DETECTION OF SIMILARITY IN BATIK MOTIFS USING BACKPROPAGATION METHOD

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ABSTRACT

One of the famous batik producing regions in Malaysia is Kelantan. Batik has a variety of motifs and colours, and each batik motifs has its own uniqueness but seems similar, which make them difficult to be identified. This research aims to detect the similarities of floral batik motifs by calculating the accuracy. At the same time, the characteristics of mathematical elements of floral motifs for batik and the relationship between mathematics and culture are identified. There are three types of motifs were selected, which are Bunga Cempaka, Daun Keladi, and Pucuk Rebung. The detection process used is the backpropagation method since this method is well known to be one of the most accurate in recognizing the pattern. The backpropagation algorithm is divided into three phases which are forward and backward propagation phases, changes in the weights, and biases phase. The result for Bunga Cempaka motifs shows the least accuracy, with 36% among the motifs. However, the backpropagation algorithm still can be used well to recognize floral batik motifs with 72% of average accuracy rate. The result also shows that these three motifs contain a reflection transformation through physical observation.

Keywords: *Backpropagation Method, Batik motifs, Neural network, Similarity.*

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1. Introduction

Ethnomathematics can be interpreted as the relation between mathematics and culture. It is defined as “the mathematics which is practised among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes, and so on” (D’Ambrosio, 1985). It is a concept that explores the aspects in which different cultural groups perceive, connect, and implement ideas and concepts that can be classified as mathematical practices (Ambarawati & Agustin, 2019). Ethnomathematics is not limited to classroom practices, but might also be recognizable in art fields including the batik industry.

Batik is one of the superior handicrafts in Malaysia. Batik is a type of fabric produced through the process of applying liquid wax and dyeing colour.“the term batik comes from the Javanese word “amba”, which means writing and “nitik” which means giving a point” (Surya et al., 2019). Batik designs are motivated by nature or mythology and thus resulting in ordinary geometrical designs, different motifs of batik with distinctive names (Kasim et al., 2017). The uniqueness of the batik motifs is possibly found to be associated with many mathematical concepts such as mathematical transformations and shapes. In common

Balinese batik, there are some elements of mathematical transformation which are translation, reflection, rotation whereas dilation elements can be found in other batik (Irawan et al., 2019).

This project is important to reveal that ethnomathematics is a very diverse field and might have a relation with many aspects of daily life including in batik motifs. This research intends to explore batik and expose the younger generation to our culture. It would be exciting especially for the younger generation if they know there is a relationship between mathematics and culture. Indirectly, it will increase the devotion of batik culture. Thus, this study would like to prove the relationship between those two particular aspects, the backpropagation method is applied for this project.

Backpropagation algorithms from artificial neural networks are often used in recognizing patterns because of its accuracy (Hirose et al., 1991). Artificial Neural Networks (ANN) is an application that consists of many neurons that can receive information. There are several stages developed in backpropagation algorithms for the identification of batik motifs which are feedforward propagation, backpropagation and weight changes (Lestari et al., 2018).The training process consists of two main parts, namely Forward Propagation and Backward Propagation. This study seeks the accuracy to detect the similarities of batik motifs by using backpropagation method. This study also explores the mathematical elements such as geometric transformations; dilation, rotation, reflection and translation may or may not be associated with the batik motifs through physical observation.

2. Methodology

2.1 STEP 1: Image Processing

i. Batik image collection

This study focuses on Kelantan floral Batik Motifs. Three floral batik motifs used in this study namely batik “bunga cempaka”, batik “daun keladi”, and batik “pucuk rebung”. The images of these batik motifs will be collected from secondary data.

ii. Scaling

Scaling involves the process of resizing the digital images. This process will resize the images into images of 50x50 pixels as suggested by previous researchers by using MATLAB software. Then, the RGB (red-green-blue) values for each pixel will be found after the size reduction and in the dimensions of 5x5 pixels.

iii. Grayscale

Grayscale is the process of removing all colour information and leaving only the luminance of each pixel. After the scaling process is carried out, the image will go through the grayscale stage which is the image turns into gray.

iv. Thresholding

Thresholding is a great way to extract valuable data encoded into pixels while minimizing background noise. This is accomplished by utilizing an input circle to optimize the threshold value before converting the original grayscale image to binary.

2.2 STEP 2: Data training and testing

Training data is the data that is used to train an algorithm or system to learn and recognize certain patterns. Testing data is the data used to test the system during the test execution. This data is used to verify either the input data produces expected results which is correlated with the patterns produced by data that undergo training.

2.3 STEP 3: Application of MATLAB

To obtain the accuracy of the batik motifs, the backpropagation algorithm is needed which will be processed through MATLAB application. Three images from each motifs will be applied to the MATLAB application for image processing. The images and results obtained during image processing stage. This application implements the backpropagation algorithm. The accuracy results will be obtained after the training and testing process.

3. Results and Discussion

3.1 Batik image collection

Three floral batik motifs which used in this study namely batik “bunga cempaka”, batik “daun keladi”, and batik “pucuk rebung” as shown below respectively. These images used in the scaling stage to reduce the value that needs to be processed during the classification process later.

Figure 1: Floral Batik Motifs for Bunga Cempaka, Daun Keladi and Pucuk Rebung

3.2 Scaling

Bunga Cempaka batik motifs with 1600x1066 pixels, Daun Keladi batik motifs with 260 x 194 pixels, and Pucuk Rebung batik motifs with 200 x 200, have been resized into 50 x 50 pixels. The RGB (red-green-blue) values for each pixel are found after the size reduction and in the dimensions of 5x5 pixels as shown below.

Figure 2: Floral Batik Motifs with 50x50 pixels

Table 1: RGB values for Bunga Cempaka motif

Pixel	1	2	3	4	5
1	[243 177 129]	[207 141 93]	[207 143 97]	[205 143 96]	[237 174 131]
2	[207 141 93]	[168 104 58]	[170 106 60]	[168 105 61]	[199 138 94]
3	[208 144 98]	[172 108 62]	[174 110 66]	[172 109 66]	[202 140 99]
4	[206 142 98]	[169 106 62]	[172 109 66]	[170 108 67]	[199 140 100]
5	[239 176 133]	[203 142 98]	[205 143 102]	[203 144 104]	[233 175 137]

Table 2: RGB values for Daun Keladi motif

Pixel	1	2	3	4	5
1	[168 151 159]	[134 117 125]	[140 123 131]	[141 124 132]	[170 153 161]
2	[133 116 124]	[101 84 92]	[108 91 99]	[109 92 100]	[136 119 127]
3	[127 110 118]	[99 82 90]	[111 94 102]	[114 97 105]	[145 128 136]
4	[125 108 116]	[99 82 90]	[110 93 101]	[113 96 104]	[144 127 135]
5	[174 157 165]	[145 128 136]	[151 134 142]	[146 129 137]	[173 156 164]

Table 3: RGB values for Pucuk Rebung motif

Pixel	1	2	3	4	5
1	[144 130 129]	[162 148 147]	[156 142 141]	[177 163 162]	[166 152 151]
2	[136 122 121]	[153 139 138]	[145 131 130]	[165 151 150]	[153 139 138]
3	[130 116 115]	[146 132 131]	[137 123 122]	[155 141 140]	[142 128 127]
4	[124 110 109]	[139 125 124]	[127 113 112]	[143 129 128]	[128 114 113]
5	[116 102 101]	[130 116 115]	[117 103 102]	[131 117 116]	[114 100 99]

3.3 Grayscale

After the scaling process, the batik motifs images undergo a grayscale process which turns the images into greyish images.

Figure 3: Grayscale image of Batik for Bunga Cempaka, Daun Keladi and Pucuk Rebung Motifs

The grayscale of each pixel is obtained by the formula: Grayscale = (R+G+B)/3.The result of grayscale value up to 5 x 5 pixels only is shown below.

Table 4: Grayscale values for Bunga Cempaka motif

Pixel	1	2	3	4	5
1	183	147	149	148	181
2	147	110	112	111	144
3	150	114	117	116	147
4	149	112	116	115	146
5	183	148	150	150	182

Table 5: Grayscale values for Daun Keladi motif

Pixel	1	2	3	4	5
1	159	125	131	132	161
2	124	92	99	100	127
3	118	90	102	105	136
4	116	90	101	104	135
5	165	136	142	137	164

Table 6: Grayscale values for Pucuk Rebung motif

Pixel	1	2	3	4	5
1	134	152	146	167	156
2	126	143	135	155	143
3	120	136	127	145	132
4	114	129	117	133	118
5	106	120	107	121	104

3.4 Thresholding

Thresholding is the process that convert the images into binary images. This study has set up the limit of threshold value T=128. This value was used to convert the pixel values into values of 0 and 1 only by using binary system. The pixel values that exceed or were equal to 128 will be changed to 1 and the values that were less than 128 will be changed to 0.

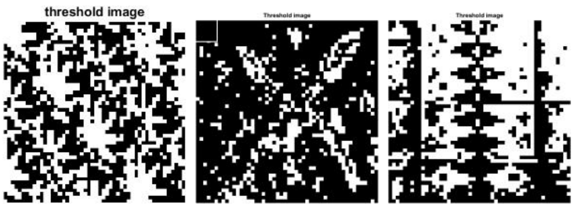

Figure 4: Threshold image of Batik for Bunga Cempaka, Daun Keladi and Pucuk Rebung Motifs

Table 7: Binary values for Bunga Cempaka motif

Pixel	1	2	3	4	5
1	1	1	1	1	1
2	1	0	0	0	1
3	1	0	0	0	1
4	1	0	0	0	1
5	1	1	1	1	1

Table 8: Binary values for Daun Keladi motif

Pixel	1	2	3	4	5
1	1	0	1	1	1
2	0	0	0	0	0
3	0	0	0	0	1
4	0	0	0	0	1
5	1	1	1	1	1

Table 9: Binary values for Pucuk Rebung motif

Pixel	1	2	3	4	5
1	1	1	1	1	1
2	0	1	1	1	1
3	0	1	0	1	1
4	0	1	0	1	0
5	0	0	0	0	0

From this stage, the values of 0 and 1 of each image have been obtained and been used as the inputs in data training and data testing. Three images for each batik motifs have undergo the same process which are scaling, grayscale and thresholding stages to reduce the image data into a one-dimensional array, which been used as the training inputs.

3.5 Data training and data testing

Input on training process is the result of thresholding process of batik motifs. Then, the motifs transformed into one dimensional array. Training parameters set up:

i) Maximum epoch = 2000
ii) Learning rate = 0.1
iii) Minimum error = 0.001

The training process begins with the feedforward propagation process. This feedforward process continued the backpropagation process and repeat as long as the error value is still greater than the targeted error. This process stops when the training process has achieved the maximum epoch or the output value has less or equal target error. As the training process is finished, the testing process had executed.

Table 10: One-dimensional array inputs for Batik motifs

Pixel	Bunga Cempaka	Daun Keladi	Pucuk Rebung
1	1 1 1	1 1 1	1 1 0
2	11 1	0 0 1	1 1 0
3	1 1 1	1 1 1	1 0 1
4	1 1 1	1 1 1	1 1 1
5	1 1 1	1 1 1	1 1 0
6	1 1 1	0 0 1	0 1 0
7	0 0 0	0 0 0	1 0 0
8	0 0 0	0 0 0	1 0 1
9	0 0 0	0 0 0	1 1 1
10	1 1 1	0 1 0	1 1 0
11	1 1 1	0 0 1	0 1 0
12	0 0 0	0 0 0	1 0 0
13	0 0 0	0 0 0	0 0 0
14	0 0 0	0 0 0	1 0 1
15	1 1 1	1 1 0	1 1 0
16	1 1 1	0 0 1	0 1 0
17	0 0 0	0 0 0	1 1 0
18	0 0 0	0 0 0	0 0 0
19	0 0 0	0 0 0	1 1 0
20	1 1 1	1 1 0	0 1 0
21	1 1 1	1 1 1	0 1 0
22	1 1 1	1 1 1	0 0 0
23	1 1 1	1 1 1	0 0 0
24	1 1 1	1 1 1	0 0 0
25	1 1 1	1 1 1	0 1 0

Another three new images for each batik motifs have been used for the testing process. Those images undergo the same process during training stages and transformed from matrix into one-dimensional array, which been used as the testing inputs.

The result obtained after the neural network has been trained using the images of Bunga Cempaka, Daun Keladi, and Pucuk Rebung motif. After the testing process, the testing output values are compared to the testing target values to determine the error. Testing output values that are less or equal to the minimum error (0.001) is labeled as identified, otherwise will be considered as unidentified. Then, the accuracy of the batik motifs were calculated by using the results of the identification from the testing process as shown below.

Table 11: The accuracy of batik motifs identification

No.	Batik Cempaka	Batik Pucuk Rebung	Batik Daun Keladi
1	Unidentified	Unidentified	Identified
2	Identified	Identified	Identified
3	Identified	Identified	Identified
4	Identified	Identified	Identified
5	Identified	Identified	Identified
6	Unidentified	Identified	Identified
7	Identified	Identified	Identified
8	Identified	Identified	Identified
9	Identified	Unidentified	Identified
10	Identified	Identified	Identified
11	Unidentified	Identified	Identified
12	Unidentified	Unidentified	Identified
13	Unidentified	Identified	Identified
14	Unidentified	Identified	Identified
15	Unidentified	Identified	Identified
16	Unidentified	Unidentified	Identified
17	Unidentified	Unidentified	Identified
18	Unidentified	Identified	Identified
19	Unidentified	Identified	Identified
20	Unidentified	Identified	Identified
21	Unidentified	Identified	Identified
22	Unidentified	Identified	Identified
23	Unidentified	Identified	Identified
24	Identified	Identified	Identified
25	Unidentified	Identified	Identified
Accuracy(%)	(9/25)x100% =36%	(20/25)x100% =80%	(25/25)x100% =100%

The average accuracy rate for all batik motifs is: (36% + 80% + 100%)/3 = 72%. Aside from obtaining the accuracy rate of similarities in batik motifs, this research also aims to find the characteristic of mathematical elements of floral batik motifs. Reflection transformation is found in the images by physical observation. Reflection transformation is one of the geometrical transformations where an object can be reflected on the other side by a line of reflection. In the batik images, there exists a symmetrical line in the middle of the motif which is easy to recognize since one side is a reflection of the other. The general transformation of reflection is as shown below.

$$A(x, y) \rightarrow -B(-x, y) \tag{1}$$

The images that contained reflection transformation are as shown below:

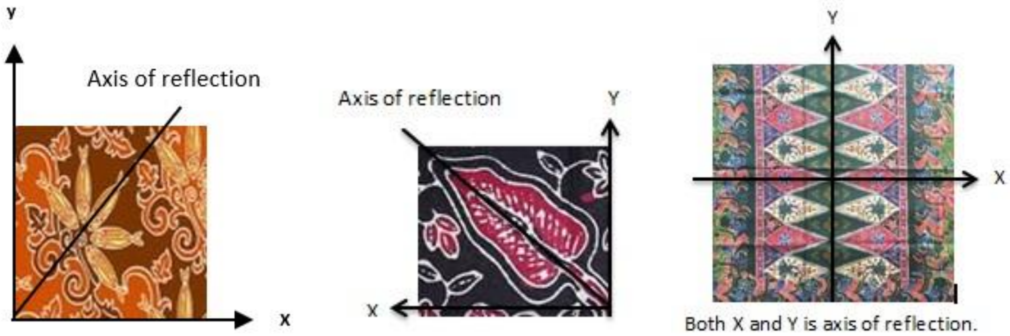

Figure 5: The reflection transformation in Batik Motifs

4. Conclusions

Based on the results, the backpropagation method succeeds in recognizing the Daun Keladi motif with the accuracy of identification 100%, followed by Pucuk Rebung motif with 80% of accuracy, and Bunga Cempaka with 36%. Even though the accuracy rate for Bunga Cempaka motif is quite low, the average accuracy rate of similarities for all batik motifs is 72%, which means the neural network system is still able to identify the batik motifs very well. Next, the characteristic of mathematical elements in batik motifs is also found within those three main batik motifs which is reflection transformation. The existence of reflection transformation in the batik motifs shows that there is a strong relationship between mathematics and the batik motifs. Some improvements can be made in the future in order to increase the accuracy rate. The training process should involve a lot of training inputs to increase the performance of an algorithm. For the future work, it is suggested to use edge detection method to identify the existence of mathematical elements in batik motifs.

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