

# MADURA BATIK DETECTOR USING COMPUTER VISION-BASED ETHNOMATHEMATICAL APPROACH

**TERA ATHENA**

English Language Education, STKIP PGRI Bangkalan, Indonesia.Email: teraathena@stkippgri-bkl.ac.id

**METY LIESDIANI**

Mathematics Education, STKIP PGRI Bangkalan, Indonesia.Email: metyliesdiani@stkippgri-bkl.ac.id

**NUR AINI**

Mathematics Education, STKIP PGRI Bangkalan, Indonesia.Email: nuraini@stkippgri-bkl.ac.id

## Abstract:

Madura batik is one of the traditional cloth from Indonesia which has a variety of motifs. Madura batik cloth motifs can be identified by detection. The detection of batik cloth is done because there are still many people who do not know the diversity of Madura batik motifs. Detection of Madura batik cloth from various motifs can be done by humans but the results can be subjective and will take more time. So that the detection research is carried out using an ethnomatic approach based on Computer Vision. The research method for detecting Madura batik cloth is carried out in several stages, namely, data collection, system architecture, feature extraction, and artificial neural network. The batik data collected are 43 datasets originating from Tanjung Bumi and have motifs in the form of circles, rectangles, triangles, and others. System architecture is needed in detecting motifs on batik images so that the system that can be made functions optimally and as expected. The feature extraction stage is carried out to determine the identity of an image, feature extraction used in this study includes color features using the HSV moments method, shape features using the Hu-Moment method, and texture features using the GLCM method. Artificial neural network is done to classify the human brain oriented that can process information. The method contained in the Artificial Neural Network is Backpropagation, a multilayer network consisting of several layers, namely, input, hidden, and output layers. The results of this research are the detection of Madura batik motifs in the form of image processing, feature extraction in images, and system evaluation. Image processing in this study consists of grayscaling, histogram equalization, and canny processes. The results of the features of an image in this study have 29 features where 6 features are from color extraction, 7 features are from shape extraction and 16 features are from texture extraction. Evaluation of the system in the confusion matrix produces precision values = 100%, recall = 100%, and f-1 score = 100%.

**Keywords:** batik; system architecture; feature extraction; artificial neural network

## INTRODUCTION

Batik is one of the traditional cloth owned by Indonesia and has been named as an Indonesian cultural heritage (Eka Indriani et al., 2019) that is still preserved and needs to be preserved. Currently, research on traditional cloth, especially batik, has been widely carried out (Firdaus & Nugroho, 2019), (Hu et al., 2021). This makes researchers in the field of computers, especially computer vision, continue to develop systems that can be applied to detect the characteristics of traditional fabrics. Computer vision-based research related to the characteristics of traditional fabrics has been applied to the introduction of Surakarta batik(Kusanti & Suprpto, 2019), Besurek batik(Karimah & Harjoko, 2017) and Bomba Kaili batik(Nuraedah et al., 2018), and Pekalongan batik(Surya et al., 2019). The introduction of Madura Batik(Indriani et al., 2019)

particularly the patterns is something that needs to be researched because there are still many people who do not know the diversity of Madura batik motifs. In addition, batik motifs can also be grouped based on geometric shapes and patterns. So that the motive can be recognized through mathematics lessons.

Madura batik has various motifs including rice flower, lekkok rice flower, chain flower, sessok flower and many other motifs. Detection of this feature can be done by humans but the results can be subjective and will take more time. An example of a Madura Batik motif can be seen in Fig. 1 and Fig. 2.



**Fig. 1. Madura Motif Batik**



**Fig. 2. Non-Madura Motif Batik**

This study proposes the detection of Madura batik using an ethnomatic approach based on Computer Vision. The image is generated using a smartphone with sufficient and even lighting. The purpose of this study is to develop a method for detecting Madura Batik fabrics on images so that they can distinguish each type of motif that exists in batik with an ethnomathematical approach.

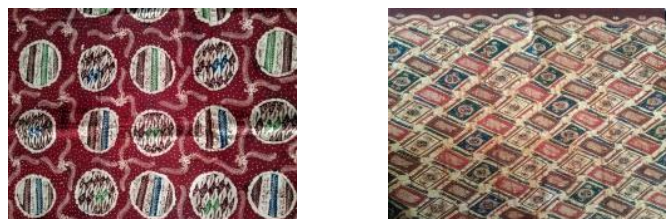
## LITERATURE REVIEW

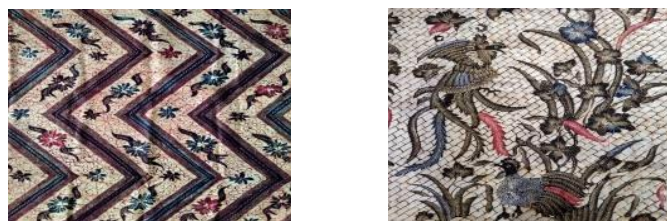
The development of the detection of Madura batik requires several processes, namely the initial stage, segmentation, feature extraction, feature selection and classification that affect the success of the batik cloth pattern recognition results. In the early stages it can be applied using grayscaling techniques(Nugrowati et al., 2014), and contrast enhancement(Juwita & Solichin,

2018). The color space can be selected so that the results in the next process are better. The segmentation process on traditional fabric images has been applied using fuzzy C-Means and median filters(Wildan et al., 2017), hidden markov tree(Murinto & Aribowo, 2016), and Region Adjacency Graph(Akmal et al., 2019). The next process, namely feature extraction, needs to be applied to produce all the features or characteristics that can distinguish between several classes of Madura Batik and not Madura batik. The feature extraction method that has been applied is based on texture using a gray level co-occurrence matrix (GLCM)(Pantazi et al., 2019), (Sulistianingsih et al., 2018). Meanwhile, the combined application of texture and shape features in areas containing cloth characteristics has been implemented in(Kasim et al., 2017) and the use of shape features with moment invariant has also been implemented(Kasim et al., 2017). Furthermore, a feature selection process is applied to select the features that best serve as input data in the classification process. This process needs to be applied to speed up the classification process with optimal results. Feature selection methods that can be applied include Principal Component Analysis (PCA) (Kumar et al., 2011), (Singh & Kaur, 2012) and Correlation Feature Selection (CFS). In the final stage, namely the classification process, there are several methods that have succeeded in solving cases related to traditional fabric pattern recognition, namely the combination of SIFT and K-Nearest Neighbor (KNN), SVM (Setyawan et al., 2015). The use of the pre-processing method to the classification described previously was not applied to the case of pattern recognition of batik cloth only, but to other cloth. However, other cases of the pattern recognition need to be considered because the research objects used have similarities in terms of color, shape, or characteristics of the cloth.

## RESEARCH METHOD

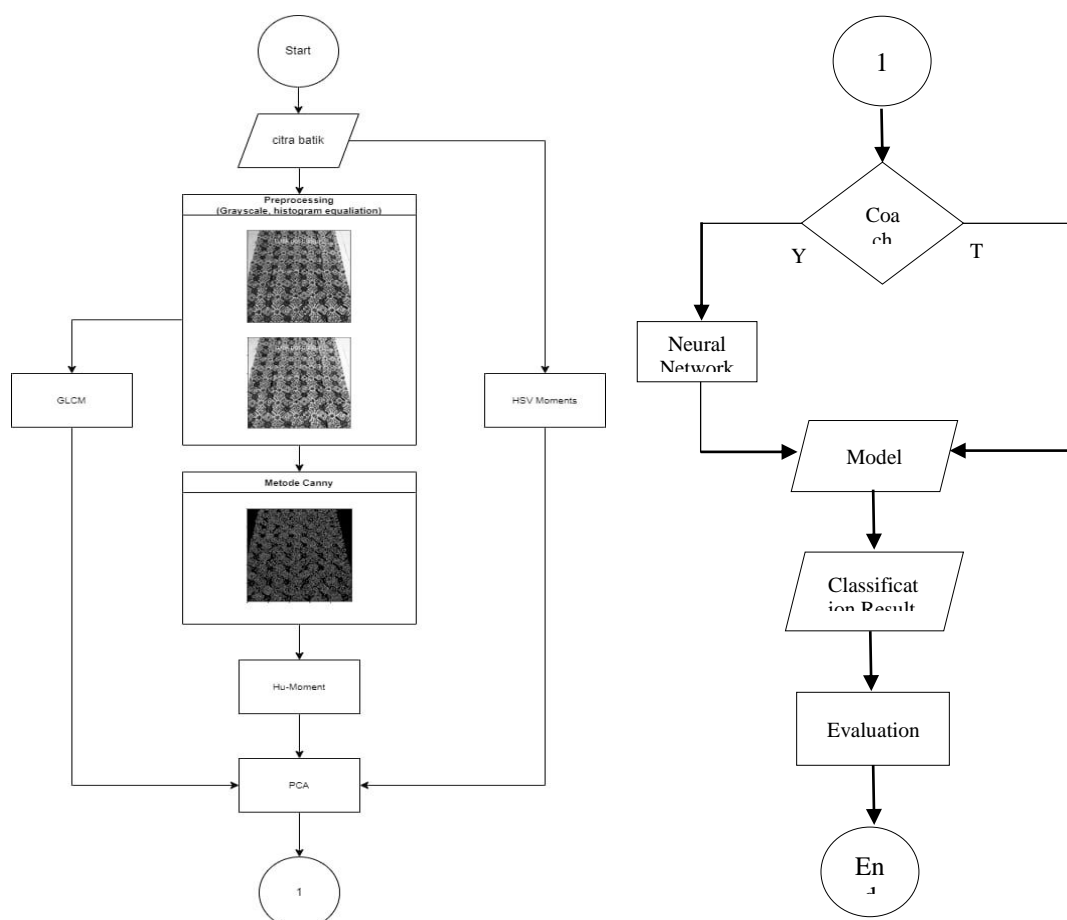
This research method is carried out through four stages, namely the stage of data collection, system architecture, feature extraction, and artificial neural network. At the data collection stage, the dataset of this research is batik data originating from Tanjung Bumi and has motifs in the form of circles, rectangles, triangles, and others. An example of a batik drawing is shown in Figure 3.





**Fig. 3. Datasets Examples**

The number of datasets used are 43 batik images which have six classes, namely batik with circle, rectangle, triangle, oval, parallelogram, and other motifs. The system architecture stage is needed in detecting motifs on batik images so that the system that can be made functions optimally and as expected. The system architecture in this study can be seen in Figure 4.



**Fig. 4. System Architecture**

There are several stages in detecting batik motifs that can be seen in the architecture of this research system, the system will receive input in the form of batik images, in extracting the color features of the image it is converted to HSV. In texture extraction, image preprocessing is done, namely converting the image to grayscale and histogram equalization, texture extraction using the GLCM method. In shape extraction, edge detection is performed using the canny method, and shape extraction is carried out using Hu-Moments. After getting the features in an image, the images will be classified into two groups, namely images in the training process and the testing process. The training process uses a neural network method which will later get a model that will be used in the testing process to detect batik motifs. After getting the results of the classification system, it will be evaluated using precision, recall, and f-1 score. The feature extraction stage is carried out to determine the identity of an image, feature extraction used in this study includes color features using the HSV moments method, shape features using the Hu-Moment method, and texture features using the GLCM method.

Color features using the HSV moments method, namely the processed image will be converted to HSV and the average value and standard deviation are taken. Here is the formula for HSV moments.

$$H = \begin{cases} 0 & \text{if } S = 0 \\ \frac{60 \times (g - b)}{S \times V} & \text{if } V = r \\ 60 \times \left[ 2 + \frac{b - r}{S \times V} \right] & \text{if } V = g \\ 60 \times \left[ 4 + \frac{r - g}{S \times V} \right] & \text{if } V = b \end{cases} \quad (1)$$

$$S = \begin{cases} 0 & \text{Jika } V = 0 \\ V - \frac{\min(r, g, b)}{V} & \text{if } V > 0 \end{cases} \quad (2)$$

$$V = \max(r, g, b) \quad (3)$$

Shape features use the Hu-Moment method, which defines or represents an image. Object recognition requires the process of the first 4 moments which have a level of resistance to scale, translation and rotation, shape feature extraction will produce 7 moments, namely h1, h2, h3, h4, h5, h6, and h7. Here is the Hu-Moment formula.

$$M_{ij} = \sum \sum I(x, y) \quad (4)$$

$$\mu_{ij} = \sum \sum (x - \bar{x})^i (y - \bar{y})^j I(x, y) \quad (5)$$

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^Y} \quad (6)$$

$$h_1 = \eta_{20} + \eta_{02} \quad (7)$$

$$h_2 = (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^4 \quad (8)$$

$$h_3 = (\eta_{30} - \eta_{12})^2 + (\eta_{21} - \eta_{03})^2 \quad (9)$$

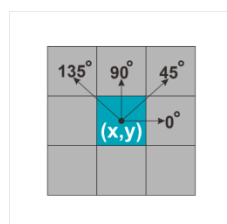
$$h_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2 \quad (10)$$

$$h_5 = (\eta_{30} - \eta_{12})(\eta_{30} + \eta_{12}) \\ [(\eta_{30} - \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] \\ + (3\eta_{21} - \eta_{03})(\eta_{21} - \eta_{03}) \\ [3(\eta_{30} + \eta_{12})^2 - (\eta_{30} + \eta_{12})^2] \quad (11)$$

$$h_6 = (\eta_{20} - \eta_{02}) \\ [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] \\ + 4\eta_{11}(\eta_{30} + 3\eta_{12})(\eta_{21} + \eta_{03}) \quad (12)$$

$$h_7 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12}) \\ [(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] \\ - (\eta_{30} - 3\eta_{12})(\eta_{21} + \eta_{03}) \\ [3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \quad (13)$$

Texture features using the GLCM (Gray Level Co-occurrence Matrix) method, which is a feature extraction method that can be used to analyze the texture of a digital image. GLCM is also a matrix arrangement of a digital image in which the pixels are paired and have a certain intensity, the coordinates of the pixel pairs have a distance  $d$  and angle orientation, the distance is represented in pixels and the angle is in degrees.



**Fig. 5. GLCM Matrix**

After creating the GLCM matrix, the texture feature taker is based on the energy, contrast, correlation, and homogeneity of the matrix. The following is the formula for capturing texture features.



$$\text{Energy} = \sum_i \sum_j P(i, j)^2 \quad \dots (14)$$

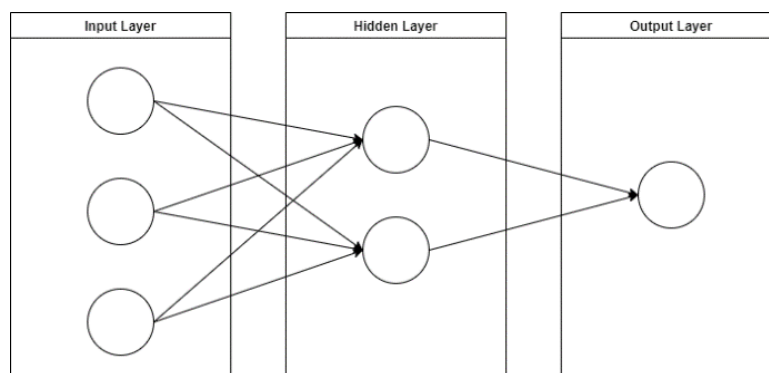
$$\text{Contrast} = \sum_{ij} |i - j|^2 P(i, j) \quad \dots (15)$$

$$\text{Correlation} = \sum_i \sum_j \left( \frac{(i - \mu_i)(j - \mu_j)P(i, j)}{\sigma_i \sigma_j} \right) \quad \dots (16)$$

$$\text{Homogeneity} = \sum_i \sum_j \frac{p(i, j)}{1 + |i - j|} \quad \dots (17)$$

Texture extraction in GLCM uses four angles, namely 00 450 900 1350 so that the resulting features are 16 features.

The last stage is the Artificial Neural Network stage. Artificial neural network is a classification method oriented to the human brain that can process information. Backpropagation is a method found in Artificial Neural Networks. Backpropagation network is a multilayer network consisting of several layers, namely, input, hidden, and output layers. Figure 6 is the architecture of Backpropagation.



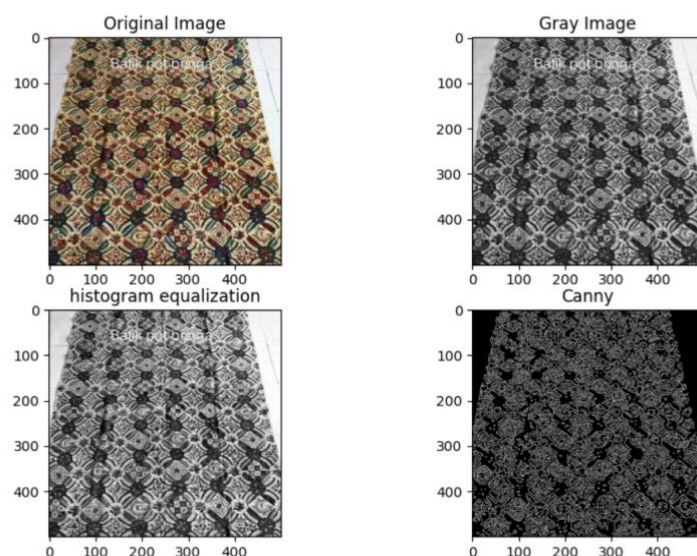
**Fig. 6. Backpropagation Architecture**

Backpropagation has a forward propagation phase and a backward propagation phase. In the forward propagation phase each value in the input layer is calculated forward to the hidden layer, then the output from each hidden layer will be propagated back to the output layer. In the backward propagation phase, it is the opposite of the forward propagation phase with the aim is to improve the weights so as to produce a model with minimum error.

## RESEARCH RESULT

The results of the research on the detection of Madura batik motifs obtained the results of image processing, feature extraction in images, and system evaluation.

Image processing in this study consists of grayscaling, histogram equalization, and canny processes. Figure 7 is an example of image processing results.



**Fig. 7. Image processing results**

The original image will be converted to grayscale and then histogram equalization is carried out to refine the image, then edges will be detected using canny.

The results of the features of an image in this study have 29 features where 6 features are from color extraction, 7 features are from shape extraction and 16 features are from texture extraction. Figure 8 is the result of color feature extraction.



Average H = 0.543

Average S = 0.313

Average V = 0.587

Standard Deviation H = 0.155

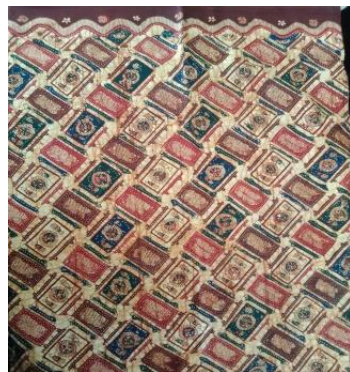
Standard Deviation S = 0.152

Standard Deviation V = 0.212

**Fig. 8. Color Feature**

Figure 9 is the result of shape extraction using the Hu-Moment method.

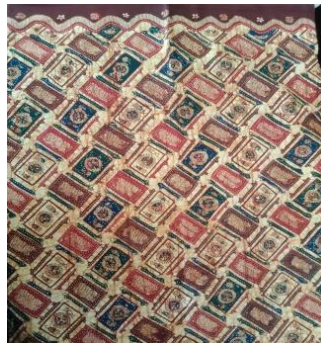




H1 = 2.615  
H2 = 7.730  
H3 = 11.335  
H4 = 11.945  
H5 = 23.938  
H6 = -16.232  
H7 = -23.628

**Fig. 9. Shape Feature**

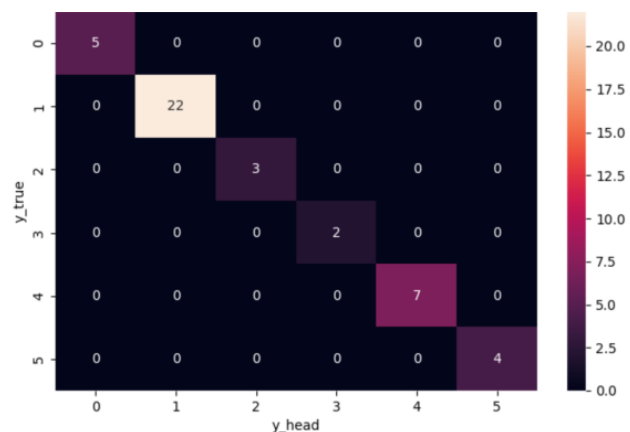
Figure 10 is the result of texture extraction using the GLCM method.



<b>Energy</b> <b>0</b> 1,323	<b>Contrast</b> <b>0</b> 0,664	<b>Correlation</b> <b>0</b> 0,202	<b>Homogeneity</b> <b>0</b> 0,862
<b>Energy</b> <b>45</b> 1,483	<b>Contrast</b> <b>45</b> 0,654	<b>Correlation</b> <b>45</b> 0,199	<b>Homogeneity</b> <b>45</b> 0,845
<b>Energy</b> <b>90</b> 0,937	<b>Contrast</b> <b>90</b> 0,729	<b>Correlation</b> <b>90</b> 0,222	<b>Homogeneity</b> <b>90</b> 0,902
<b>Energy</b> <b>135</b> 0,637	<b>Contrast</b> <b>135</b> 0,195	<b>Correlation</b> <b>135</b> 0,828	<b>Homogeneity</b> <b>135</b> 72,646

**Fig. 10. Fitur Tekstur**

After getting the image features, classification is carried out on certain images, to find out the level of truth of the system created, a system evaluation is carried out, the evaluation is carried out by conducting a training and testing process, all data in this study will go through both processes so as to produce an evaluation value, evaluation system based on the value of precision, recall, and f-1 score on the confusion matrix. Figure 11 is on this system.



**Fig. 11. Confusion matrix**

Based on the confusion matrix above, the precision value = 100%, recall = 100%, and f-1 score = 100%.

## CONCLUSION

The detection of Madura batik motifs in this study consisted of a grayscaling process, histogram equalization, and canny. At the data collection stage, the dataset of this research is batik data originating from Tanjung Bumi and has motifs in the form of circles, rectangles, triangles, and others. The number of datasets used are 43 batik images which have six classes, namely batik with circle, rectangle, triangle, oval, parallelogram, and other motifs. At the architectural stage, the system is needed to detect motifs on batik images so that the system that can be made functions optimally. The feature extraction stage is carried out to determine the identity of an image, feature extraction used in this study includes color features using the HSV moments method, shape features using the Hu-Moment method, and texture features using the GLCM method. Artificial neural network is done to classify the human brain oriented that can process information. The method contained in the Artificial Neural Network is Backpropagation, a multilayer network consisting of several layers, namely, input, hidden, and output layers. The results of this research are the detection of Madura batik motifs in the form of image processing, feature extraction in images, and system evaluation. Image processing in this study consists of gray scaling, histogram equalization, and canny processes. The results of the features of an image in this study have 29 features where 6 features are from color extraction, 7 features are from shape extraction and 16 features are from texture extraction. Evaluation of the system in the confusion matrix produces precision values = 100%, recall = 100%, and f-1 score = 100%.

The results obtained show that the application of combining color and texture features can reduce misclassification.

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