlas02	-	V
Jlamprang01	V	-
Jlamprang02	V	-
Sampek01	-	V
Sampek02	V	-
Sangat01	V	-
Sangat02	-	V
Melati01	V	-
Melati02	V	-
Gurdo01	V	-
Gurdo02	V	-
Meru01	V	-
Meru02	V	-
Parang Lereng01	V	-
Parang Lereng02	-	V
Rusak Barong01	V	-
Rusak Barong02	V	-
Pauh01	V	-
Pauh02	V	-
Jumlah	20	4

5. CONCLUSION

Based on the results and discussion that Algorithm HMTSeg gives a better segmentation and this image segmentation method can be applied in batik pattern recognition. The accuracy of pattern recognition where HMTSeg is used on image segmentation and the Euclidean distance is used on image pattern recognition, in which the texture feature parameters are used : the mean and the energy is equal to 80 %.

6. ACKNOWLEDGMENT

The author would like to thank for the **Kemenristekdikti Indonesia** which has provided research funding through research grants Penelitian Hibah Bersaing (PHB) 2015 through a research agreement letter No. PHB-028/SP3/IV / 2015, April 1, 2015

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