IMAGE RETRIEVAL BASED ON TEXTURE AND COLOR METHOD IN BTC-VQ COMPRESSED DOMAIN

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ABSTRACT

Because of high volume of graphic information, the retrieval of compressed images is one of the needs of information era. One of the rapid methods for image compression which has the capability to maintain important information of images for retrieval is Block Truncation Coding (BTC). In this article a new method for retrieval of images compressed by BTC has been provided. This method has been examined on a database consisting of 9983 images with different contents and its results have been compared with similar methods.

1. INTRODUCTION

Transfer of a digital image has been considered as one of the most important research topics for more than 40 years. When on one hand we have high volume of graphic information and its ever-increasing expansion and on the other hand we need to access them through high speed data transfer tools, there is no way except storing them in a way that, firstly to decrease the volume of storage and secondly to make it possible to retrieve the proposed images with acceptable speed and precision. Therefore two sciences of image retrieval along with image compression should solve this issue jointly. It means that we should use such methods for image compression which have ability for maintaining important information of image for its retrieval [7]. In standard methods of image compression such as JPEG, retrieval of images has not been considered [9] and successful methods like Vector Quantization (VQ) despite its suitable power in compression and retrieval, have low speed for compression [3]. To put it simply, the problem is how to show an image with high efficiency in the binary form. Maintenance of visual and natural features of image is considered in different techniques of compressing, so that efficiency of an image depends on two parameters of 1-Data rate (bit/pixel) and 2-Distoration. Data rate is a scale that shows how much band width and consequently how many bits are necessary to store an image. If the retrieved image is completely similar to original image, it is idiomatically called "Lossless technique" and otherwise it is called "Lossy technique". One of the most usable methods is the method of cutting the image to non-covering blocks. The Deficiency of this method is that margins of blocks may be seen at the retrieval time.
BTC-VQ method has high speed in compressing, and also in Article [8] it has been shown that this method has suitable capability for image retrieval, because in addition to using the information of block-in connection, it also stores the important information of each block in compressed form.
In this article, BTC-VQ has been used for compressing, and a new method is presented for image retrieval based on Color Histogram [10] and Block Pattern Histogram (BPH) [8]. Simultaneous utilization of Color Histogram and BPH provides us suitable information about image from the viewpoint of intermediate important information based on color and from the viewpoint of graphic important information such as edges, and this causes an increase in system speed and efficiency. Utilization of color histogram minimizes the limits of browsing images and will cause the block pattern histogram to find the images with higher speed. One of the defects of BTC-VQ is low degree of compressing in comparison to other compressing methods such as JPEG and VQ.
In rest of the article, at first BTC-VQ and then retrieval method based on compressing are explained. In the fourth part, results of experiments and in the fifth part, conclusion, are stated.

2. BTC-VQ COMPRESSING METHOD

At first BTC method is explained and then its developed method, BTC-VQ is studied. In BTC, first the image is divided separately into 4×4 blocks. If we show each block of image with $x(i,j)$, by considering this point that each block is 4×4, the mean of the existing color in each block is calculated as follows [1]:

$$\bar{x} = \frac{\sum_{i=1}^{4}\sum_{j=1}^{4} x(i,j)}{4*4}$$

With utilization of such mean quantity, we can establish a 4×4 matrix of $bp(i,j)$ block pattern by the use of the following formula:

$$bp(i,j) = \begin{cases} 1 & x(i,j) \geq \bar{x} \\ 0 & x(i,j) \prec \bar{x} \end{cases}$$

And we show the mean quantities of zero and one patterns with *M0* and *M1*, respectively:

$$M_0 = \frac{\sum_{i=1}^{4}\sum_{j=1}^{4} bp(i,j)x(i,j)}{\sum_{i=1}^{4}\sum_{j=1}^{4} bp(i,j)}$$

$$M_1 = \frac{\sum_{i=1}^{4}\sum_{j=1}^{4} (1-bp(i,j))x(i,j)}{4*4-\sum_{i=1}^{4}\sum_{j=1}^{4} bp(i,j)}$$

And if we show the decoded block with $y(i,j)$, this block is calculated as follows:

$$y(i,j) = \begin{cases} M_0 & bp(i,j) = 1 \\ M_1 & bp(i,j) = 0 \end{cases}$$

Compressing and retrieval of BTC method has been shown as an example in Figure 1[2].

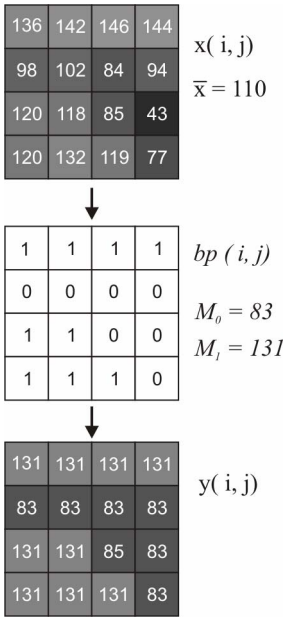

Figure 1. BTC compression.

BTC-VQ is the improved method of BTC. In this method instead of using 16-bit to store a 4×4 matrix (1 bit for each 0 or 1 location), we store one 8-bit matrix. This is the only difference between these methods. For performing this job, VQ method is used. In this method so many images are used for identification of most blocks patterns existing in images. For 4×4 blocks, this job is performed in Vistex Lab in MIT University by utilization of 3,500,000 images and finally 256 most repeated blocks have been elected as figure 2.

BTC-VQ method has two advantages over BTC method:

* More compression; Instead of storing two bytes for each block pattern, we just use one byte.
* Possibility for retrieval with higher quality, because most important features of blocks patterns exist in these 256 patterns and in order to establish Block Pattern Histogram, all such patterns are used.

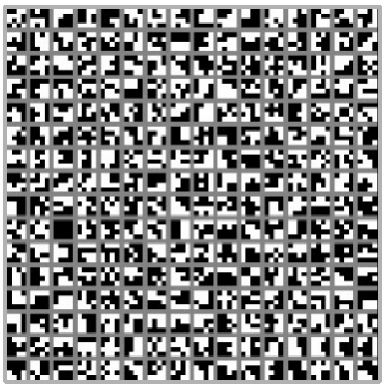

Figure 2. 256 Block Patterns elected by VQ method for 4×4 Blocks.

BTC method was first propounded for non color image compression, but in following years, methods for utilization of it in colored images area are propounded [4], [5]. In this article for all the three color levels (red, green and blue), BTC-VQ method is separately applied and finally all three color levels have been combined. The Sequences of Converting a non compressed image to a compressed image by BTC-VQ is as figure 3.

3. RETRIEVAL BASED ON COLOR AND BLOCK PATTERN

As explained before, in this research, BTC-VQ method has been used for image compression and we use a method for retrieval that has been propounded based on utilization of features extracted from images by BTC-VQ method. In this paper, two steps are used for retrieval. First, images are retrieved through comparison of color histogram and then through block pattern histogram. In continuation of this part we study these two methods.

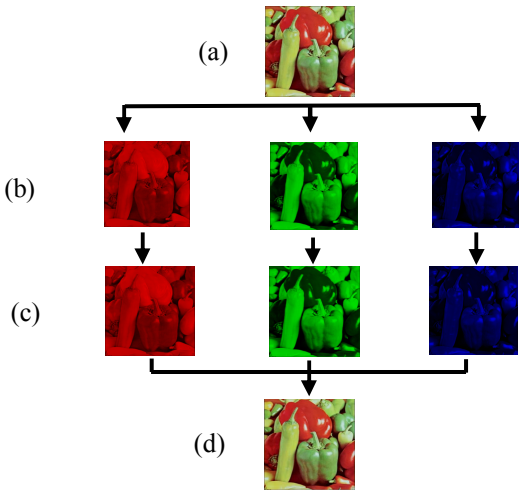

Figure 3. 3-D tags of establishing compressed picture based on BTC-VQ method.

(a) Source image (b) BTC compressed with RGB color system (c) BTC-VQ RGB layer compressed (d) final BTC-VQ compressed image

3.1. Retrieval through Comparison to Color Histogram

This method is used in the first stage of retrieval and its purpose is finding similar images to desire image from the viewpoint of color. In this regard, for each image, three color histograms (red, green and blue) are established separately. For comparison of images from viewpoint of similarity, we compare their histograms. For increasing speed in calculation, we use a simple method (because this stage applies on all images and affects on speed of the algorithm). Therefore for comparing color histograms, we use Minkowski-form metrics. It means that if ch_q is color histogram of query image and ch_t is color histogram of target image, the following equation has been used for determining the result of comparison:

$$Color_{q,t} = \left[\sum_{m=0}^{255}\left|ch_{qr}(m) - ch_{tr}(m)\right|\right] + \left[\sum_{m=0}^{255}\left|ch_{qg}(m) - ch_{tg}(m)\right|\right] + \left[\sum_{m=0}^{255}\left|ch_{qb}(m) - ch_{tb}(m)\right|\right]$$

It means that the histograms of all three color levels of red, green and blue of both images are reduced from each other and we calculate color differential of two images.
This method is used for two reasons:

1) For similar images, there is so much probability that hold similar color histogram.
2) Limiting browse area, make the performance of the next stages quicker.

The defect of this method is that so many pictures are omitted in the first stage of retrieval (there are so many similar images but different color, for example lighted images). To solve this problem, the degree of importance of the color is charged by searcher in images base.

3.2. Retrieval through comparison to block pattern histogram

This method is used after first method; it means that in this stage, images which, in the first method, were similar to each other from viewpoint of color are evaluated. As explained, BTC-VQ method uses 8-bit block pattern, it means that it has different 256 block patterns. Therefore, in this method simply three separate histograms with 256 levels are established for each image (three colors of red, green and blue, separately) and by comparing these histograms, more similar images are categorized.
To compare the texture histograms, Minkowski-form metrics of each level of histogram has been used. It means that if th_q is texture histogram of query image and th_t texture histogram of target image, the $Texture_{q,t}$ equation is similar to $Color_{q,t}$ with the same form.
It means that for all three levels of red, green and blue colors, block pattern histograms of both images are deducted from each other and we calculate the difference of block pattern of both images. The similarity coefficient of the two images is calculated as follows:

$$d_{q,t} = \lambda_1 * Color_{q,t} + \lambda_2 * Texture_{q,t}$$

λ_1 and λ_2 are the coefficients of the importance of color histogram method concerning block pattern histogram method, and $d_{q,t}$ is the similarity coefficient of images, that by considering it, the final images are classified.

Advantages of this method are as follows:

- High speed. Time intricacy algorithm of establishing index of block pattern for each image equals to $O(n^2)$ and also time intricacy of comparison of each image with basic image equals to $O(n)$. On the other hand, this stage of retrieval is performed on the images which are limited in the previous stage that causes high increase in speed.
- Utilization of features extracted at the time of image compression.
- Suitable efficiency in retrieval, which has been shown in Experimental Results.

4. EXPRIMENTAL RESULTS

To study efficiency of the method presented in former sections, a database with 9983 images was selected. This database usually consists of 96×128 and 128×85 images and is so variable. This database has been used in articles [6], [11] and exists in Stanford University website:
http://www-db.stanford.edu/~wangs/image.vary.jpg.tar
In the first stage of the experiment, the images have been changed to BTC-VQ compressed area. Then 100 different images from database and 10 similar images to each of them (from the viewpoint of human) were selected as search images.
In continuation, considering initial experiments, it was found that by the color histogram method, alone, 95.3% of similar images to the base image are located in the first 500 priorities search.
On the other hand, it was cleared that, using color and block pattern histograms, to find 4.7% missed images, it does not perform good results; but applying both color and block pattern histograms, to the 500 found images in the former stage, makes better results.
Therefore considering such experiments on the first stage of retrieval; That is, through color histogram, more similar images to the search images are selected for continuing retrieval stage. In the second stage; That is, retrieval through comparison of Block Pattern Histogram, similarity coefficient of both images is reached by adding the result of comparison in color histogram and block pattern histogram. In this experiment, considering initial experiments, in similarity coefficient formula, the amount of color importance is considered twice as much as the amount of pattern importance. It means:

$$d_{q,t} = 2 * Color_{q,t} + 1 * Texture_{q,t}$$

This selection has been reached through performing initial experiments.

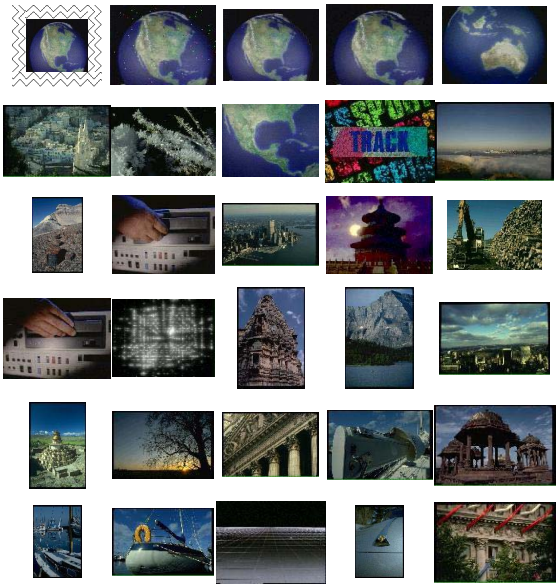

Figure 4. Some of 500 similar images found by comparison of color histograms.

A sample of experiment is seen in figure 4 and 5. In figure 4, the basic image has been shown in left corner above the picture, and this is the result of the first stage of retrieval and some of 500 similar images showed in priority. In figure 5, the result of second stage and 10 similar images found, have been shown.

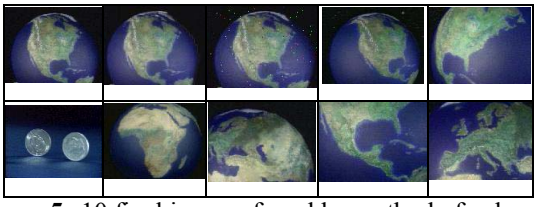

Figure 5. 10 final images found by method of color and block pattern histograms comparison.

Two parameters of Recall rate (retrieved related images in proportion to images exist in databases) and Precision rate (retrieved related images in proportion of all the retrieved images), are suitable rate for determining the efficiency rate of a retrieval method. Among 100 images which have been searched, the amount of recall rate and precision rate parameters have been as table 1. In this research precision rate has been reached through Fibonacci series method; therefore they are not so high.

	CH Method	BPH Method	Combining Method
Precision Rate Average	0.194	0.351	0.467
Recall Rate Average	0.482	0.574	0.822

Table 1. Recall Rate and Precision Rate of Color Histogram, And Block Pattern Histogram

Since this method has been presented in compressed area and is simple and quick, these amounts of recall rate and precision rate are acceptable.

5. CONCLUSION

In this article, based on BTC compressing method, a new method of retrieval is proposed, and it is shown how we can, based on features by which compressing methods are presented, provide a retrieval method. In this method, two methods of Color Histogram and Block Pattern Histogram are propounded as compound and are studied on a big database and the results of recall rate and precision rate have been acceptable. It is also shown that methods based on texture images can be used effectively on non-texture images.

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