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Classification of batik patterns using K-Nearest neighbor and support vector machine

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Article Info

ABSTRACT

This study is proposed to compare which are the better method to classify Batik image between K-Nearest neighbor and Support Vector Machine using minimum features of GLCM. The proposed steps are started by converting image to grayscale and extracting colour feature using four features of GLCM. The features include Energy, Entropy, Contras, Correlation and 0°, 45°, 90°, and 135°. The classifier features consist of 16 features in total. In the experimental result, there exist comparison of previous works regarding the classification KNN and SVM using multi texton histogram (MTH). The experiments are carried out in the form of calculation of accuracy with data sharing and cross-validation scenario. From the test results, the average accuracy for KNN is 78.3% and 92.3% for SVM in the cross-validation scenario. The scenario for the highest accuracy of data sharing is at 70% for KNN and at 100% for SVM. Thus, it is apparent that the application of the GLCM and SVM method for extracting and classifying batik motifs has been effective and better than previous work.

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1.   INTRODUCTION

Indonesia is famous for its arts and culture which are spread throughout the territory of Indonesia, by which each region has different arts and cultures, due to a diverse situation, condition and environment. One of the famous works of arts originating from Indonesia is prominently known as *batik*, identified as a traditional pattern on cloth drawn with traditional methods. In Javanese, *batik* means drawing a point on a cloth, as it is derived from the words: "*ngembat*" (writing) and "*titik*" (dot) [1]. *Batik* as one of the famous arts and cultures originating from Indonesia has its own characteristics depending on its place of origin. Unfortunately, most Indonesian wear *batik* motifs due to its attracting colour and pattern without knowing the name of the used motif, the origin of the motif, or the philosophy contained in the motif due to a wide range of *batik* patterns in Indonesia.

Several studies have been conducted previously for pattern recognition and image classification both for image retrieval and image classification system [2-4]. Kurniawardhani *et al.* [5] proposed an invariant feature extraction method for rotation by using the combination of extraction method, which compared the method of combining LBPROT-CLBP_M with LBPROT-CRLBP_M. From the results of the research, the LBPROT-CRLBP_M method could increase the accuracy by approximately 30% with a maximum accuracy of 90%. The other issue about classification using KNN was also proposed by [6, 7]. Minarno *et al.* [8] combining the grey level co-occurrence matrix (GLCM) method with discrete wavelet transform (DWT) to classify *batik* images, which were named as co-occurence matrix of sub-band images.

Arebey et al. [9] used the GLCM, KNN and multi-layer perception (MLP) methods to detect and classify solid waste levels. From the results of the research, the KNN method gave better results compared to the MLP method. Nurhida *et al.* [10] compared the performance of the GLCM method, Canny Edge Detection, and Gabor for extraction of *batik* features, showing that the GLCM method had the best performance with classification accuracy reaching 80%. Minarno *et al.* [11] compared performance for precision and recall among the GLCM method, multi texton histogram (MTH), MTH + GLCM and the multi texton co-occurrence descriptor (MTCD). Meanwhile, Fahrurozi *et al.* [12] combined the GLCM method with several edge detection methods to perform feature extraction on wood fibres. Chai *et al.* [13] applied the GLCM method to identify fractures in the bone, gaining accuracy of 86.67%. In addition, research conducted by [14-16] used the GLCM method as feature extraction. Raheja *et al.* [17] used the GLCM method to detect defects in fabric. Mitrea *et al.* [18] used the GLCM method in diagnosing liver tumours in ultrasound images. Fakhira et al using SVM to classify knots timber using 400 x-ray dataset and the highest accuracy is 76%.

This study is proposed to compare which are the better method to classify Batik image between K-Nearest neighbor and support vector machine using minimum features of GLCM. The proposed steps are started by converting image to grayscale and extracting colour feature using four features of GLCM. The features include Energy, Entropy, Contras, Correlation and 0°, 45°, 90° and 135°. The total features utilized on the classifier are 16 features. In the experimental result, the authors compared the previous work of classification KNN and SVM using multi texton histogram [19]. The experimental result showed combination GLCM and SVM is better than previous work.

2. DATASET

This study applies a dataset of *batik* motif images with a total of 300 images. There are 50 classes in the dataset, which consist of 6 *batik* motif images in each set (with the size of each picture of 180x180 pixels). Figure 1 provides an example of a *batik* motif image utilized in this paper.

Figure 1. Example of *batik* patterns

3. GRAY LEVEL CO-OCCURENCE MATRIX (GLCM)

Gray level co-occurrence matrix (GLCM) is defined as a matrix whose elements consist of pairs of pixels having a certain brightness level, where pairs of pixels are separated by distance d, with a θ angle [19-21]. GLCM is considered as the most common method based on the static approach for texture extraction and GLCM approach usually presented in a symmetrical matrix, increasing the required computational time [22]. GLCM can be calculated with both symmetrical and asymmetrical matrix. The distance in the calculation of GLCM is expressed in pixel units while the angle in the calculation of GLCM is expressed in degrees. Certain angles are often used in GLCM for inter-angle (0°, 45°, 90°, and 135°) calculations [23-25]. Figure 2 provides an illustration of the angle commonly used on GLCM, and Figure 3 provides an illustration of the GLCM.
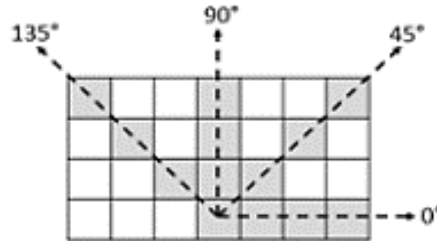

Figure 2. The angles in GLCM

In order to obtain the texture characteristics of an image, features energy, entropy, contrast, and correlation, calculations are extracted from GLCM. The most common statistical calculations used in GLCM include:

Energy:

$$\sum_{i,j=0}^{N-1} P_{i,j}{}^2 \tag{1}$$

$$\sum_{i,j=0}^{N-1} P_{i,j} \log P_{i,j} \tag{2}$$

Contrast:

$$\sum_{i,j=0}^{N-1} P_{i,j}(i-j)^2 \tag{3}$$

Correlation:

$$\sum_{i,j=0}^{N-1} \frac{(i-\mu_x)(j-\mu_y)p_{i,j}}{\sigma_x^2 \sigma_y^2} \tag{4}$$

with:

$P_{i,j}$	=	Normalized pixel value,
i	=	(i) pixel composition,
j	=	(j) pixel composition,
μ_x	=	$\sum_{I,J=0}^{N-1} i.P_{i,j}$
μ_y	=	$\sum_{I,J=0}^{N-1} j.P_{i,j}$
σ_x^2	=	$\sum_{I,J=0}^{N-1} (i-\mu_x)^2.P_{i,j}$
σ_y^2	=	$\sum_{I,J=0}^{N-1} (i-\mu_y)^2.P_{i,j}$

The extraction of features as applied in this paper uses GLCM method as illustrated in Figure 3. This stage aims to get the features contained in *batik* images as displayed in the histogram. In the first stage as presented in Figure 4, *batik* image which originally has an RGB colour model changes to a grayscale image, having one channel value in each pixel, with the equal values on the Red, Green, and Blue channels. After grayscale image is obtained in the 2nd stage, the image is quantized to 16 bins to reduce the burden of the computational process. The extracts of GLCM feature at an angle of 0°, 45°, 90°, and 135° is obtained in the 3rd stage. Finally, in the 4th stage, the features are stored on the histogram.
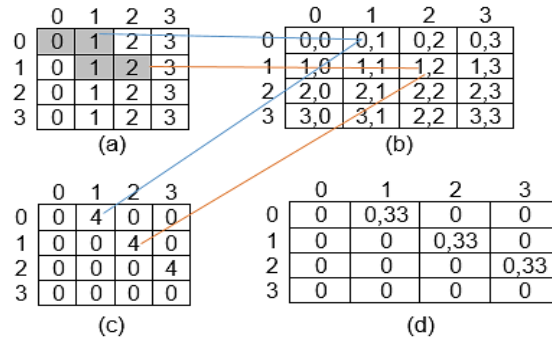
Figure 3. Illustration of GLCM, (a) Original image, (b) Pixel address, (c) GLCM matrix, (d) GLCM normalization matrix
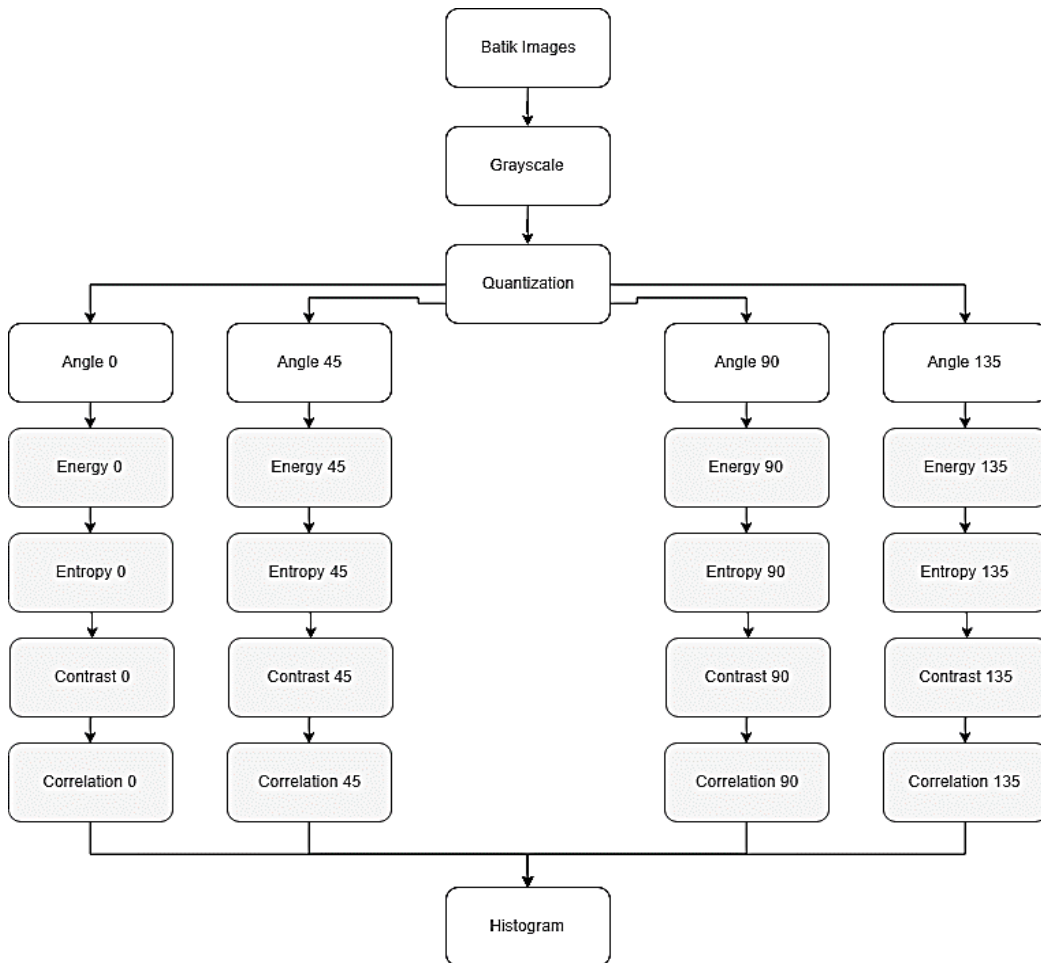
Figure 4. Processing stages in the GLCM method

Figure 5(a) illustrates one of the images as used in this paper, with a size of 180x180 pixels. Figure 5(b) presents the result of the grayscale process as carried out in Figure 5, to be used in the quantization process. Figure 5(c) provides the result of the quantization process as carried out in Figure 5. In this paper, the grayscale image is quantized to 16 bin to achieve the pixel value of 0-15.

Figure 6 depicts the histogram result of GLCM feature extraction in sequential order from the left to the right (angle energy 0 (1), contrast angle 0 (2), entropy of angle 0 (3), correlation angle 0 (4), angle energy 45 (5), angle contrast 45 (6), angle entropy 45 (7), correlation angle 45 (8), angle energy 90 (9), contrast angle 90 (10), entropy angle 90 (11), correlation angle 90 (12), energy angles 135 (13), contrast angles 135 (14), entropy angles 135 (15), and angular correlations 135 (16)). The extracted features that have been obtained are applied for the classification process.
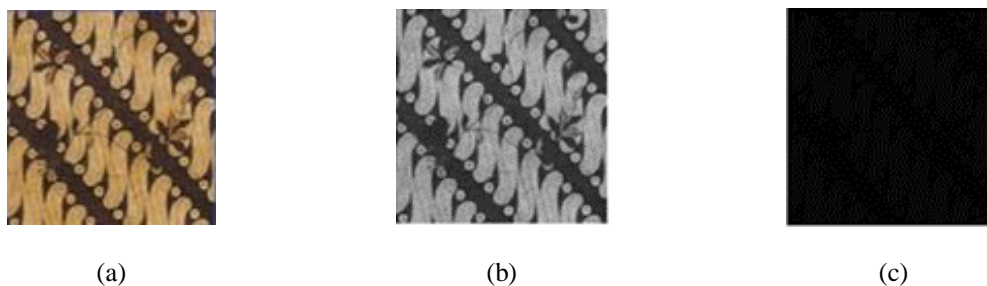

(a)   (b)   (c)

Figure 5. (a) *Batik* image, (b) *Batik* grayscale image, (c) *Batik* quantization image
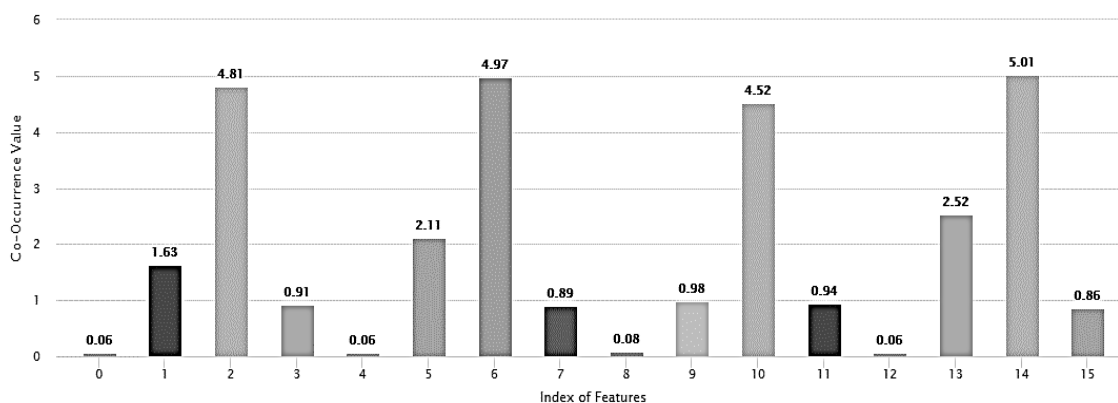
Figure 6. An example GLCM histogram features of batik image in Figure 5

4. PERFORMANCE MEASUREMENT

This study applies the calculation of accuracy to measure the performance of the system which has been built with:

$$Accuracy = \frac{m}{n} . 100\% \tag{5}$$

with:

        m = Total correct tested data,
        n   = Total tested data

5. RESULT AND DISCUSSION

In the first test, 300 data sets of *batik* motifs are divided into 50% (150 images) as trained data and 50% (150 images) as tested data. Table 1 and Table 2 depict the results of shared data testing (50:50). In the second test, 300 data sets of *batik* motifs are divided into 60% (200 images) as trained data and 40%

(100 images) as tested data. Table 3 and Table 4 show the results of shared data testing (60:40). In the third test, 300 data sets of *batik* motifs are divided into 80% (250 images) as trained data and 20% (50 images) as tested data. Table 5 and Table 6 presents the results of shared data testing (80:20). The fourth test using cross-validation for KNN classification method was conducted by using the parameter of K=1 until K=6, while for the classification method was performed by using kernel parameter=polynomial with a degree of=3 and c=4 showed in Table 7.

       The results of testing as performed by the system or application to classify *batik* motifs are achieved through GLCM method, whose features is extracted from *batik* motif images, comprising of energy, entropy, contrast, and correlation at 0°, 45°, 90°, and 135° which requires an extracting time for the GLCM features with the classification process in 20 seconds. The testing using the cross-validation (K-Fold) scenario, the highest accuracy of KNN algorithm is pointed at 86% with K 5 and pointed at 100% with K 5 in SVM algorithm. Previous research used the MTH feature to classify *Batik*. The classifiers included SVM and KNN. The testing of the previous studies compared between 4 textons and 6 textons using SVM and KNN. The best results were KNN with 6 textons producing the best accuracy of 82% while the proposed research produced 100% accuracy shown in Table 8.

Table 1. Test results of 50% trained data and 50% tested data by using KNN method

k	Accuracy
3	70%
5	67%
7	49%
9	44%

Table 2. Test results of 50% trained data and 50% tested data by using the SVM method

Kernel	Degree	C	Gamma	Accuracy
Poly	3	4	-	76%
Poly	3	8	-	76%
Poly	3	16	-	76%
Poly	4	4	-	75.33%
Poly	5	4	-	75.33%
poly	6	4	-	74%
Linier	-	4	-	74.66%
Linier	-	8	-	78%
Linier	-	16	-	78.66%
RBF	-	4	1	74.66%
RBF	-	4	2	74.66%
RBF	-	4	3	74.66%
RBF	-	4	4	75.33%

Table 3. Test results of 60% trained data and 40% tested data by using KNN method

k	Accuracy
3	67%
5	67%
7	66%
9	53%

Table 4. Test results of 60% trained data and 40% tested data by using the SVM method

Kernel	Degree	C	Gamma	Accuracy
Poly	3	4	-	86%
Poly	3	8	-	86%
Poly	3	16	-	84%
Poly	4	4	-	85%
Poly	5	4	-	85%
poly	6	4	-	85%
Linier	-	4	-	78%
Linier	-	8	-	81%
Linier	-	16	-	84%
RBF	-	4	1	76%
RBF	-	4	2	77%
RBF	-	4	3	79%
RBF	-	4	4	79%

Table 5. Test results of 80% trained data and 20% tested data by using KNN method

k	Accuracy
3	66%
5	60%
7	62%
9	56%

Table 6. Test results of 80% trained data and 20% tested data by using the SVM method

Kernel	Degree	C	Gamma	Accuracy
Poly	3	4	-	76%
Poly	3	8	-	76%
Poly	3	16	-	76%
Poly	4	4	-	78%
Poly	5	4	-	80%
poly	6	4	-	80%
Linier	-	4	-	74%
Linier	-	8	-	74%
Linier	-	16	-	76%
RBF	-	4	1	76%
RBF	-	4	2	76%
RBF	-	4	3	76%
RBF	-	4	4	78%

Table 7. The scenario of cross-validation testing result

	Accuracy						Mean
	K= 1	K= 2	K= 3	K= 4	K= 5	K= 6	
KNN	66%	82%	76%	78%	86%	82%	78.3%
SVM	76%	98%	94%	90%	100%	96%	92.3%

Table 8. The comparison with the previous work [19]

	Accuracy		
	MTH 4 Textons	MTH 6 Textons	Proposed Method
KNN	70%	82%	86%
SVM	64%	76%	100%

6. CONCLUSION

This study proposed a system to classify *batik* motif images by using grey-level co-occurrence matrix (GLCM) method. The average accuracy obtained in testing with cross-validation scenario reached 92.3% for SVM and 78.3% for KNN. Meanwhile, the highest accuracy in testing with a shared data scenario reached 86% for SVM and 70% for KNN. Based on the results of testing, the classification using GLCM and SVM method considered as the effective and reliable approach for recognizing *batik* pattern images which were better than previous work (MTH and SVM).

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