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AN EFFICIENT BATIK IMAGE RETRIEVAL SYSTEM BASED ON COLOR AND TEXTURE FEATURES

[1]RIMA TRI WAHYUNINGRUM, [2]INDAH AGUSTIEN SIRADJUDDIN

[1, 2] Department of Informatics Engineering, University of Trunojoyo Madura, INDONESIA

E-mails: [1]rimatriwahyuningrum@gmail.com, [2]indah.agustien@if.trunojoyo.ac.id

ABSTRACT

Research in batik image retrieval is still challenging today. In this paper, we present an efficient system for batik image retrieval that combine color and texture features. The proposed approach is based on color auto-correlogram method as color feature extraction method and Gray Level Co-occurrence Matrix (GLCM) method as texture feature extraction method. Firstly, HSV (Hue Saturation Value) color space but only the hue component is quantized into 18 color categories and continued in the process of color auto-correlogram. Secondly, converts the batik image from RGB color space to grayscale to obtain texture features using GLCM (Gray Level Co-occurrence Matrix). Finally, the integration of the color and texture features provide a robust feature set for batik image retrieval with calculates the similarity measure. Precision and recall are used as the accuracy measure in our proposed research, then the results are compared with the well-known existing approaches. The experimental results show that the proposed batik image retrieval is more accurate and efficient in retrieving the user interested images.

Keywords: *Feature Extraction, Color Auto-Correlogram, Gray Level Co-Occurrence Matrix (GLCM), Image Retrieval*

1. INTRODUCTION

Currently, image plays an important role in many applications, since it has the advantage of visual representation. In recent years, image retrieval is wildly used instead of text retrieval, since storage and transmission of an enormous number of images are possible, as the fast development of computers and networks [1]. Content-Based Image Retrieval (CBIR) usually indexes images by low-level visual features such as color, texture, and shape. The visual features cannot completely characterize the semantic content, but they are easier to integrate into mathematical formulations [2].

To retrieve images from the database, features of an image are required. Since color is the most prominent features of an image, therefore methods based on color are proposed in many researches, i.e. color histogram, color moments, color correlogram, color auto-correlogram and MPEG-7 based scalable color descriptor (SCD), color layout descriptor (CLD), color structure descriptor (CSD), and dominant color descriptor (DCD), have been used in the literature [3, 4] to represent the color information of an image. Meanwhile, texture feature explores the structural arrangement of surfaces and its relationship in the images. Hence, many researchers [3-6] conducted studies on texture features extracted using the Gabor filter, Markov random field, Hidden Markov random field, Gray Level Co-occurrence Matrix (GLCM), Homogeneous texture descriptor (HTD), wavelet transform based techniques and so on.

Batik is a crucial part of the cultural heritage of Indonesia. As an acknowledgment of this, UNESCO on October 2009, determined that Indonesian batik as a Masterpiece of Oral and Intangible Heritage of Humanity, and has insisted that Indonesia preserve this heritage. Batik patterns consist of textures patterns, i.e. motifs are written in an orderly or a disorderly sequence. Therefore, an efficient batik image retrieval system based on color auto-correlogram as color feature extraction and Gray Level Co-occurrence Matrix as texture feature extraction is proposed in this research.

2. RESEARCH METHOD

2.1 Content Based Image Retrieval Framework

In a typical content-based image retrieval approach, a user submits an image-based query that is then features are extracted from this query images. The visual features may include shape, color or texture depending upon the type of image retrieval system being used. These features are examined to search and retrieve similar images

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from the image database. The distance between features of a query image and each image in the database is calculated to find the similarity of visual features. Images are displayed as retrieved images for the query image in the image retrieval system, which have the closest similarity, according to the predefined threshold value in the system. The preset threshold value is usually set to restrict the number of results that the content-based image retrieval system displays. A general content-based image retrieval system is shown in Fig. 1.

2.2 Color Feature Extraction

The color feature is the most commonly used the visual feature for image retrieval. In the literature, many color models are available that can be used to represent images such as HSI, HSV, LAB, LUV, and YCrCb. Colors play a significant role in human perception. The most commonly used color model is RGB, where each component represents color red, green and blue. The color histogram is easy to compute; unfortunately this histogram method is less suitable for color feature extraction, since the method gives no space information in color histogram. Therefore other methods are required to integrate spatial information with color histogram, for example the auto-correlogram method. Here, the color auto-correlograms will be used in HSV color space. In this paper, we use only the hue component is quantized into 18 color categories.

The color auto-correlogram transmit the idea of the existence of larger or smaller areas of a particular color within the image. An expression for the color auto-correlogram is shown in Eq. (1) [7]:

$$\gamma_{c_i}^{k}(I) = Pr_{p1 \in Ic_i,\ p2 \in I}\left[p2 \in Ic_i \mid |p1 - p2| = k\right] \quad (1)$$

The value of the color auto-correlogram of a color c_i (i is the index of the colors in the image) and a distance k, in the image I, is the probability that, a pixel p_1 of color c_i in the image I, there will be a pixel p_2, also of color c_i, at a distance k from pixel p_1, as shown in Fig. 2. In this work, we considered the color auto-correlogram with distances $k = [1, 3, 5, 7]$, as shown in Fig. 3.

Auto-correlogram captures the spatial correlation between identical colors only, defined by Eq. (2) [7]:

$$\alpha^{I}(i,k) = \gamma_{c_i}^{k}(I) \quad (2)$$

2.3 Texture Feature Extraction

The texture is another important feature of an image that can be extracted for the purpose of image retrieval. Image texture refers to surface patterns that show granular details of an image. Composition of different colors information is also provided in the texture pattern. For example, the different texture pattern can be seen in sky image and block walls image. These two images can be distinguished based on the texture.

There are two main approaches for texture analysis, i.e. structural and statistical approach [5]. The structural texture approach is used if the surface pattern is repeated. For example the block walls that contain repeated pattern. Meanwhile, if the pattern is not repeatedly in the same image, then the statistical approach is suitable. For example, in an image there are different flower objects that contain similar properties. GLCM is one of the most commonly used statistical approaches to extract texture feature of an image, such as energy, inertia, entropy, and uniformity.

The GLCM presents the joint probability that a pair of gray pixels with the position ($\Delta i,\Delta j$) will occur at the same time, where Δi and Δj are determined by a specified displacement δ between the pair of pixels and angle θ, and they are subject to $\Delta i=\delta cos\theta$ and $\Delta j=\delta sin\theta$. Because the distribution of gray intensities will be different at every orientation, 8 connected neighbors seem to be the best for computing GLCM, and there will be $\delta=1$; $\theta=0\circ,45\circ,90\circ,135\circ$ for the 8 connected neighbors. For instance, considering an image region with eight gray levels, there will be $m(i,j)\in[0,7]$. The corresponding gray-level co-occurrence matrix is quantized into $D=8$, as shown in Fig. 4.

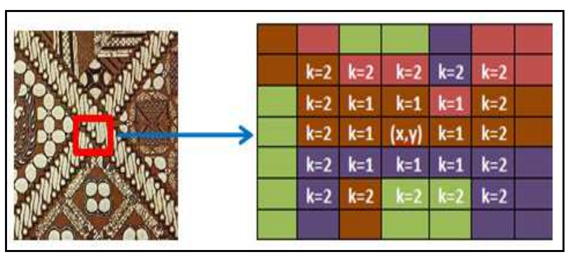

Figure 2. Getting Position k1, k2 on Color Auto-correlogram

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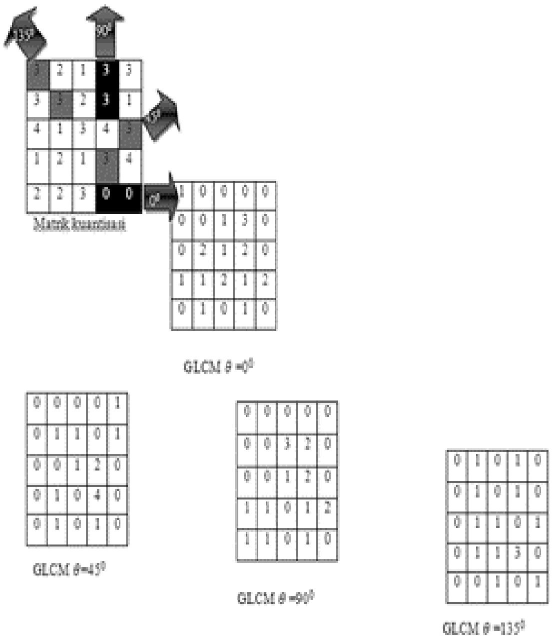

Figure 4. Making GLCM with θ = 0^0, 45^0, 90^0, 135^0

Furthermore, extract the following statistical values from each matrix based on Eq. (3)-(6) [6]:

$$E = \sum_{i=1}^{D}\sum_{j=1}^{D}[m(i,j)]^2, \qquad (3)$$

$$I = \sum_{i=1}^{D}\sum_{j=1}^{D}(i-j)^2 m(i,j), \qquad (4)$$

$$P = -\sum_{i=1}^{D}\sum_{j=1}^{D} m(i,j)\log[m(i,j)], \qquad (5)$$

$$H = \sum_{i=1}^{D}\sum_{j=1}^{D}\frac{m(i,j)}{1+(i-j)^2}, \qquad (6)$$

Where *E* denotes energy, *I* represents inertia, *P* denotes entropy, and *H* represents uniformity. They are the commonly used texture descriptors and can effectively reflect the texture feature. Each feature consists of a four way corner (0^0, 45^0, 90^0, 135^0) so the total are 16 features.

2.4 Similarity Measure

Similarity measure is required to compute the similarity between the query image *Q* and each image *I* in a batik image database, hence the similar images are retrieved. This similarity measure calculates the combined extracted feature, i.e. color and texture features. We define color auto-correlogram feature similarity as shown in eq. (7) [8]:

$$S^{auto}(Q,I) = \frac{\sum(i,k)\min[\alpha^Q(i,k),\alpha^I(i,k)]}{\sum(i,k)\alpha^Q(i,k)} \qquad (7)$$

Whereas the texture feature similarity is given by Eq. (8) [9]:

$$S_{Texture}(Q,I) = \left(\sum_{i=1}^{4}[(\mu_i^Q-\mu_i^I)^2 + (\sigma_i^Q-\sigma_i^I)^2]\right)^{1/2} \qquad (8)$$

Where μ_i^Q and σ_i^Q denote the texture feature of query image *Q*, μ_i^I and σ_i^I denote the texture feature of the target image *I*.

The similarity measure to calculate the distance between the query and target feature vector is shown in Eq. (9) [10].

$$S(Q,I) = w_C S^{auto} + w_T S_{Texture} \qquad (9)$$

where w_k, w_T is the weight of the color and texture features respectively. Color feature and texture feature are fused to realize comprehensive image retrieval. The weight of color and texture features is determined through lots of experiments. Linear weighted mode combining with similar distances of color and texture features are adopted to retrieve images comprehensively.

To find the proper weight values of color and texture features, experiments have been done 20 times when the retrieval approach combining the two features is adopted. One weight value changes to smaller from near 1 in the range of (0,1) gradually, meantime the other weight value will be larger from near 0 in the range of (0,1) correspondingly keeping the sum of the two weight values as 1. With the difference between the two weight values approximating 0, retrieval results approach the input image that is the expected result. When the two weight values are approximately equal, the retrieval results approximate to be the best visual effect. Therefore, the default weights of color and texture features in the system are assumed as 0.5 and 0.5.

2.5 Performance Evaluation

To measure the accuracy of our proposed approach, the standard methods such as Precision and Recall are used. These are the most common measurements used for the evaluation of information and image retrieval systems. The Precision (P), Recall (Rc) and Accuracy are defined below in Eq. (10) [5]. Where I_N is the number of images retrieved, that are most relevant to the query

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image. T is the total number of images in the database that are similar to the query image. R is the total number of images retrieved.

$$\left.\begin{aligned} P &= \frac{I_N}{R} \\ Rc &= \frac{I_N}{T} \end{aligned}\right\} \quad (10)$$

Different researchers use different threshold values to apply such metrics [11]. We use three experiment, namely comparing only color auto-correlogram, only GLCM and combine the two methods (the proposed method) respectively for 200 training images as database images and eight images from the database, two images from outside the database as query images by threshold ranges between 1-0.6.

3. RESULT AND DISCUSSION

In this experiment, we use eight classes of batik images where each class consists of 25 images, so the total is 200 images. Eight classes of batik images namely: Sumenep Batik, Pamekasan Batik, Bangkalan Batik, Pekalongan Batik, Cirebon Batik, Yogya Batik, Solo Batik and Bali Batik. In every test scenario consists of eight images from the database, and two images from outside the database.

In this paper, we propose an effective batik image retrieval system by combining two methods of two different features that is auto-correlogram for color features and GLCM for texture features. The combination of two different extracted features (texture and color features) in the content based image retrieval system yields better performance accuracy compare to the use of one extracted feature only (texture or color feature).

Fig 5 shows the retrieved images with one extracted feature, i.e. the texture feature. And the retrieved image with one extracted feature, i.e. the color feature is depicted in Fig. 6. Meanwhile the combination of two extracted features (color and texture) can be seen in Fig. 7.

As seen in the Fig. 5, the retrieved images are images that have similar texture with query image. Images with different color are also retrieved in this approach. Fig. 6 shows that the images with similar color but different texture are retrieved. Therefore, the use of one extracted feature is less effective for the content based image retrieval.

Fig. 7 shows the result of the combination of two extracted features (color and texture), as seen in the figure, the retrieved images are better compare with retrieved images shown in Fig. 5 and Fig. 6.

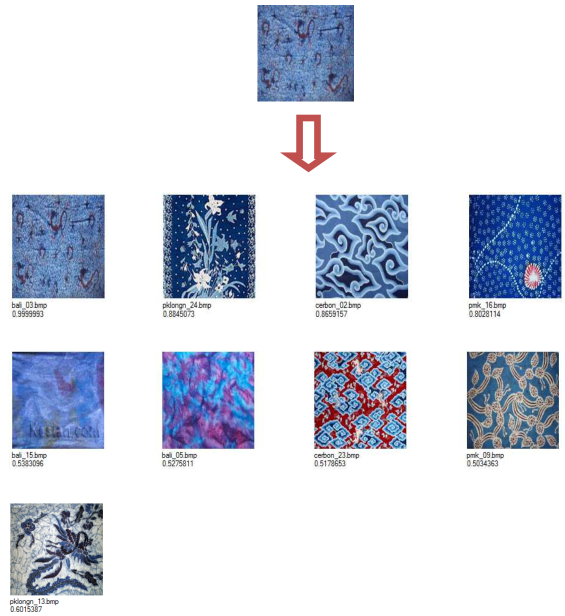

Figure 5: Bali_03 Query Images and The Results of Image Retrieval in Texture Feature

Figure 6: Bali_03 Query Images and The Results of Image Retrieval in Color Feature

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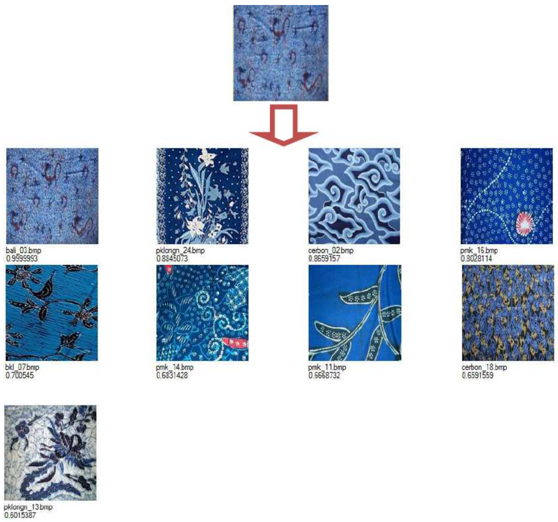

Figure 7: Bali_03 Query Images and The Results of Image Retrieval in The Proposed Method

Table 1 shows the average precisions, recall and accuracy of batik image retrieval.

Table 1. Average Precessions and Recall of Batik Image Retrieval

Average	Color Correlogram	GLCM	Proposed Method
Precision	0.72	0.65	0.87
Recall	0.59	0.47	0.68

To evaluate the overall performance of the proposed image feature in retrieval, a number of experiments were performed on our image retrieval proposed approach and the methods to be compared, i.e. color auto-correlogram and GLCM. Based on Table 1 shows the precision of image retrieval at the proposed method is the highest compared the two methods.

4. CONCLUSION

In this paper, we have proposed and described image retrieval approach for smart batik image retrieval, which is based on color and texture features. The proposed approach is based on the two well-known algorithms: color auto-correlogram, and gray level co-occurrence matrix (GLCM). These two algorithms ensures that the proposed approach yield the retrieved images that are highly relevant with the query image, since the proposed approach combine two distinct feature of the image. The color auto-correlogram is used to extract the color features of an image using Hue component is quantized into 18 color categories and texture features are extracted with GLCM.

The evaluation is carried out using the standard Precision and Recall measures. The results show that our proposed approach produce better results as compared to the existing methods. The proposed approach is effective in batik image retrieval.

In future research, the proposed a smart color image retrieval scheme for combining all the three i.e. color, texture and shape information/feature, which achieved higher retrieval efficiency.

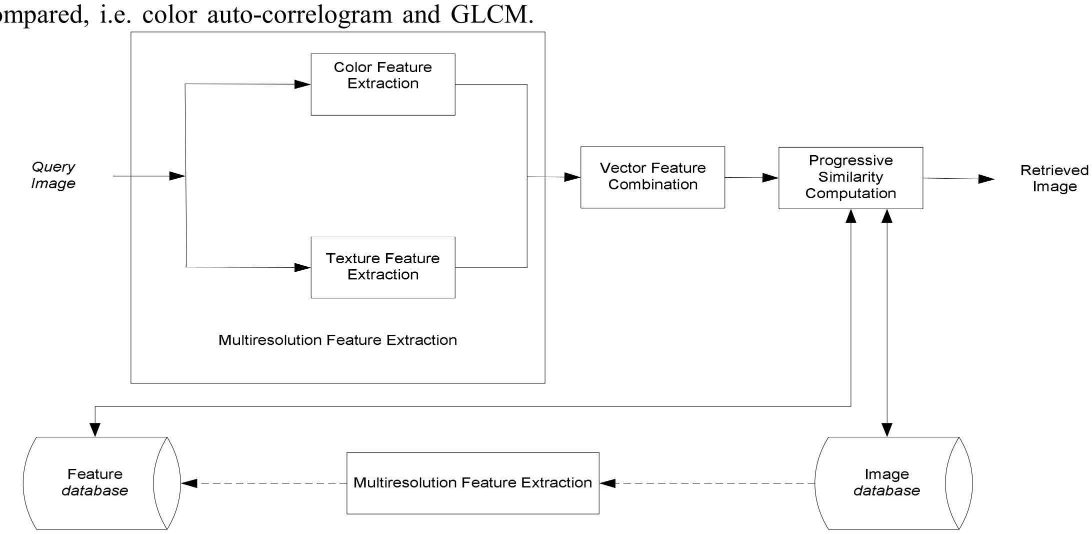

Figure 1: Block Diagram of The Proposed Method

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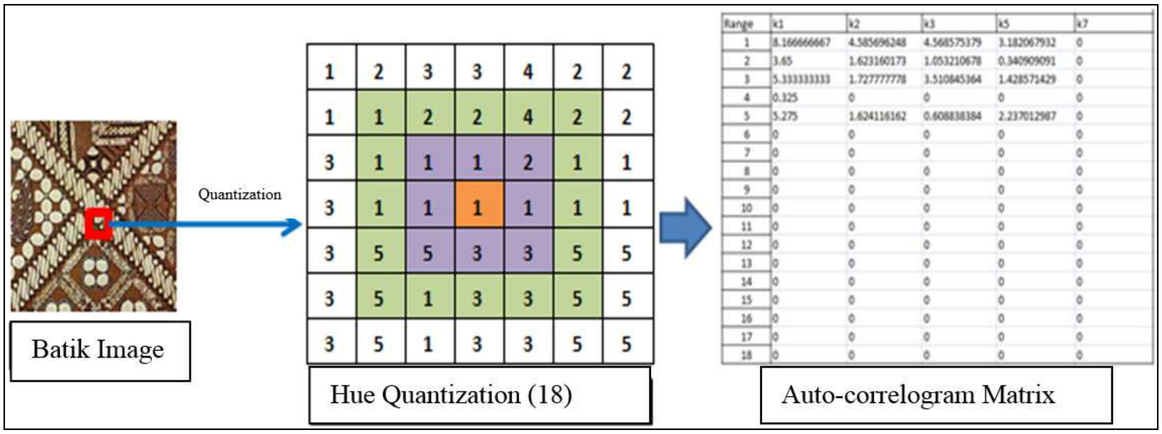

Figure 3: Matrix Color Auto-correlogram

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