Batik Image Search System with Extracted Combination of Color and Shape Features

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Abstract

Batik is a culture-dependent technique and symbolism surrounding hand-dyed cotton and silk garments from Indonesia It an cultural art that has a long history of acculturation, with diverse patterns influenced by a variety of cultures. Each region in Indonesian has specific colors and shapes reflecting the identity of the region. Due to many diverse Batik' patterns and colors, it is difficult to retrive the Batik images from both the color and pattern. In this paper we propose a new system for Batik image search with providing an analytical function for feature extraction by involving color and shape features and combining the extracted features. We use 3D-Vector Quantization for color feature extraction. It can uniformly represent the distribution of image colors and reduce complexity of the colors. Beside the color features, we also use shape features of the Batik by applying Hu's moment. The extracted shape features from the Hu's moment consists of orthogonal moment invariants those can be used for scale, position, and rotation invariant pattern identification for the Batik patterns. Finally, the distribution of color moments are used to aggregate the extracted color and shape features. For experimental study, we apply our proposed system to 210 Batik image dataset from 3 common Batik kinds of pattern: Kawung, Parang and Mega Mendung. The system performs the easy-to-use application for the users in which they may easily search the Batik images with involving both the color and shape features.

Keywords: Batik pattern, Batik Image Search, Feature Extraction, Color Vector Quantization, Color Moment.

Introduction

Batik is a culture-dependent technique and symbolism surrounding hand-dyed cotton and silk garments from Indonesia It an cultural art that has a long history of acculturation, with diverse patterns influenced by a variety of cultures. UNESCO stated that Batik cultural arts are masterpieces of the oral and intangible heritage of humanity. The shape and colors of batik actually has symbolic meanings. The variety of pattern and colors of batik are often affected by culture-dependent from different regions in Indonesia. Each region in Indonesian has specific colors and shapes reflecting the identity of the region. Due to many diverse Batik' patterns and colors, it is difficult to retrive the Batik images from both the color and pattern.

There are some researchers trying to deal with classification and retrieval system for Batik. Veronica and Sitohang [1] presented clustering and classifying algorithm for batik images based on color, contrast, and pattern. It proposed a color clustering algorithm using HSV color system and shape and texture based techniques to classify the Batik images.

Alvian et al. [2] proposed to classify batik by using Fuzzy C-Means with texture features. It developed three phases for Batik image clustering: (1) Image Acquisition, (2) Feature Extarction, and (3) Image Clustering. The classification system used the Discrete Wavelet Transform (DWT), Rotated Wavelet Filters (RWF), and Grey Level Co-occurrence Matrix (GLCM) as methods to identify the texture of batik. Dhani Pratikaningtyas et al. [3] classified Batik using Wavelet Transformation Pack. The researchers use several different types of wavelet to classify batik texture. Another research from Arisandi Bernardinus et al. [4] introduced Batik classification using Rotated Wavelet Filter to extract the shape feature and using Neural Network to classify the batik pattern.

Our Proposed System

In this paper we propose a new system for Batik image search system with providing an analytical function for feature extraction by involving color and shape features and combining the extracted features. The 3D-Vector Quantization is applied for color feature extraction. The system uses Hue-moments to extract shape features. Finally, the distribution of color moments are used to aggregate the extracted color and shape features.

System Design

Our proposed system consists of two steps: (1) Feature Extraction, and (2) Batik image search. Here is the architecture system of our proposed system categories, as shown in Figure 1.

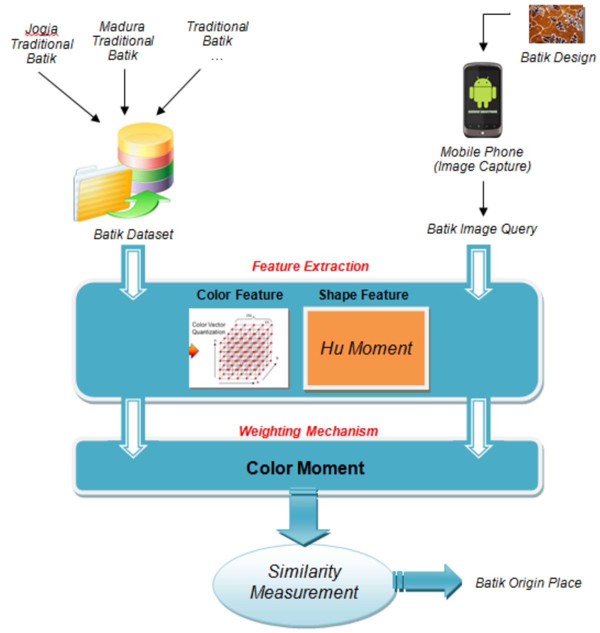
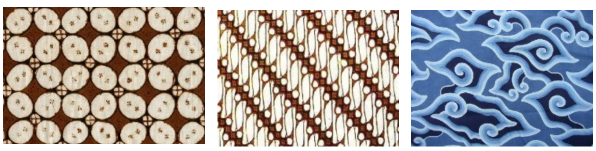


Figure 1. Architecture System of our proposed Batik image search

Batik Dataset

Batik dataset consists of 210 batik images. The batik images that we use as dataset are batik image that has a unique pattern that usually repeated. These patterns are usually owned by an old batik image. These batik images are Parang and Kawung from Yogyakarta, and Mega Mendung from Cirebon, as shown in Figure 2.



(a) (b) (c)

Figure 2. Batik dataset, (a) Kawung from Yogyakarta, (b) Parang from Yogyakarta, (c) Mega Mendung from Yogyakarta

To extract the metadata of the Batik dataset, we save the information of Batik's name, origin places and patterns. For Batik's patterns, we involve the color and shape features and extract the metadata into the database. The metadata extraction of Batik images is figured out in Figure 2.

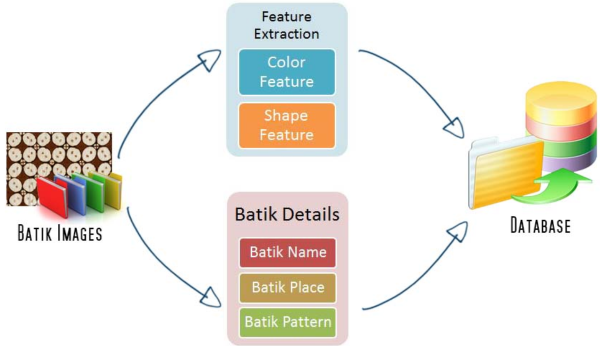


Figure 2. The metadata extraction of Batik images

Batik Image Query

Batik image query is an image of batik that used as an input data for this application system. Batik image query can be obtained from image that has already saved in a smartphone or from capturing batik using camera from smartphone. The image that obtained from camera capture then processed to get the metadata that will be used to gain the similarity value with batik dataset. Before this image go to the extraction feature process, this image will be automatically scaled.

Feature Extraction

After collecting Batik images, we extract the dominant features of these images and save the feature metadata. The extracted features consist of color and shape features. The color features are extracted using 3D Color Vector Quantization, while shape features are extracted using Hu Moment.

3D Color Vector Quantization

The 3D Color Vector Quantization [5] is used to extract to the color features of Batik images. The main idea of use of method is that the system uniformly represents image colors in certain positions of RGB's vector color space. It intends to reduce a complexity RGB colors in the image and unifies the close colors in the vector space. If we use hisogram of RGB color space, then we will get 256x256x256 combination of RGB color. The process of extracting color feature of image will take longer with this complex color combinations, moreover if we use smartphone to process the feature extraction. For this reason, we decide to use the 3D Color Vector Quantization that use 5x5x5 quantization size of RGB color space. Using this quantization size, we will get 125 color combinations that can be represented in the 125 positions in the RGB color space. With the reduction of RGB color combinations, the process of extracting color feature will take faster. Figure 3 shows the mechanism for color feature extraction using 3D Color Vector Quantization.

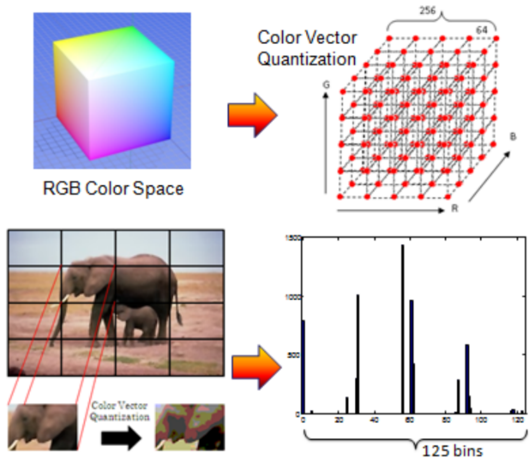


Figure 3. Mechanism of color feature extraction

This method starts with obtaining the pixels of image. RGB color will be extracted from each pixel. This color will be remapped into histogram of Color Vector Quantization, so we will get the color feature metadata. The metadata of color feature MCL_b for pixel b can be described in Eq. 1.

$$MCL_b = \{fc_{b,1}, fc_{b,2}, \ldots, fc_{b,125}\} \quad (1)$$

Where:

$fc_{b,i}$ is a color feature from pixel b of *i*-th color histogram from 3D-Color Vector Quantization of RGB vector space.

Hu Moments

We used Hu Moment to extract the shape feature of batik images. Hu Moment is derived by Hu [6] from algebraic invariants applied to the moment generating function under a rotation transformation. The result is a set of absolute orthogonal (i.e. rotation) moment invariants, which can be used for scale, position, and rotation invariant pattern identification. Hu moment equation can be seen in Eq. 2.

$$\begin{aligned}
I_1 &= \eta_{20} + \eta_{02} \\
I_2 &= (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^2 \\
I_3 &= (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2 \\
I_4 &= (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2 \\
I_5 &= (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \\
I_6 &= (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] + 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03}) \\
I_7 &= (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (\eta_{30} - 3\eta_{12})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]
\end{aligned} \quad (2)$$

Where η_{pq} is central moment (μ_{pq}) that has already been normalized. The central moments are moments those have the property of translation invariant. In many applications such as shape recognition, it is useful to generate shape features which are independent of parameters which cannot be controlled in an image. Such features are called invariant features. There are several types of invariance. For example, if an object may occur in an arbitrary location in an image, then one needs the moments to be invariant to location. Central moments are normalized to obtain the scale invariance. The normalized central moments are defined in Eq. 3.

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^{\gamma}}, \gamma = \frac{p+q+2}{2}, p + q = 2,3, \ldots \quad (3)$$

Weighting Mechanism

The weighting mechanism is used to make the balance of several data with color moments [9]. In this paper, we used manual weighting mechanism to combine the two features that we have. This manual weighting mechanism use the value that user has already input in the application interface. The range of this value is 0–1. The input values will be calculated with the features that we have to gain the balance of these two features.

Similarity Mechanism

In order to retrieve most significance images of Batik dataset to the image query, we measure the similarity between the feature metadata of Batik dataset and an image query. In our proposed system, we involve two similarity metrics: (1) Cosine distance metric [7] to calculate the similarity for the color features, and (2) Our semantic distance [8] to measure the similarity for shape features.

Cosine similarity distance metric is a measure of similarity between two vectors of an inner product space that measures the cosine of the angle between them. The cosine of 0° is 1, and it is less than 1 for any other angle. It is thus a judgment of orientation and not magnitude: two vectors with the same orientation have a Cosine similarity of 1, two vectors at 90° have a similarity of 0, and two vectors diametrically opposed have a similarity of -1, independent of their magnitude. The Cosine similarity is particularly used in positive space, where the outcome is neatly bounded in [0,1]. In this paper, the color feature extraction dataset has range from 0-1 so for the images that have the same orientation have Cosine similarity 1, and for the images that have different orientation have the Cosine similarity 0. The Cosine similarity distance metric can be shown in Eq. 4.

$$similarity = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=1}^{n} (A_i)^2} \times \sqrt{\sum_{i=1}^{n} (B_i)^2}} \quad (4)$$

where A is matrix of query image and B is matrix of image dataset.

Unlike the color feature which its metadata is normal so that we can use common distance metrics such as the Eucledian or Cosine, for the similarity measurement in the shape features which are not normal, we need to normalize their metadata before calculating the similarity. However, if we apply data normalization to the metadata, there is precision issue whether the normalized metadata can totally represent the original metadata or not. Therefore, in our proposed Batik image search system, we use our semantic distance metric [8] that directly able to normalize the data distance in each attribute inside the similarity calculation for the shape features. The proposed distance metric is applied if the data is not normal. It represents a semantic similarity between two data points those correspond an image query and the image database. Let x and y be two data points, the proposed distance metric between them is defined in Eq. 5.

$$D_{x,y} = \frac{\sum_i^n \frac{|x_i - y_i|}{|x_i| + |y_i|}}{n} \quad (5)$$

where:

n = the number of attributes

In this paper, $D_{x,y}$ is the distance of metric x and metric y for data in Batik dataset and the image query.

Experimental Study

To examine the performance of our proposed Batik image search system, we make a series of experimental studies involving 210 images from 3 common Batik kinds of pattern: Kawung, Parang and Mega Mendung. This retrieved images calculated by the ranking position to get the precision value. We take the top ten images of each Batik patterns those have closest similarity to the image query. We calculate the score of ranked image with Eq. 6.

$$Score = \sum_{i=1}^{10} scr_i \begin{cases} scr_i = 10 - i + 1 \leftarrow cr_i = cq \\ scr_i = 0 \leftarrow otherwise \end{cases} \quad (6)$$

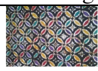
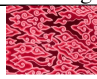
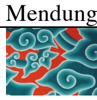
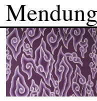
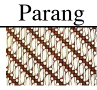
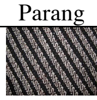
where:

$cr =$ category of retrieved images.
$cq =$ category of image query.
$scr_i =$ score for each image retrieve i

To analyze the performance of each image features, we conduct 3 types of experiments:
(1) Experiments with color features,
(2) Experiments with shape features, and
(3) Experiments with combined color and shape features

Experiments with Color Features
We conduct 10 experiments involving different patterns of image queries and retrieve with color features. Table 1 shows the performance scores of each Batik patterns and total errors for color features.

Table 1. Performance Score for Color Features

Experiment		Result for each pattern			Highest Values	End Result	Correct
No	**Batik**	**Parang**	**Kawung**	**Mega Mendung**			
1	 Kawung	33	22	0	33	Parang	No
2	 Kawung	12	31	12	31	Kawung	Yes
3	 Kawung	24	31	0	31	Kawung	Yes
4	 Mega Mendung	10	12	33	33	Mega Mendung	Yes
5	 Mega Mendung	8	0	47	47	Mega Mendung	Yes
6	 Mega Mendung	9	20	26	26	Mega Mendung	Yes
7	 Parang	10	16	29	29	Mega Mendung	No
8	 Parang	25	27	3	27	Kawung	No
9	 Parang	24	31	0	31	Kawung	No
10	 Parang	28	27	0	28	Parang	No
						Error: 50%	

Experiments with Shape Features
We conduct 10 experiments involving different patterns of image queries and retrieve with shape features. Table 2 shows the performance scores of each Batik patterns and total errors for shape features.

Experiments with Color and Shape Features
In these experiments, we make three types of experiments using three different conditions. Each type of experiment will be performed 10 times of experiments with ten different batik images. The three types of experiments has different weights of combination of color and shape features: (1) 30% color features and 70% shape features, (2) 70% color features and 30% shape

features, and (3) 50% color features and 50% shape features. Table 3-5 shows the performance scores of each Batik patterns and total errors for combined color and shape features.

Table 2. Performance Score for Shape Features

Experiment		Result for each pattern			Highest Values	End Result	Correct
No	Batik	Parang	Kawung	Mega Mendung			
1	Kawung	6	30	19	30	Kawung	Yes
2	Kawung	10	36	9	36	Kawung	Yes
3	Kawung	15	40	0	40	Kawung	Yes
4	Mega Mendung	1	8	46	46	Mega Mendung	Yes
5	Mega Mendung	12	14	29	29	Mega Mendung	Yes
6	Mega Mendung	9	17	29	29	Mega Mendung	Yes
7	Parang	26	8	21	26	Parang	Yes
8	Parang	22	27	6	27	Kawung	No
9	Parang	37	12	6	37	Parang	Yes
10	Parang	20	26	9	26	Kawung	No
						Error: 80%	

Table 3. Performance Score for 30% Color and 70% Shape Features

Experiment		Result for each pattern			Highest Values	End Result	Correct
No	Batik	Parang	Kawung	Mega Mendung			
1	Kawung	19	35	1	35	Kawung	Yes
2	Kawung	16	26	13	26	Kawung	Yes
3	Kawung	18	37	0	37	Kawung	Yes
4	Mega Mendung	11	3	41	41	Mega Mendung	Yes
5	Mega Mendung	7	20	28	28	Mega Mendung	Yes
6	Mega Mendung	8	29	18	29	Kawung	No
7	Parang	21	11	23	23	Mega Mendung	No
8	Parang	20	35	0	35	Kawung	No
9	Parang	45	10	0	45	Parang	Yes
10	Parang	21	34	0	34	Kawung	No
						Error: 60%	

Table 4. Performance Score for 70% Color and 30% Shape Features

Experiment		Result for each pattern			Highest Values	End Result	Correct
No	Batik	Parang	Kawung	Mega Mendung			
1	Kawung	28	27	0	28	Parang	No
2	Kawung	18	28	9	28	Kawung	Yes
3	Kawung	21	34	0	34	Kawung	Yes
4	Mega Mendung	9	10	36	36	Mega Mendung	Yes
5	Mega Mendung	7	6	42	42	Mega Mendung	Yes
6	Mega Mendung	7	27	21	27	Kawung	No
7	Parang	10	15	30	30	Mega Mendung	No
8	Parang	27	32	1	32	Kawung	No
9	Parang	34	21	0	34	Parang	Yes
10	Parang	27	28	0	28	Kawung	No
						Error: 50%	

Table 5. Performance Score for 50% Color and 50% Shape Features

Experiment		Result for each pattern			Highest Values	End Result	Correct
No	Batik	Parang	Kawung	Mega Mendung			
1	Kawung	24	29	2	29	Kawung	Yes
2	Kawung	19	21	15	21	Kawung	Yes
3	Kawung	15	40	0	40	Kawung	Yes
4	Mega Mendung	9	6	40	40	Mega Mendung	Yes
5	Mega Mendung	8	11	36	36	Mega Mendung	Yes
6	Mega Mendung	8	30	17	30	Kawung	No
7	Parang	13	14	28	28	Mega Mendung	No
8	Parang	26	29	0	29	Kawung	No
9	Parang	39	16	0	39	Parang	Yes
10	Parang	23	32	0	32	Kawung	No
						Error: 60%	

Conclusion

This paper has presented a new system for Batik image search with providing an analytical function for feature extraction by involving color and shape features and combining the extracted features. The color features are extracted using 3D Color Vector Quantization, while shape features are extracted using Hu's moment. The distribution of color moments are used to aggregate the extracted color and shape features. For experimental study, the proposed Batik image search system is examined to 210 Batik image dataset from 3 common Batik kinds of pattern: Kawung, Parang and Mega Mendung. The experiments showed the performance with 50% correct retrieved images for color features, 80% correct retrieval results for shape features, and 60%, 50%, 60% respectively for combined color and shape features.

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