Content Based Image Retrieval Based on A Novel Image Block Technique Combining Color and Edge Features

Goo-Rak Kwon, Zou Haoming and Sei-Seung Park, *Member, KIMICS*

***Abstract*—In this paper we propose the CBIR algorithm which is based on a novel image block method that combined both color and edge feature. The main drawback of global histogram representation is dependent of the color without spatial or shape information, a new image block method that divided the image to 8 related blocks which contained more information of the image is utilized to extract image feature. Based on these 8 blocks, histogram equalization and edge detection techniques are also used for image retrieval. The experimental results show that the proposed image block method has better ability of characterizing the image contents than traditional block method and can perform the retrieval system efficiently.**

***Index Terms*—CBIR, color feature, edge feature, image block matching.**

I. INTRODUCTION

THE growth of multimedia information has been enormous recently, especially with the advent of the Internet. A huge digital image archive is made up of millions of images, photos created by hospitals, governments, companies and academic organizations. These images are useful in many fields. However, we cannot access or make use of these images unless they are well organized and easily retrievable. Originally, searching an image database was based on human annotation: each image in a database is given some keywords to denote the semantic content of the image; then, all the keywords are used to index images. Thus, searching and retrieving images is based on the keywords of images [1].

In the early 1990s, Content-based Image Retrieval (CBIR) was proposed to overcome the limitations of Text-based Image Retrieval. It is a typical task of computer vision. Computer vision is probably the most exciting branch of image processing, and the number of applications in robotics, automation technology and quality control is constantly increasing. In CBIR, images in a database are indexed using their own primitive visual features instead of human annotations such as shapes, colors, and textures. The use of different visual features is also a criterion to categorize a CBIR system. Since the visual features of an image are only based on the image itself, there is no problem of subjectivity [2][3]. The low level visual features such as color, texture and shape of image are the main contents of CBIR as shown in Fig. 1.

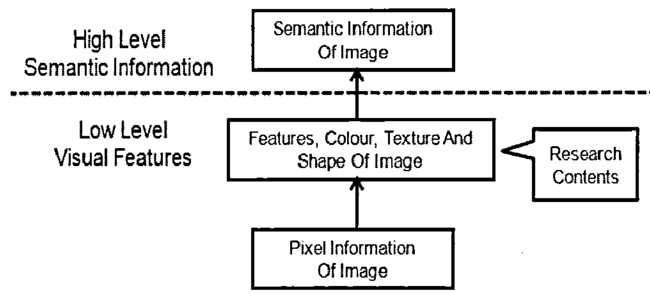

Fig. 1 Main contents of CBIR.

Query By Example (QBE) is one of the most popular methodologies used in CBIR systems, in which images are selected from an image database similar to a given image presented by users. IBM's QBIC [4] is such a CBIR system. When an example image is given; its visual features are also extracted and used to match against those in the database. Some distance metrics are used to compute the similarity between the query image and images in the database. The result of the query is a set of images similar to the query image, rather than an exact match. These result images are also sorted according to their distance to the query image.

Color feature is one of the most widely used visual features in image retrieval since color is immediately perceived by human beings [5] when looking at an image. Therefore, Color-based Image Retrieval is the most popular CBIR technique. Using color features in CBIR requires taking many factors into consideration: color model selection, color feature representation, and the metric to compute the distance between color features.

Edge information of objects in images is also a very important image visual feature. Usually in such a CBIR system, spatial features of all images in the database are extracted and indexed, as well as query images. The system then searches the database to find images with a similar shape or texture features to the query image. Segmentation is the most important step during image shape feature extraction and includes many procedures such as edge detection.

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II. PROPOSED ALGORITHM

A. Image block based histogram

In the Global color histogram, the visual feature of a color image may be represented by different visual feature representations, such as the image's color histogram. The main drawback of global histograms for classification is that the representation is dependent of the color of the object being studied, ignoring its shape and texture. Color histograms can potentially be identical for two images with different object content which happens to share color information. Conversely, without spatial or shape information, similar objects of different color may be indistinguishable based solely on color histogram comparisons.

In the Traditional block method, image block based histogram could amend the disadvantage of global histogram lacking spatial information to some extent [6]. Such method blocked the image in some way then calculate color feature separately. Blocking the image to several parts could help finding interested target part effectively. Malki J and Dimai [7][8] proposed a regular image block method in Fig. 2. It could improve the discriminatory performance obviously.

1	2	3
4	5	6
7	8	9

Fig. 2 Traditional block method.

Since the position of the target object always in the middle of the image, in this paper, the image is divided by 7x7 blocks. It is 49 sub-blocks of same size. The proposed method has 8 blocks by combining some of the sub-blocks as shown in Fig. 3.

From Fig. 3 we can notice that the middle part of the image is divided to 4 related blocks. B1, B2, B3 and B4 indicate the background of the image. Compared with the traditional block method, these 8 blocks contain more information with both color and spatial distribution feature.

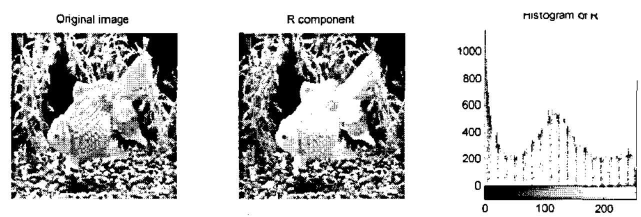
B. Feature extraction

The three components of R, G and B are obtained from the color image. Fig. 4 shows the image of R component and histogram of an original color image. Then 8 blocks are obtained using the proposed image block method for each component. Fig. 5 shows the 8 blocks obtained using the proposed method of R component and the histograms of each block.

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49

B1: 1,2,3,4,5,6,7
B2: 1, 8, 15, 22,29,36,43
B3: 43,44,45,46,47,48,49
B4: 7,14,21,28,35,42,49
B5: 9,10,11,12,13,16,17,18,19,20,23,24,25,26,27
B6: 23,24,25,26,27,30,31,32,33,34,37,38,39,40,41
B7: 9,16,23,30,37,10,17,24,31,38,11,18,25,32,39
B8: 11,18,25,32,39,12,19,26,33,40,13,20,27,34,41

Fig. 3 Proposed image block method.



(a) (b) (c)

Fig. 4 R component and histogram. (a) Original image. (b) Image of R component. (c) Histogram of R component.

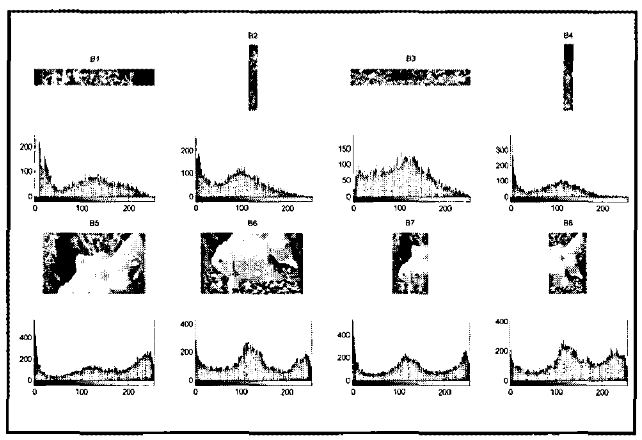


Fig. 5 8 blocks and their histograms of R component.

The procedure of the proposed algorithm has 7 steps sh own in Fig. 6 below.

1. Input a query image first.
2. R, G, B components are obtained from the query image.
3. 8 blocks are produced using the proposed block method.

4. After getting image blocks, the color feature is obtained from each block. An explanation will be shown in chapter **II.*B*.*1***.
5. Also from these 8 blocks, the edge feature is obtained. An explanation will be shown in chapter **II.*B*.*2***.
6. We use the extracted image features for image similarity measurement. The feature obtained from the query image is compared with trained database.
7. We can obtain the final retrieval results.

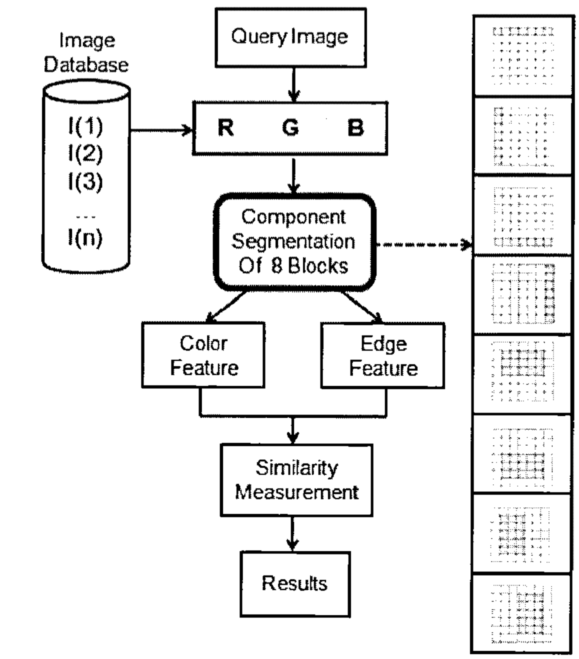


Fig.6 Procedure of the proposed algorithm.

1) Color feature extraction

After component segmentation of 8 blocks, the color feature is extracted by 3 steps:

1. Get the histogram of each block;
2. Histogram equalization of 4 gray-level for each block.
3. Calculate the statistical information of the gray values in every gray-level.

There are 4 gray-level. That is 0, 85, 170, and 255. Table I shows the number of the gray values in every gray-level of each block.

2) Edge feature extraction

After component segmentation of 8 blocks, the edge feature is extracted as below:

1. Edge detection using 'canny' operator [9] of each block. Fig. 7 shows one of the block image and edge image of this block.
2. Get the binary edge image of each block.
3. Calculate the total number of edge in each block.

TABLE I
NUMBER OF THE GRAY VALUES IN EVERY GRAY-LEVEL OF EACH BLOCK

Block \ Num \ Gray Value	0	85	170	255
1	4416	4340	4366	4378
2	4350	4427	4309	4414
3	4352	4355	4452	4341
4	4401	4336	4354	4409
5	9385	9387	9419	9309
6	9390	9257	9488	9365
7	9365	9326	9433	9376
8	9438	9316	9415	9331

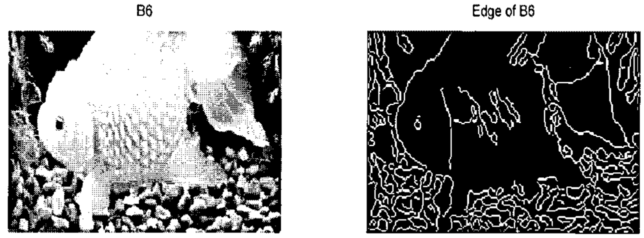


Fig. 7 Edge detection use 'canny'.

C. Similarity measure

After having extracted features, our next task is to find a similarity measure. Usually Euclidean distance, histogram intersection, or cosine or quadratic distances are used for the calculation of the images' similarity ratio. Any of these values does not reflect the similarity rate of two images in itself. It is useful only with comparison to other similar values. This is the reason that all the practical implementations of content-based image retrieval must complete computation of all images from the database.

The simplest way to calculate the distance between the two color histograms is L1 distance [10]. It calculates the absolute value of the difference between two features. The proposed algorithm utilized Euclidean distance for calculation of the images' similarity rating. As an example, to explain different distance metrics, we assume two images, A and B, H_j^A and H_j^B are the normalized feature values for image A and image B, respectively. The calculation equation is given by

$$d(A,B)=\sum_{j=1}^{n}\left|H_j^A - H_j^B\right|. \quad (1)$$

III. SIMULATION AND RESULTS

The validation of the algorithms proposed is verified through the computer simulation. Fig. 8 shows the universal CBIR system. It contained two parts: Creation of image database and image retrieval.

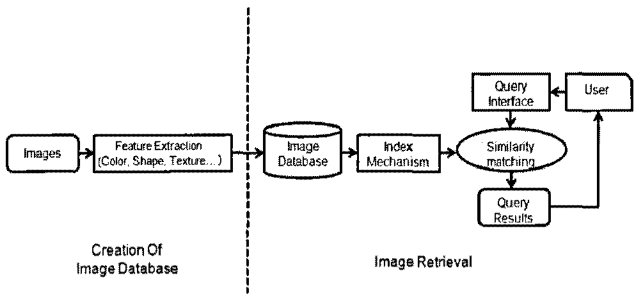


Fig. 8 Image retrieval system.

In the creation of image database part, images are acquired from a collection one after another. And then feature extraction process is applied to them using such algorithm. Any of the values does not reflect the similarity rate of two images in itself. It is useful only with comparison to other similar values. This is the reason that all the practical implementations of content-based image retrieval must complete computation of all images from the database. At last the extracted feature vector is saved in a database against the image name under consideration.

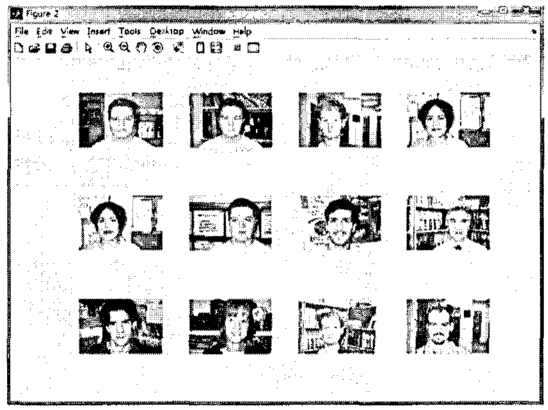
After database creation, the image retrieval system could start by user specified query image. This is called Query By Example (QBE). It is one of the most popular methodologies used in CBIR systems, in which images are selected from an image database similar to a given image presented by users. The feature extraction process runs on the query image and extracts the feature information in the form of a vector. And this vector is used to calculate similarity of query image against the feature vectors saved in the feature database of the image collection.

The simulation is achieved by MATLAB 7.0. The proposed algorithm is tested using the image database downloaded and selected from image database of Washington State University. The database contained 300 images of 3 different classes:

- Human face
- Airplane
- Nature scenery

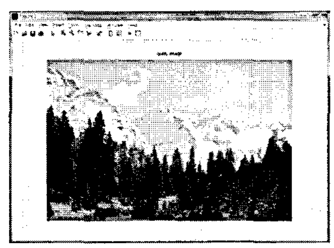
The following figures show some of the simulation results that generated the closest results using proposed algorithm.

(a)

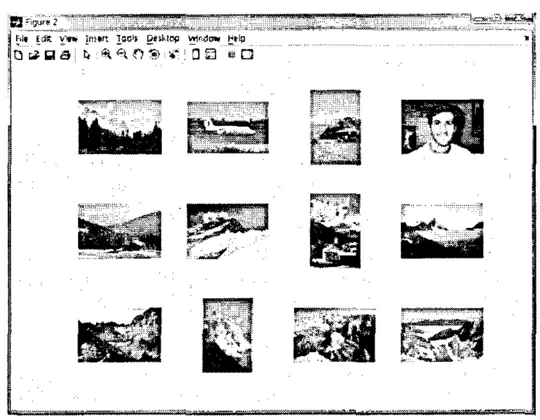


(b)

Fig. 9 Simulation result of human face. (a) Query image. (b) Query results.

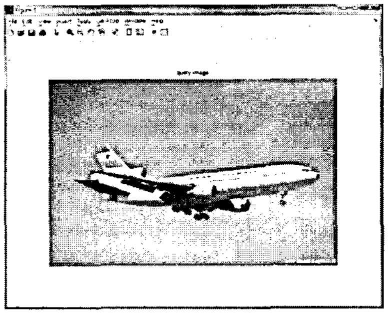


(a)

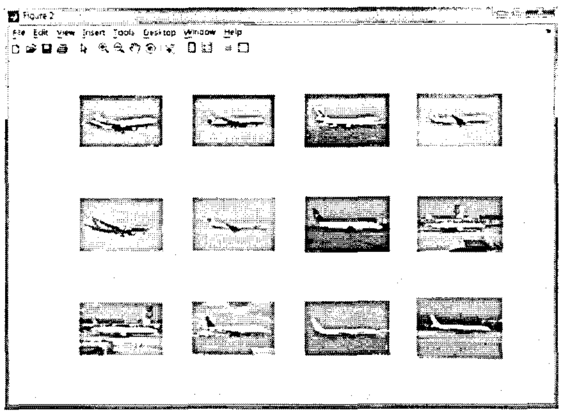


(b)

Fig. 10 Simulation result of nature scenery. (a) Query image. (b) Query results.

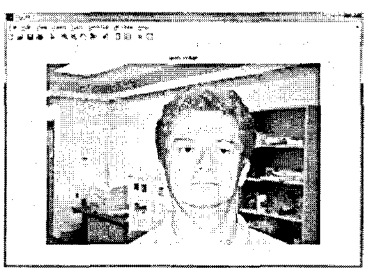


(a)

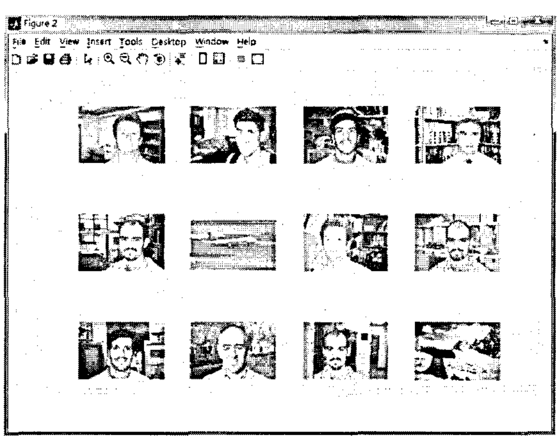


(b)

Fig. 11 Simulation result of airplane. (a) Query image. (b) Query results.



(a)



(b)

(c)

Fig. 12 Simulation results. (a) Query image. (b) Simulation result of human face using traditional block method. (c) Simulation result of human face using proposed method.

For comparing the effectively and search precision of the algorithm, we use traditional block method for feature extraction and generate retrieval results using the same database. Fig. 12 shows the simulation results of human face's case based on the same query image using two algorithms.

The following Table II shows the precision comparison using two algorithms based on different outputs. The precision is the average value of every tested image in the database.

TABLE II
PRECISION COMPARISON

	Method	10 outputs	30 outputs
Human face	Traditional Block Method	0.80	0.68
	Proposed Method	0.92	0.76
Air Plane	Traditional Block Method	0.57	0.50
	Proposed Method	0.75	0.67
Nature Scenery	Traditional Block Method	0.58	0.52
	Proposed Method	0.69	0.61

In the experimental results, we are able to notice that the proposed image block method have better ability of characterizing the image contents than traditional block method, especially for the images that the target object located in the middle part of the image.

IV. CONCLUSIONS

A content based image retrieval algorithm which is based on image block method that combined both color and edge feature is proposed. In consideration of the main drawback of global histogram's representation is dependent of the color without spatial or shape information, a new image block method that divided the image to 8 related blocks which contained more spatial information is utilized to extract image feature. Based on these 8 blocks, histogram equalization and edge detection techniques are also used for image retrieval.

From the experiment results of the proposed algorithm that verified through the computer simulation, we show that the proposed method which put emphasis on the middle part of the image is more consistent with human subjective vision. And the proposed image block method represents information of image more efficiently. From the precision of results we also show that the proposed method is more suited for searching those images with target object in the middle of the image.

ACKNOWLEDGMENT

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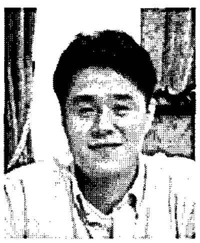

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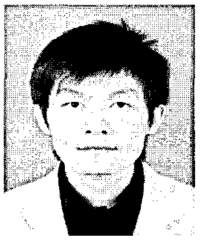

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