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Content Based Image Retrieval Using Local Color Histogram

Metty Mustikasari[1], Sarifuddin Madenda[2], Eri Prasetyo[3], Djati Kerami[4], Suryadi Harmanto[5]
Gunadarma University[1,3,5], STMIK Jakarta[2], University of Indonesia[4]
metty@staff.gunadarma.ac.id, sarif@jak-stik.ac.id, eri@staff.gunadarma.ac.id

Abstract—This paper proposes a technique to retrieve images based on color feature using local histogram. The image is divided into nine sub blocks of equal size. The color of each sub-block is extracted by quantifying the HSV color space into 12x6x6 histogram. In this retrieval system Euclidean distance and City block distance are used to measure similarity of images. This algorithm is tested by using Corel image database. The performance of retrieval system is measured in terms of its recall and precision. The effectiveness of retrieval system is also measured based on AVRR (Average Rank of Relevant Images) and IAVRR (Ideal Average Rank of Relevant Images) which is proposed by Faloutsos. The experimental results show that the retrieval system has a good performance and the evaluation results of city block has achieved higher retrieval performance than the evaluation results of the Euclidean distance.

***Keywords*— AVRR, City block distance, Content-based image retrieval (CBIR), Euclidean distance, IAVRR, Local color histogram, precision, recall.**

I. Introduction

Recently, there has been a growing interest in develop efficiently and effectively manage large image databases and efficiently run image retrievals to get the best results without exhaustively searching the global database every time. This leads to great savings in time and, especially in the fields in which most work a database are image files or any kind of media whose contents is depicted with inadequate by simple keywords or texts.

CBIR process consists of computing a feature vector that characterizes the nature of the images. The images are stored in a feature database. In CBIR system the user provides a query image and the system calculates the feature vector, and then compares it with a certain image features of the image database. Comparisons were made by using a distance measurement technique, and the minimum distance is a metric for the matched or similar images. Feature vectors should be capable enough to fully characterize the structural and spatial image properties, which take the same image from the image database.

Color histogram is the most common technique for extracting color image features because of the calculation of the low cost and is not sensitive to small variations in the structure of the image. However, color histogram holds two major drawbacks. They can not fully accommodate the spatial information, and they are not unique. Two different images with the same distribution of color histogram is very similar result. In addition, the same images from the same viewpoint carrying different lighting conditions make different histogram.

Currently a lot of research Gathering Recognize the content based image retrieval using color features. Several papers proposed color based image retrieval using Global histogram approach [3, 7, 9, and 12]. The Global Color Histogram is the traditional method for color-based image retrieval. However, it does not include information concerning the color distribution of the regions, so the distance between images sometimes cannot show the real difference between images. For example, the distance between two images that are similar to each other should be smaller than the distance between two different images, but using the Global Color Histogram we could obtain the same distance. Moreover, in the case of a Global Color Histogram, it is possible for two different images to have a very short distance between their color histograms. This is the main disadvantage of Global Color Histogram [13].

Gong and others [4] proposed Local Color Histogram. Using this method the images are divided into nine equal parts and calculated a histogram for each of these. This given some spatial sensitivity, but increases the computing power and storage needed. One also looses the insensitivity to rotation we have in global color histograms.

Shengjiu Wang [13] proposes a rotation-insensitive variant of Local Color Histogram he calls the Harbin approach in his paper A Robust CBIR Approach Using Local Color Histograms. This method also divides the images into a number of equally sized regions and computes their Local Color Histogram. The difference from Gongs approach lies in the method for comparing the images. His Harbin approach uses a system of weighted bipartite graphs to calculate the minimum cost distance between two images. With this method each part of one image is compared to all the parts of the comparison image. This make the method less sensitive to rotation compared to Gong and others method described above.

This paper describes a color based image retrieval system using Local Histogram and comparison of the retrieval performance. The rest of the paper consists of: Section II presents the proposed method. Section III describes the experimental results. Finally, Section IV presents the conclusions.

II. Proposed Method

A. Method

The outline of the method in this experiment is described as follows:

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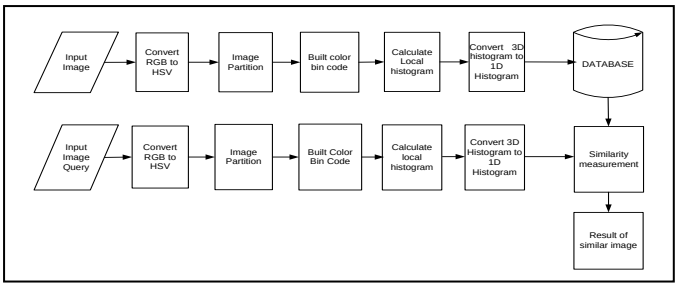

Figure 1. Local Histogram method scheme

In the Figure 1, a method scheme of color based image retrieval using Local Color Histogram is proposed. There are two stages of image retrieval. The first one is image building and the second is image retrieval. In the first stage is image stored in database. While image query is chosen, the RGB color space is converted to HSV color space. The image is divided into 9 sub blocks in equal size. After that process is conducted by the system, color bin code of each sub block is built. While the process of color bin code is done, 3D local histogram is computed then the 3D histogram is converted to 1D histogram. Finally all the images are saved to the database.

The second stage has the same process with the first stage. After converting the Histogram 3D to histogram 1D, The similarity measurement is computed for each sub-block image query and every sub-block image database using Euclidean distance or City Block distance. Then the result of image retrieval is ordered based on similarity distance value.

B. Local Histogram

Local Color Histogram (LCH) includes information concerning the color distribution of regions. The first step is to segment the image into blocks and then to obtain a color histogram for each block. An image will then be represented by these histograms. When comparing two images, we calculate the distance, using their histograms, between a region in one image and a region in same location in the other image. The distance between the two images will be determined by the sum of all these distances [13].

As stated in previous paragraph, each sub block of image query is compared with each sub block of image database. Therefore each sub block of image query is compared with the whole nine sub blocks of image database. The matching process is illustrated in figure 2.

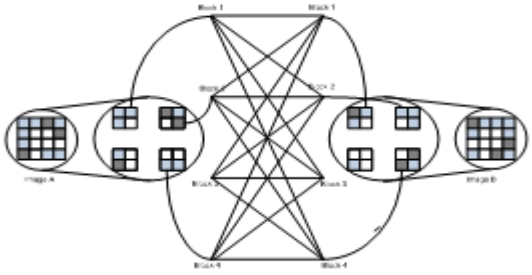

Figure 2. Sub block of query image and sub block of database

C. Distance Metrics

City Block or Euclidean Distances is one of method is used for measure similarity of image retrieval. This method is defined as:

$$L(C_1, C_2) = \left(\sum_{k=1}^{K} \sum_{m=1}^{M} \sum_{n=1}^{N} |(C_1(k,m,n) - C_2(k,m,n)| \right)^{q} \quad 1/q$$

When q = 1 the distance metric becomes City Block . When q=2 the distance metric becomes the Euclidean distance. The Euclidean distance can be treated as the spatial distance in a multi-dimensional space.

D. Performance Evaluation

1) **Recall and Precision**

The performance of retrieval system can be measured by metrics such as recall and precision [1]. Those metrics can be measured the effectiveness of the image retrieval. As Precision and Recall are a standard way to evaluate retrieval results for image retrieval systems, hence we used them in our research.

Recall signifies the relevant images in the database that retrieves in response to a query. Precision is the proportion of the retrieved images that are relevant to the query. More precisely, let A be the set of relevant items, let B the set of the retrieved items and a, b, c are given in Figure 3.

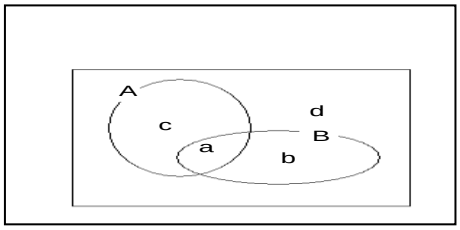

Figure 3. Sets for explaining retrieval effectiveness

In figure 3, *a* stands for 'retrieved relevant' images, *b* for 'retrieved irrelevant' images, *c* for 'unretrieved relevant' images and *d* for 'unretrieved irrelevant' images. Then recall and precision are defined as the following conditional probabilities [3].

$$Recall = P(B\backslash A) = \frac{P(A \sim B)}{P(A)} = \frac{a}{a+c}$$

$$Precision = P(A\backslash B) = \frac{P(A \sim B)}{P(B)} = \frac{a}{a+b}$$

With these conditions, images retrieval is said to be more effective if precision values are higher at the same recall values.

2) **AVRR and IAVRR**

Image Retrieval performance in this paper is analyzed according to its accuracy. Indicators such as precision and recall are commonly used for retrieval effectiveness computation. However, they do not really reflect the accuracy of the image retrieval system because the ranking of each displayed image is generally not taken into account. The normalized recall measure partially overcomes this limitation [8].

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Faloutsos et *al* have defined a measure for evaluating the effectiveness of QB IC system [8]. For each image query, the average rank (AVRR) of all relevant retrieved images is computed as well as the ideal average rank of relevant images (IAVRR). The formula assumes that the system returns all the *P* relevant images which, in the ideal case (IAVRR), occupy the first *P* positions. This effectiveness measure obviously takes into account the ranking of relevant images. However, it ignores the deviation between n the ideal ranking and the actual ranking of a relevant image. For example, if the system returns images in a completely inverse order of the ideal ranking, the following formula returns a perfect effectiveness value (= 1).

$$\text{Effectiveness} = \frac{\text{AVRR}}{\text{IAVRR}}, \text{ where } IAVRR = \sum_{i=1}^{p} \frac{i}{p} \text{ and } \text{AVRR} = \sum_{i=1}^{p} \frac{ri}{p}$$

where *P* is the total number of relevant images $i = (1, 2, \cdots, P)$ is similarity image ranking by human expert judgment and r_i corresponds to system image [8].

III. Experimental Result

The database used in this experiment is Wang's images database. The images database of 1000 images, which is considered to be one of the benchmark database for CBIR, consisting of 10 categories and each of which has 100 images. This experiment uses only 300 color images and 3 categories of Images which are dinosaurs, buses, and flowers. Color space is used in this experiment is HSV Color space in JPEG format. The experiment has been carried out in the Matlab environment.

The retrieval method is shown in the block diagram Figure 1. As stated before the color spaces used in this experiment is HSV. Normally the query and database images are represent in RGB color space and is converted into respective quantization as HSV (12X6X6) color pixels. For the first stage all 300 color images are saved to the database which is divided into three categories. The second stage is retrieval system that addresses three queries from three categories to be retrieved.

Performance evaluation of this experiment is using Precision, Recall and Effectiveness computation based on participant's ranking of similar images. First step, three image queries from three categories were addressed to the system. City block and Euclidean distance are used to measure similarity between queries and the images present in the database. If the distance between feature vectors of the query image and feature vectors image in the databases is equal to zero, the corresponding image in the database is to be considered as a match to the query. The search is based on similarity rather than on exact match and the retrieval results are then ranked accordingly to a similarity index. The second step is the retrieval performance results that are evaluated using recall, precision and effectiveness using AVRR and IAVRR. The Effectiveness is counted based on the averaged ranked of retrieval (AVRR) results divide by the Ideal Averaged ranked (IAVRR) which is ranked by participants.

Figure 4. Image retrieval results of flower image

Figure 4 represents retrieval results for category flower using City block distance and retrieval results for category flower using Euclidean distance. When a search for the images is requested, a selection process will recover the closest images in the database. In each set, on top left corner is the query image and the retrieved image are listed according to their distance with the query image. On top of every retrieved image its distance from the query image is shown. It should be noted that in each set of retrieval, the first image retrieved is the query image itself is present in the database. It will be retrieved first indicating perfect match.

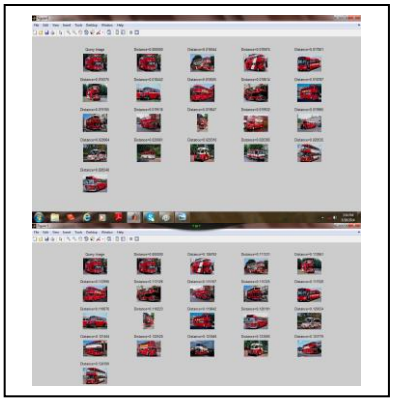

Figure 5. Image retrieval results of bus images

Figure 5 represents retrieval results for category bus using City block distance and retrieval results for category bus using Euclidean distance. Figure 6 represents retrieval results for category dinosaurs using City block distance and retrieval results for category dinosaurs using Euclidean distance.

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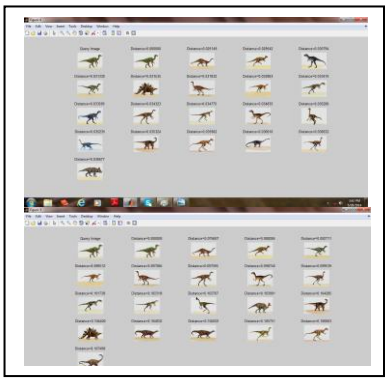

Figure 6. Image retrieval results of dinosaurs images

As stated before for evaluating the quality of image retrieval, we used Average Rank (AVRR), Ideal Average Rank (IAVRR) to obtain retrieval effectiveness, precision and recall parameters. The retrieval evaluation results can be shown in table 1 and figure 7. Algorithm is stated as effective if the value of effectiveness using AVRR and IAVRR is 1. Images retrieval is also said to be more effective if precision values are higher at the same recall values. The higher the retrieval precision, the better the distance measure conforms to human perception.

TABLE 1. Average Precision

Query Image	Precision City Block Distance	Precision Euclidean Distance
 Flower	0.860	0.759
 Bus	0.755	0.641
 Dinosaurus	0.531	0.400
Average	0.715	0.600

retrieval results of 3 types of images, the range of precision using City Block distance is 0.531 to 0.860 and the range of precision using Euclidean distance is 0.400 to 0.759. The average precision using City block Distance is 0.715 and the average precision using Euclidean Distance is 0.600.

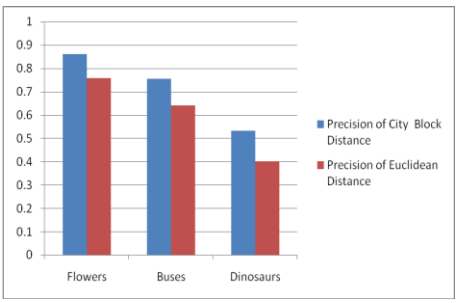

Figure 7. Precision of Euclidean and City Block distances

The retrieval results using Euclidean distance can be seen from table 2 and figure 8. The range of the value retrieval effectiveness of City block Distance is 1.290 to 2,360 and the range of the value retrieval effectiveness of Euclidean Distance is 1,527 to 3,850. The average effectiveness using City block Distance is 1,783 and the average effectiveness using Euclidean Distance is 2,572.

TABLE 2. Average Effectiveness

Query Image	City Block Distance	Euclidean Distance
 Flower	1.290	1.527
 Bus	1.700	2.340
 Dinosaurus	2. 60	3.850
Average	1.783	2.572

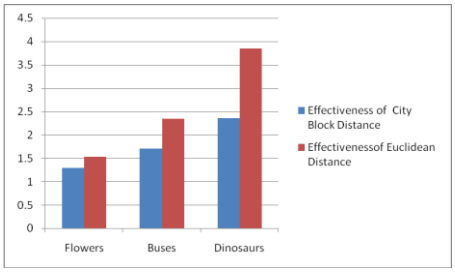

Figure 8. Effectiveness of Euclidean and City Block distances

As can be seen in figure 6 and table 1, the retrieval results for flower images using city block has the highest precision. The retrieval results for flower images using Euclidean distance also has the highest precision. The retrieval result using of both Euclidean distance and City block distance using AVRR and IAVRR for flower images as can be seen from figure 7 and table 2 has also the most effective as the value retrieval effectiveness is nearest to 1.

From the retrieval performance using both precision average and effectiveness using ratio of AVRR and IAVRR is found that Euclidean distance performs significantly lower than City block distance. However the obtained result is depending on a combination among the number of the images to be recovered, quantization used, color space, metrics, and the threshold considered.

IV. Conclusion

In this paper an image retrieval using local color histogram technique is proposed. The image retrieval is measured by city block distance and Euclidean distance. Performance evaluation of this experiment is using Precision, Recall and Effectiveness

computation based on participant's ranking of similar images. The experimental results show that in terms of retrieval effectiveness, this system has a good performance. From the point of view of similarity measurement, the retrieval results using City block distance is more desirable than the retrieval result using Euclidean distance. As further studies in order to improve the performance and test the robustness, the proposed retrieval method should be evaluated for more various database and similarity measurements.

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