THE EFFECTIVE OF IMAGE RETRIEVAL IN JPEG COMPRESSED DOMAIN

Suhendro Y. Irianto
Department of informatics. Darmajaya Informatics and Business Institute
Jalan Z.A. Pagar Alam, Lampung, Indonesia
suhendroirianto@ymail.com

ABSTRACT

We propose a new method of feature extraction in order to improve the effective of image retrieving by using a partial Joint Photographic Experts Group (JPEG) compressed images algorithm. Prior to that, we prune the images database by pre-query step based on colour similarity, in order to eliminate image candidates. Our feature extraction can be carried out directly to JPEG compressed images. We extract two features of DCT coefficients, DC feature and AC feature, from a JPEG compressed image. Then we compute the Euclidean distances between the query image and the images in a database in terms of these two features. The image query system will give each retrieved image a rank to define its similarity to the query image. Moreover, instead of fully decompressing JPEG images, our system only needs to do partial entropy decoding. Therefore, our proposed scheme can accelerate the effectiveness of retrieving images. According to our experimental results, our system is not only highly effective but is also capable of performing satisfactoril.

KEY WORDS

JPEG, DC coefficient, image retrieval, compressed domain.

1. INTRODUCTION

The world of digital image databases has grown tremendously in both size and number over the years. Images are very often compressed before being saved due to storage space when they are saved. In other words, we can save storage space and decrease processing time of massive images. Unfortunately, compressed images cannot be conveniently processed for image retrieval since they need to be decompressed beforehand, that means increasing in both complexity and searching time.

For that reasons, it is important to develop an efficient and effective image retrieval technique to retrieve desired images from the compressed domain. Image retrieval techniques can be classified into two types: spatial domain image retrieval [1, 2, 3] and frequency domain image retrieval [4, 5]. The colour histogram technique is an approach often used in the spatial domain. Conversely, discrete cosine transformation (DCT) and discrete wavelet transformation are often used in the frequency domain. In spite of the image type they belong to, image retrieval systems are methods used to extract image features and to provide rules which are used to compare two images. These rules usually involve a threshold and a measurement of the distance between the two images. A user will provide a query image to start the search procedure to find similar images. Then the system automatically computes the distance between the query image and every image in an image database. Finally, the system will rank each image retrieved in relation to its minimum distance from the query image, the rank indicating the degree of similarity.

The Joint Photographic Experts Group (JPEG) is the image compression standard [6] and is extensively used on the World Wide Web as its good compression rate and image quality. The conventional approaches used for JPEG compressed images decode each JPEG compressed image in the compressed domain to the pixel domain before they extract features from the images. These approaches consume time and require high cost in computation. Some researches [4, 7, and 8] have recently resulted in improvements in that image features can be directly extracted from the compressed domain without fully decompressing these images.

Method purposed by Clymer and Bhatia [9] that organizes the DCT coefficients of an image into a quad tree structure. This way, the system can use these coefficients on the nodes of the quad tree as image features. However, although such a retrieval system can effectively extract features from DCT coefficients, the main weakness of this method is that the computation of the distances between images will grow undesirably fast when the number of relevant images is immense or the threshold value is big.

In addition, Fang and Kiang proposed a statistical parameter- based method [4] that uses the mean and variance of the pixels in each block as image features. The mean and variance can be directly computed on DCT coefficients. The drawback of this method is system has to calculate the mean and variance of each block in each image, including the query image and the images in the database.

This paper is to propose a novel JPEG compressed image retrieval method that can improve the retrieval accuracy. Our proposed method is based on JPEG coefficients through pre-query process of colour similarity by means of adobe photo album.

The rest of this paper is ordered as follows. In Section 2, we will present our method in retrieving and matching between query and image. Then, in section 3 we show experimental results and analyses, followed by conclusion and future work in section 4 and 5.

2. METHODS

Before to applying a partial JPEG streamlines, our purposed method uses pre-query step to prune irrelevant images from the database. The pre-query step is carried out by utilizing adobe photo album 2.0 based on colour similarity, in order to eliminate irrelevant images. An image of every collection was used in the pre-query image. The five best image retrieved of each collection then used as query images for the next step in JPEG stream line for calculating the precision and recall.

To search and match between query image and images in the database, the minimum distance of two images calculated to determine the least minimm distance among images. Images retrieved out according to the minimum distances in ascending order and ranked of rank 1 to rank 9 in every query ended.

In the progressive DCT-based mode, the process of block partitioning and Forward DCT transform is the same as in the sequential DCT-based mode. An image is first partitioned into blocks of 8x8 pixels. Then, the blocks are processed from left to right and top to bottom. The 8x8 two-dimensional Forward DCT is applied to each block and the 8x8 DCT coefficients. The quantized DCT coefficients are first stored in a buffer before the encoding is performed. After the forward DCT, quantization of the transformed DCT coefficients is performed. Each of the 64 DCT coefficients is quantized by a uniform quantizer:

$$Sq_{ij}= \text{round} (S_{ij}/Q_{ij})$$

where the Sqij is the quantized value of the DCT coefficient, Sij, and Qij is the quantization step obtained from the quantization table. We use Luminance quantization table in our algorithm.

The DCT coefficients in the buffer are then encoded by a multiple scanning process. In each scan, the quantized DCT coefficients are coefficients are divided into multiple bands according to a zigzag order. Theoretically, the magnitude values of the DCT coefficients correspond to the signal energy in a particular block, which also reflect the texture feature of those pixel values inside that block. For DC coefficient, only the difference between its previous DC and itself is encoded. Both AC and DC coefficients are grouped into a number of categories according their magnitude values.

The DCT coefficient values can be regarded as the relative amount of the 2D spatial frequencies contained in the 64-point input signal. Coefficient with zero frequency both dimensions called the “DC coefficient” and the remaining 63 coefficients are called “AC coefficient”. Thus, on each image, we obtain DCT coefficients of an 8x8 block pixels, DC coefficient and AC coefficients. In 8x8 pixels we have a DC coefficient and 63 AC coefficients, which make an N-blocks image enhanced with $DC_1, DC_2, DC3, \ldots, DCN$ and $AC_1, AC_2, AC_3, \ldots, AC63$ in each block. By giving in N-blocks of an image, we can construct indexing key of every image in database using this equation:

$$h_i = \sum_{i=1}^{N} DCi \;/\; N \quad \text{N=number of block}$$

Where, hi is an indexing key in database, Himage = $[h_1, h_2, h_3, \ldots, h_N]$. Similar to the equation above we calculate query image indexing key as:

$$q_i = \sum_{i=1}^{N} DCi \;/\; N \quad \text{, N= number of block}$$

qi is an indexing key of image query, Qimage = $[q_1, q_2, q_3, \ldots, q_N]$

In order to search image from database, we calculate the minimum distance between image query and image in the database by using the equation:

$$d(H_q, H_k) = \left(\sum_{i=1}^{N} \left| h_{iq} - h_{ik} \right|\right) / 64, \quad k \in [0,5000]$$

Where, d(Hq,Hi) is the distance between image query and image in the database, based on the equation we retrieved 12 images according the minimum distance calculated in ascending order.

To retrieved images from database we adopted a partial JPEG streamline to calculate the first twelve minimum Euclidean distances of images. In a simple way, the algorithm of the system we purposed can be described as follow: (i). get image query, (ii).generate image database ,(ii).image portioning 8x8 DCT coefficients , (iv). Calculate the indexing keys of query image and images in the database,(v). compute the absolute differences of Euclidean distance using equation (4), and finally (vi). rank the images.

3. EXPERIMENTS RESULT

To evaluate the effectiveness of image retrieval system, experiments were performed by using Visual.C# and Matlab. In our experiments, 5000 images were collected, consisting of 10 collections including motorbikes, buildings, cars, flowers, girls, mountains, sky, sun set, and textures.

3.1. Ranking scheme

To make queries into image database, initially we do pre-query step which is eliminated irrelevant images using colour similarity retrieval algorithm for each collection. Subsequently step, we chose one of the images retrieved which is used as the candidate of image query.

Of all the collections we make 10 queries, and 9 images retrieved out of every query. According to the Euclidean minimum distances, the retrieved images are arranged as ranks in ascending order, where the first image corresponds to the minimum distance derived between the retrieved image and the query image. Hence, in every query we have 10 images retrieved, where rank 0 is excluded as it was the image itself. Rank 1 to rank 9 was formulated in table 1, as the query step is able to retrieved 1 relevant image on every collection query made rank 1 and rank 6 as 100% image retrieved of the time. Table-2 shows more detail the percentage of Rank 2, 3 and the rest which is none of the rank lower than 70%.

3.2. Queries effectiveness

In our experiments we used 5,000 images database consist of ten collections, and five queries are carried out on every collection. We have no duplicate images in our 5000 images database as we utilize Picasa [12] in constructing the database.

As the images retrieved, we calculates the precision and recall of the method, where bike flowers, sun set are very high nearly 90%, and even the texture collection performs 100 % in precision through all of 5 queries, whilst recall, cars have highest among others, 82%

Table 1. The effectivness of image retrieval

Collections	Precision	Recall
Motorbikes (BIKE)	66.66%	23.40%
Buildings (BLDG)	85.18%	15.00%
Cars (CARS)	85.18%	82.20%
Cats (CATS)	66.66%	16.60%
Flowers (FLOW)	88.89%	22.40%
Girls (GEWE)	70.37%	54.20%
Mountains(MTNS)	85.18%	16.20%
Sky(SKY)	96.29%	31.80%
Sun Set (SSET)	85.52%	52.80%
Texture (TEXT)	100.00%	23.40%

4. CONCLUSION

Although the mature of JPEG researches have provided the efficient and effective algorithm of image retrieval, many researches have been carried out to perfect the image retrieved as we wanted, but still yet as it is. This paper purposed an option method if not a new method of image retrieval by utilizing pixel domain technique jointly with compress domain technique on compress domain for image retrieval. The experiments showed that by pruning the database through the pre-query step retrieved nearly 85% in every rank of all collection, and obtained an average precision 90% and recall 35%. The average precision of texture and sky which are 100 % and 90% respectively showed that pre-query step has significantly increased the effectiveness of image retrieval in compress domain.

5. FUTURE WORK

For the immediate future, we are working automatic pre-query step based on colour similarity and image captions and image keywords. We are also looking to investigate more distance methods in creating indexing key. In the long-term, we would like to extend our system on ontology-based image on compress domain for larger database.

REFERENCES

[1]. S.Hao, T. Svoboda, V. Ferrari, T. Tuytelaars and L. Van Gool. Fast indexing for image retrieval based on local appearance with Re-ranking. Computer Vision Lab, Swiss Federal Institute of Technology, Zurich, Switzerland. http://www.xanthi.ilsp.gr/cimwos/pdf/shao-icip03.pdf

[2]. M.K. Mandal, F. Idris, S. Panchanatha, A critical evaluation of image and video indexing techniques in the compressed domain, Image and Vision Computing 17 (7) (1999) 513–529.

[3]. T. Ojala, M. Pietikainen, D. Harwood, A comparative study of texture measures with classification based on feature distribution, Pattern Recognition 29 (1) (1996) 51–59.

4]. G. Feng, J. Jiang, JPEG compressed image retrieval via statistical features, Pattern Recognition 36 (4) (2012) 977–985.

[5]. M. Schneier, M. Abdel-Mottaleb, Exploiting the JPEG compression scheme for image retrieval, IEEE Transactions on Pattern Analysis and Machine Intelligence 18 (8) (2010) 849–853.

6]. G.K. Wallace. The JPEG still picture compression standard, ACM Communications 34 (4) (1991) 31–45.

[7]. J. Jiang, A. Armstrong, G. Feng, Direct content access and extraction from JPEG compressed images, Pattern Recognition 35 (11) (2012) 2511–2519

[8]. G. Schaefer, JPEG image retrieval by simple operators, Proceedings of Second International Workshop on Content Based Multimedia and Indexing, Brescia, Italy (2011) 207–214.

[9]. S. Climer, S.K. Bhatia, Image database indexing using JPEG coefficients, Pattern Recognition 35 (11) (2002) 2479–2488.

[10]. Shi.Q, Yun., Sun, H. Image and Video Compression forMultimedia Engineering. Fundamentals, Algorithms, and Standards. CRC Press.2000.Chap7..

[11]. www.Picasa.com