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Classification of Batu Bara Songket Using Gray-Level Co-Occurrence Matrix and Support Vector Machine

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Abstract

Songket is a traditional woven cloth from the Malay and Minangkabau tribes. Songket can also be classified from the brocade woven family and woven with gold or silver thread. Songket cloth's beauty is the Indonesian people's wealth and preservation. Batu Bara Regency is one of Indonesia's regions with several Songket motifs characteristics. Public knowledge of Batu Bara Songket motifs is still minimal, and the differences between one motif and another are still unknown. This research provides information about the variety of Songket fabrics by classifying six types of Batu Bara Songket motifs, namely the Bunga Tanjung motif, Pucuk Betikam motif, Pucuk Cempaka motif, Pucuk pandan motif, Tampuk Manggis motif and Tolab Berantai motif based on the extraction of the Gray Level texture feature. The Co-Occurrence Matrix includes four parameters: Contrast, Correlation, Energy, and Homogeneity, as well as a classification method with a Support Vector Machine. The feature extraction values process as input for classification using a Support Vector Machine. The highest accuracy achieved in this study was 57%, using 60 training data and 30 test data.

Keywords: Classification; Batu Bara Songket Motif; Gray Level Co-Occurrence Matri; Support Vector Machine

Abstrak

Songket merupakan jenis kain tenunan tradisional yang berasal dari suku melayu dan Minangkabau. Songket juga dapat digolongkan dari keluarga tenunan brokat dan dapat ditenun dengan benang emas dan perak. Keindahan kain songket merupakan kekayaan masyarakat Indonesia yang harus terus dilestarikan. Kabupaten Batu Bara merupakan salah satu wilayah di Indonesia yang memiliki beberapa ciri khas motif kain songket. Pengetahuan masyarakat akan motif-motif songket Batu Bara masih minim dan perbedaan antara motif yang satu dengan motif yang lain masih belum diketahui. Penelitian ini dibuat dengan tujuan untuk memberikan informasi tentang ragam kain songket dengan mengklasifikasi enam jenis motif songket Batu Bara yakni motif bunga tanjung, motif pucuk betikam, motif pucuk cempaka, motif pucuk pandan, motif tampuk manggis dan motif tolab berantai berdasarkan ekstraksi ciri tekstur Grey Level Co-Occurrence Matrix meliputi empat parameter yakni Contrast, Correlation, Energy, dan Homogeneity, serta metode klasifikasi dengan Support Vector Machine. Nilai ektraksi ciri tersebut selanjutnya akan diproses menjadi masukan untuk klasifikasi menggunakan Support Vector Machine. Akurasi tertinggi yang dicapai dalam penelitian ini sebesar 57 %, dengan menggunakan 60 data latih dan 30 data uji.

Kata kunci: Klasifikasi; Motif Songket Batu Bara; Grey Level Co-Occurrence; Support Vector Machine

INTRODUCTION

Indonesia is a country that is rich in unique and distinctive cultural heritage diversity. Every nation or tribe has a culture (Tahrir et al., 2017). A diverse cultural heritage can become essential for Indonesia, and its preservation is mandatory. One manifestation of the results of this cultural process is the creation of works of art that all Indonesian ethnic groups own. Indonesia's diverse traditional fabrics result from cultural processes, geographical differences, flora, fauna, lifestyle differences, and livelihoods producing various traditional fabrics. Indonesian Traditional Fabrics are in great demand

in national and international markets (Johan Wahyudi & Ihdahubbi Maulida, 2019). One of the ethnic cultures in Indonesia is Malay, especially in North Sumatra (Rigitta, 2021).

Songket is a traditional Malay and Minangkabau woven fabric in Indonesia, Malaysia, and Brunei (Nurhalimah et al., 2020). Songket belongs to the brocade woven family. Weaving Songket cloth by hand using gold and silver threads is generally worn on formal occasions. The beauty of Songket can attract domestic and foreign tourists who like Indonesian traditional cloth art (Salamah & Kusumanto, 2017).

Batu Bara Regency has a type of Songket with its characteristics (Abdiansyah, 2018), Public knowledge of the Batu Bara Songket motifs is still minimal, and the difference between one motif and another is still unknown. The lack of automated data collection is the cause of this, and no application can analyze the types of Batu Bara Songket motifs, which can help the community to provide knowledge to the public about the Batu Bara Songket motif and is no longer wrong in recognizing the Batu Bara Songket motif.

Several studies regarding the classification of Songket motifs based on texture have several times in previous studies, such as the feature extraction study using the grey-level co-occurrence matrix (GLCM) method. The Gabor filter for image classification of Pekalongan batik (Surya et al., 2017), other studies on the classification of Songket cloth in Lombok use GLCM and moment invariant as well as linear discriminant analysis (LDA) (Nurhalimah, 2020), feature extraction of Songket images based on texture using the grey level co-occurrence matrix (GLCM) method (Amalia, 2018), application of a speeded-up robust feature on the random forest for classification of Palembang Songket motifs (Yohannes et al., 2020).

This study has advantages over previous research, namely using grounded theory through qualitative analysis using Songket cloth objects that are observed and interacted with based on the participants' views. This research was made to provide information about the various types of coal Songket cloth that previous researchers have not studied by classifying six types of Batu Bara Songket motifs, namely six types of Batu Bara Songket motifs Namely Bunga Tanjung Motif, Pucuk Betikam Motif, Pucuk Cempaka Motif, Pucuk Pandan Motif, Tampuk Manggis Motif, and Tolab Berantai Motif.

Gray Level Co-Occurrence Matrix (GLCM) method is a method for extracting image textures. Texture extraction to retrieve essential information from an image before it is used for the following process, using feature extraction methods considered optimal in research (Ramadhani & Bethaningtyas Dyah, 2018). The *Gray Level Co-Occurrence Matrix* (GLCM) method is an adequate texture descriptor and has better accuracy and computation time than other texture extraction methods (Widodo et al., 2018).

The *Support Vector Machine* (SVM) method is a machine learning technique. They learn by using a pair of input and output data as the desired target. It is called supervised learning, and the advantages of the *Support Vector Machine* (SVM) method are in recognizing and classifying an object (Anggraini, 2017). *Support Vector Machine* (SVM) is a classification method with high generalizability and input space dimensions (Neneng et al., 2016).

RESEARCH METHODS

Types of research

The author's research is a type of grounded theory through the analysis of qualitative and quantitative methods.

Time and Place of Research

This research was conducted precisely at the "Yusra" craftsmen of Batu Bara woven cloth. Padang Genting Village No. 6 district Talawi and the place for system design in the computer laboratory of the Faculty of Science and Technology, State Islamic University of North Sumatra. Research Time in November 2021 to March 2022.

Research Target / Subject

The research target in this study is the Batu Bara community, who do not know much about the types of Batu Bara songket motifs.

Procedure

The process carried out to research the classification of Batu Bara Songket motifs based on texture with *the Gray Level Co-Occurrence Matrix* (GLCM) and *Support Vector Machine* (SVM) methods, namely through several stages of designing the analytical method.

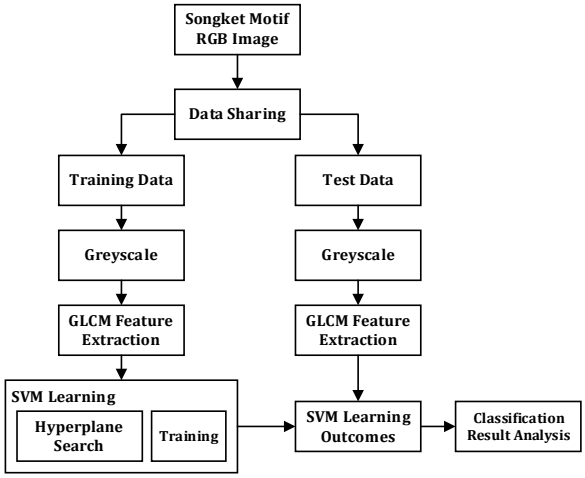


Figure 1. Songket Motif Classification System Planning Diagram

Figure 1 shows that the diagram uses input as an RGB Songket motif image. The image is divided into two parts: the training and test data images. Then the training and test data images are changed from RGB to grayscale. After that, the GLCM feature extraction is sought, which consists of contrast, entropy, energy, and homogeneity features. For training data, multiclass SVM learning is used in the hyperplane separator of the six types of Songket motifs. The last stage is to test the system on the test data images and analyze the results of image classification on the hyperplane function that has been obtained.

The steps taken in the GLCM calculation are as follows the formation of the initial GLCM matrix from pairs of two parallel pixels corresponding to the directions 0°, 45°, 90°, and 135°. The following form a symmetrical matrix by adding the initial matrix GLCM with its transpose values, normalizing the GLCM matrix by dividing each matrix element by the number of pixel pairs, and then feature extraction, namely *contrast, Homogeneity, energy, correlation* (Widodo et al., 2018).

Contrast

$$= \sum_{i1} \sum_{i2} (i_1 - i_2)^2 p(i_1, i_2) \quad \text{.....(1)}$$

Homogeneity

$$= \sum_{i1} \sum_{i2} \frac{p(i_1, i_2)}{1+|i_1 - i_2|} \quad \text{..... (2)}$$

Energy

$$= \sum_{i1} \sum_{i2} p^2(i_1, i_2) \quad \text{..... (3)}$$

Correlation

$$= \sum_i \sum_j \frac{(i-\mu i)(j-\mu j) p_{(i,j)}}{\sigma i \, \sigma j} \quad \text{..... (4)}$$

In the process of classifying Songket motifs using SVM, in research, in this case, the SVM multiclass approach that It uses is a classification method "one against all." In this method, k binary SVM models are built, with k being multiple classes. Each classification of the model it wants to use uses total data to find solutions to problems. SVM classifies two classes between one class and others seen as one class. The class for a data sample is directly determined by this method. When the data sample is not included in the group containing the set class but in a specific class, then that class is a class from the sample data in question (Pitoyo, 2020).

Table 1. SVM Classification with One-Agains-All method

yi = 1	yi=-1	Kernel Hypothesis
Class 1	Not class 1	$F1(x)=(w^1)x+b^1$
Class 2	Not class 2	$F2(x)=(w^2)x+b^2$

..... (5)

Table 1 shows test results on test data that produce a decision function with the maximum value given a value of y_i=1 (true), while other decision functions give a value of y_i=-1 (false).

Accuracy :

$$\text{Accuracy} = \frac{Correct\ classification\ number}{Amount\ of\ data} \times 100\ \% \quad \text{.....(6)}$$

Data, Instruments, and Data Collection Techniques

Songket motif image data collection is divided into training and test data. The training data consists of 60 samples of Songket motif image data, and the test data consists of 30 samples of Songket motifs. The total sample data is 90 images of the Songket motif.

The data collection technique used in this study is :

1. Interview

Figure 2. is an interview technique that was conducted by seeking information and knowledge sourced from experts engaged in fields related to this research, namely with Mrs. Hj. Ratna, one of the craftsmen who also opened a Songket business in the Batubara district, so the author gets relevant data references and knows the names of the Batu Bara Songket motifs.

Figure 2. Interview with Mrs. Hj. Ratna

2. Observation

The technique is an observation of data collection techniques by observing directly an object to seek information and knowledge related to research.

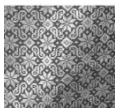
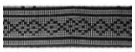
Image			
Motif	Bunga Tanjung	Pucuk Betikam	Pucuk Cempaka
Image			
Motif	Pucuk Pandan	Tampuk Manggis	Tolab Berantai

Figure 3. Sample image of Batu Bara Songket

In Figure 3. It is an example of a sample of Batu Bara Songket images, where each Songket sample shown in Figure 3. has 30 image data. The six types of Songket motifs are Tanjung Flowers, Betikam Shoots, Cempaka Shoots, Pandan Shoots, Tampuk Manggis, and Tolab Berantai.

3. Library Studies,

Namely in this study also used literature studies taken from scientific articles, books, and others.

Data analysis technique

This analysis is needed to determine what kind of software will be produced. The needs analysis in this study is as follows:

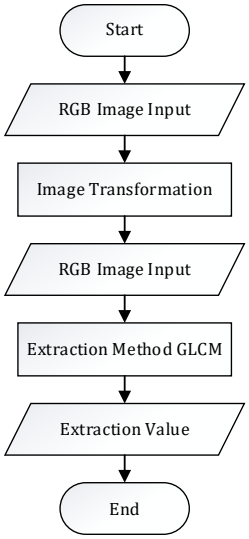


Figure 4. GLCM Feature Extraction Flowchart

From the flowchart Figure 4. The above explains the stages in the GLCM feature extraction method, namely as follows :

a. Input the RGB image of the Batu Bara Songket motif.
b. Then the image is changed from RGB to grayscale.
c. After that, look for the GLCM feature extraction, which consists of contrast, Homogeneity, energy, and entropy features.
d. Generates image extraction values from the GLCM method.

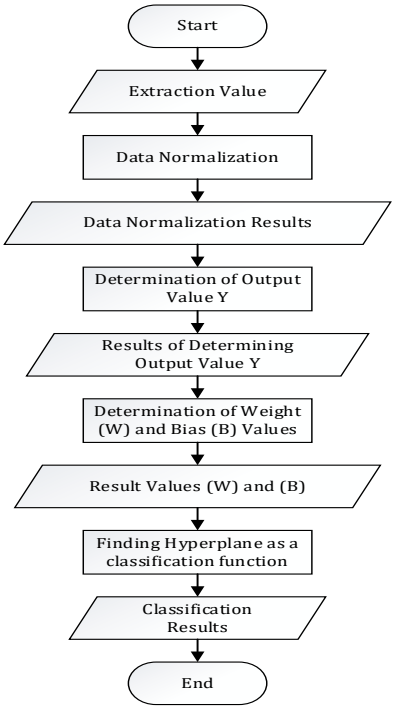


Figure 5. SVM Classification Method Flowchart

From the flowchart Figure 5. above explains the stages in the Support Vector Machine (SVM) classification method, namely as follows:

a. After getting the value from feature extraction From the GLCM method, input the GLCM feature data.
b. Data normalization was using the equation formula attached to the SVM theory.
c. After Normalization, can pay, pay output value (y).
d. Then the value of weight (w) and bias (b).
e. After all, can be seen, the system looks for hyperplane as a decision function.
f. So the classification uses the SVM method.

Output in the Batu Bara Songket motif classification system based on texture using the *Gray Level Co-Occurrence Matrix* (GLCM) method and *Support Vector Machine* (SVM), namely the results of the classification of Songket motif types through a feature extraction process using the *Gray Level Co-Occurrence method Matrix* (GLCM) and the classification process uses the *Support Vector Machine* (SVM) method.

RESULTS AND DISCUSSION

Testing

Based on the existing image samples, a testing process on these images. At the testing stage, the digital image is in (*.jpg) format with a size of 512x512 pixels. The system testing process using the MATLAB application see in the process below:

1. Application Initial Screen

Figure 6. Initial Display Form

Figure 6. is the initial form, which is the main page for running the program to be worked on.

2. Image Input Display

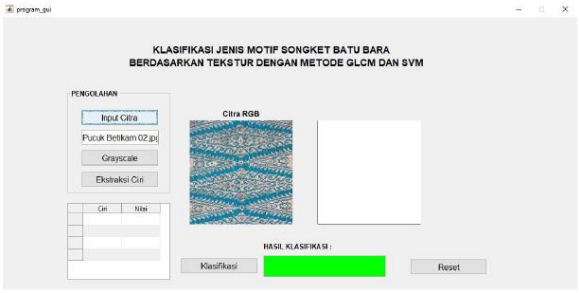


Figure 7. Image Input Display Form

Figure 7. in this form, the image input is by pressing the Image Input button, and then the system will direct it to select the data to be tested, and then the system will automatically display the inputted image and the image file name.

3. Grayscale Display

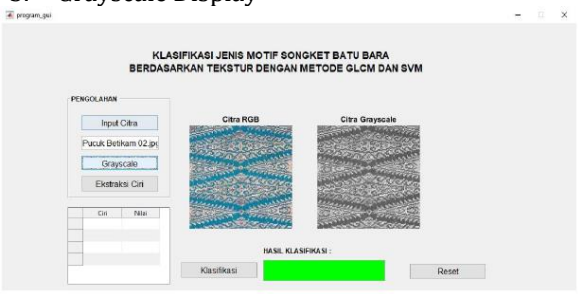


Figure 8. RGB Display Form to Grayscale

In figure 8. this form will be processed using a Grayscale. By pressing the grayscale button, the system will process the RGB file to grayscale and display the resulting grayscale image on axes2.

4. *Gray Level Co-Occurrence Matrix* (GLCM) Feature Extraction Display

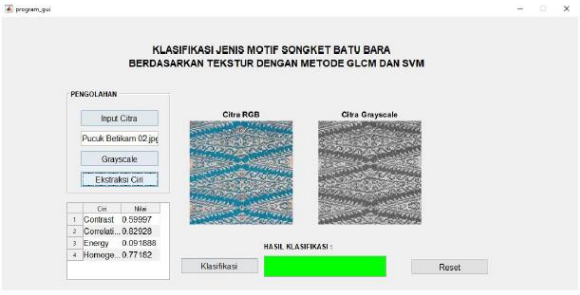


Figure 9. *Gray Level Co-Occurrence Matrix* Feature Extract Display Form

Figure 9. this form will perform feature extraction on the image by pressing the Feature Extract button. The table will display the feature extraction value of the Gray Level Co-Occurrence Matrix (GLCM).

5. Classification Result Display

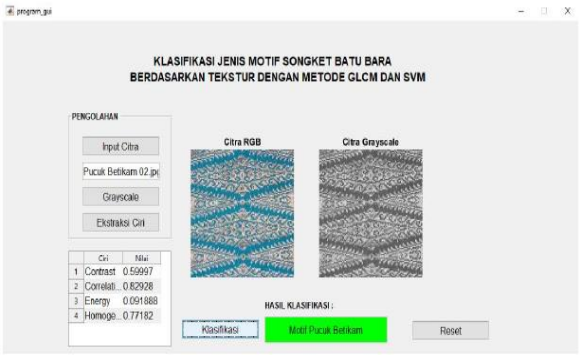


Figure 10. Image Classification Results Display Form of Batu Bara Songket Motifs

Example 10 The supplied image's classification results show on this form's display. Clicking the classification button will cause the system to display the supplied image's classification findings automatically.

System Test Results

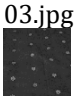
Based on test data on the image of the type of Songket Batu Bara motif that has been, if there is, in this case, a testing process will be carried out on the motif image Songket Batu Bara with format (*.jpg). In the process of testing the motif classification Songket below, there are 30 test data with 5 data from each type of Songket motif, 5 test data for Bunga Tanjung, 5 test data for Pucuk Betikam, 5 test data for Pucuk Cempaka, 5 test data for Pucuk Pandan, 5 test data for Tampuk Manggis, and 5 test data for Tolab Berantai. From the result testing of as many as 30 test data. The following are the results of system testing of each image of the Songket motif tested to obtain a classification of the type of Coal Songket motif, see table 2 below:

Table 2. Data Testing

No.	Decision Function SVM MultiClass One Against All	Score yi	Types of Batu Bara Songket	Classification Result	Information
1.	f1(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Bunga Tanjung	'Motif Bunga Tanjung'	True
2.	f1(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Bunga Tanjung	'Motif Bunga Tanjung'	True
3.	f1(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Bunga Tanjung	'Motif Bunga Tanjung'	True
4.	f1(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Bunga Tanjung	'Motif Bunga Tanjung'	True
5.	f1(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Bunga Tanjung	'Motif Bunga Tanjung'	True
6.	f2(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	-1	Pucuk Betikam	'Motif Pucuk Pandan'	False
7.	f2(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Pucuk Betikam	'Motif Pucuk Betikam'	True
8.	f2(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Pucuk Betikam	'Motif Pucuk Betikam'	True
....	.....	....	.....	.....	.....
30.	f6(x)=sign(w1.x1+ w2.x2+ w3.x3+ w4.x4+b)	1	Tolab Berantai	'Motif Tolab Berantai'	True

Table 2 shows 30 test data with 5 data from each type of Songket motif. Each test data has a one against all SVM decision functions according to each class. Entering the yi value shows the classification results and the types of Songket motifs. If the yi value is one, then the classification results are declared correct by the type of Songket motif being tested. Conversely, if the yi value is -1, then the classification results are declared wrong and do not produce output that matches the type of Songket motif in table 3.

Table 3. Classification Test Results

No	Image File	Classification Result	Average Extraction Result
1.	 Bunga Tanjung 01.jpg	'Motif Bunga Tanjung'	Contrast = 0.055182 Correlation = 0.89292 Energy = 0.80746 Homogeneity = 0.97932
2.	 Bunga Tanjung 02.jpg	'Motif Bunga Tanjung'	Contrast = 0.054825 Correlation = 0.90229 Energy = 0.89758 Homogeneity = 0.98303
3.	 Bunga Tanjung 03.jpg	'Motif Bunga Tanjung'	Contrast = 0.044537 Correlation = 0.9417 Energy = 0.79726 Homogeneity = 0.98128
4.	 Bunga Tanjung 04.jpg	'Motif Bunga Tanjung'	Contrast = 0.081439 Correlation = 0.81279 Energy = 0.91401 Homogeneity = 0.98792
5.	 Bunga Tanjung 05.jpg	'Motif Bunga Tanjung'	Contrast = 0.029251 Correlation = 0.91165 Energy = 0.76756 Homogeneity = 0.98585
6.	 Pucuk Betikam 01 .jpg	'Motif Pucuk Pandan'	Contrast = 0.59997 Correlation = 0.82928 Energy = 0.091888 Homogeneity = 0.77182
7.	 Pucuk Betikam 02.jpg	'Motif Pucuk Betikam'	Contrast = 0.45013 Correlation = 0.75828 Energy = 0.14618 Homogeneity = 0.81243
8.	 Pucuk Betikam 03.jpg	'Motif Pucuk Betikam'	Contrast = 1.4175 Correlation = 0.67485 Energy = 0.097793 Homogeneity = 0.70073
9.	 Pucuk Betikam 04.jpg	'Motif Pucuk Pandan'	Contrast = 0.4908 Correlation = 0.91867 Energy = 0.10273 Homogeneity = 0.80891
10.	 Pucuk Betikam 05.jpg	'Motif Pucuk Pandan'	Contrast = 0.40894 Correlation = 0.85346 Energy = 0.11702 Homogeneity = 0.82458
11.	 Pucuk Cempaka 01.jpg	'Motif Pucuk Pandan'	Contrast = 0.27883 Correlation = 0.92845 Energy = 0.12754 Homogeneity = 0.86776

Continue Table 3. Classification Test Results

No	Image File	Classification Result	Average Extraction Result
12.	 Pucuk Cempaka 02.jpg	'Motif Pucuk Pandan'	Contrast = 0.53642 Correlation = 0.92068 Energy = 0.070588 Homogeneity = 0.79759
13.	 Pucuk Cempaka 03.jpg	'Motif Pucuk Pandan'	Contrast = 0.47518 Correlation = 0.93722 Energy = 0.087429 Homogeneity = 0.81312
14.	 Pucuk Cempaka 04.jpg	'Motif Pucuk Betikam'	Contrast = 2.06 Correlation = 0.78755 Energy = 0.060153 Homogeneity = 0.64077
15.	 Pucuk Cempaka 05.jpg	'Motif Pucuk Pandan'	Contrast = 0.26947 Correlation = 0.9625 Energy = 0.13427 Homogeneity = 0.89281
16.	 Pucuk Pandan 01.jpg	'Motif Pucuk Pandan'	Contrast = 0.20786 Correlation = 0.98435 Energy = 0.20333 Homogeneity = 0.91465
17.	 Pucuk Pandan 02.jpg	'Motif Tolab Berantai'	Contrast = 0.7327 Correlation = 0.9424 Energy = 0.32664 Homogeneity = 0.85992
18.	 Pucuk Pandan 03.jpg	'Motif Pucuk Pandan'	Contrast = 0.2666 Correlation = 0.97432 Energy = 0.30293 Homogeneity = 0.90128
19.	 Pucuk Pandan 04.jpg	'Motif Pucuk Pandan'	Contrast = 0.27675 Correlation = 0.97278 Energy = 0.19923 Homogeneity = 0.89126
20.	 Pucuk Pandan 05.jpg	'Motif Pucuk Pandan'	Contrast = 0.21481 Correlation = 0.98068 Energy = 0.25459 Homogeneity = 0.91031
21.	 Tampuk Manggis 01.jpg	'Motif Tampuk Manggis'	Contrast = 0.52105 Correlation = 0.94653 Energy = 0.14224 Homogeneity = 0.85553
22.	 Tampuk Manggis 02.jpg	'Motif Pucuk Pandan'	Contrast = 0.29603 Correlation = 0.95872 Energy = 0.13533 Homogeneity = 0.88979
23.	 Tampuk Manggis 03.jpg	'Motif Pucuk Pandan'	Contrast = 0.56491 Correlation = 0.9307 Energy = 0.28442 Homogeneity = 0.87347
24.	 Tampuk Manggis 04.jpg	'Motif Pucuk Pandan'	Contrast = 0.81957 Correlation = 0.88644 Energy = 0.085617 Homogeneity = 0.7813

Continue Table 3. Classification Test Results

No	Image File	Classification Result	Average Extraction Result
25.	 Tampuk Manggis 05.jpg	'Motif Pucuk Cempaka'	Contrast = 1.7677 Correlation = 0.86206 Energy = 0.064323 Homogeneity = 0.69035
26.	 Tolab Berantai 01.jpg	'Motif Tolab Berantai'	Contrast = 0.33832 Correlation = 0.96599 Energy = 0.46026 Homogeneity = 0.90777
27.	 Tolab Berantai 02.jpg	'Motif Tolab Berantai'	Contrast = 0.82393 Correlation = 0.88715 Energy = 0.46915 Homogeneity = 0.86199
28.	 Tolab Berantai 03.jpg	'Motif Tolab Berantai'	Contrast = 0.62157 Correlation = 0.88225 Energy = 0.46947 Homogeneity = 0.90785
29.	 Tolab Berantai 04.jpg	'Motif Tolab Berantai'	Contrast = 0.24126 Correlation = 0.96976 Energy = 0.47912 Homogeneity = 0.92227
30.	 Tolab Berantai 05.jpg	'Motif Tolab Berantai'	Contrast = 0.37501 Correlation = 0.97167 Energy = 0.46261 Homogeneity = 0.90785

Table 3 shows 30 test data with 5 data from each type of Songket motif. There is a Songket image file with the file name according to the name of the Songket motif. The classification results are found in the system according to the class of Songket motifs tested. The system's average classification results are obtained according to the class of Songket motifs tested.

From the test results of all 30 test data, there are 13 types of Songket motifs that are wrong in the placement of Songket motifs according to their class, so from the results of the classification of Songket motifs, the accuracy results are obtained with a value of 57% with a description of 17 test data that are correct for class placement and 13 incorrect test data in class placement.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the results of tests carried out by classifying the Batu Bara Songket motif based on the image of the Songket motif using *the Gray Level Co-Occurrence Matrix* (GLCM) and *Support Vector Machine* (SVM) methods, the following conclusions were drawn:

In the manual calculation of the *Support Vector Machine* (SVM) classification using the one against-all decision function equation with class = sign(f(x)). The function sign is used to check the results of the calculations performed on the test data. The test results on the test data produce the decision with the maximum value given a value of y_i=1, while the other decision functions are given a value of y_i=-1.

From the results of testing all test data, which are 30 test data, from the results of the classification of the type of Songket motif, the accuracy results with a value of 57% with a description of 17 test data that is correct in class placement and 13 test data are wrong in class placement.

Extraction of Gray Level Co-Occurrence Matrix (GLCM) features of Batu Bara Songket motif images used to classify types of Batu Bara Songket motifs. The distance of neighboring pixels (distance) is one and in the direction of 0°, 45°, 90°, and 135°. The resulting feature of the *Gray Level Co-Occurrence Matrix* (GLCM) represents the texture value of the Songket motif image. So that these values are used to classify the types of Batu Bara

Songket motifs using the *Support Vector Machine* (SVM) method, conclusions should be in the form of paragraphs that answer the research objectives. It tells how the researcher's work can advance current knowledge but does not seem to discuss it.

Suggestion

The addition of the type of Songket motif studied is universal. The use of different methods as a comparison of this study. It expanded using other feature extraction methods, such as color or shape extraction. Image capture of Songket motifs is idealized in terms of lighting. Moreover, it can be developed into a mobile-based application or website so the wider community can use it.

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