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Efficient Content Based Image Retrieval Analysis of Distance Matrices

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Abstract: In this paper, we proposed a new method of feature extraction to improve the efficiency for retrieving the JPEG Compressed Images. We extract two DCT features, namely DC feature and AC feature, from the compressed image. Then we measure the image distance between the query image and the images in the database using these DCT features. Our retrieval system will give rank to the retrieved database images to define its similarity with the query image. Our proposed system does not need to full decoding, it only needs partial entropy decoding. Therefore, our proposed system takes less time for retrieving the images.

Keywords: [DCT, DPCM, Huffman Coding, JPEG Compression, Variable length coding.]

1. INTRODUCTION

Content Based Image Retrieval (CBIR) is the retrieval of images based on visual features such as colour, shape and texture. These features are used to retrieve images in database. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. Digital image database have grown enormously in both size and number, over the years. The compressed image database will reduce the storage space and transmission time. Image retrieval system technique is classified into two methods: Spatial domain retrieval [1,2] and frequency domain retrieval [3,4]. The term has been widely used to retrieving desired images from a large image database. The color histogram technique is an approach often used in the spatial domain. On the other hand, discrete cosine transformation (DCT) and discrete wavelet transformation are often used in the frequency domain [5]. Image retrieval systems are methods used to extract image features and to provide rules which are used for comparing two images according to these features. 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 matching images. Then the system will automatically compute the distance between the input query image and each image in an image database. If the distance between the query image and images in the database is less than the threshold value. The purpose of this paper is to propose a novel JPEG compressed image retrieval method that can accelerate the retrieval speed while maintaining an acceptable accuracy rate [10, 11]. Our proposed method is based on JPEG DCT coefficients, but a more effective extracting features scheme is provided. Our scheme does partial entropy decoding. Then the two important features, the (DC) difference and (AC) correlation, are extracted from the DCT coefficients [12]. The DC features of our scheme are the magnitude between two quantized DC coefficients that are in the current and the previous block. As for the AC correlation features, they are extracted from the first nine quantized AC coefficients in each block. Then we measure the distance between query image and images in the database. This system will provide rank according to retrieved images which are less than the threshold value. The advantage of our proposed method is that we only need to do partial entropy decoding rather than a complete decoding of JPEG decompression. The proposed method is tested by using Corel image database.

2. Related works

The Joint Photographic Experts Group (JPEG) compressed image retrieval is based on DCT coefficients [13, 14]. DC and AC coefficients are compressed by using DC Huffman encoding and AC Huffman encoding method.

2.1 JPEG Image compression standard

JPEG image compression standard is standardized by International Organization for Standardization and International Telecommunication Unit [15], because of good compression rate and image quality. JPEG image compression standard also includes DCT transformation, quantization and image entropy encoding. Fig.1 shows a simple block diagram of JPEG image compression standard. The input image is a RGB image. The image is first converted into YCbCr image, and then image is divided into non-overlapping block whose size is 8×8. The value 128 is subtracted from each image value and then all the blocks are transformed into DCT. The transformed block is defined as DCT block. After this step, each block will have its own DC and AC coefficients. The coefficient at the location (0,0) in each block is called the DC coefficient, and the other coefficients are called AC coefficients. Next, a weighted quantization table called Q table, is used to quantize the DC and AC coefficients of each block.

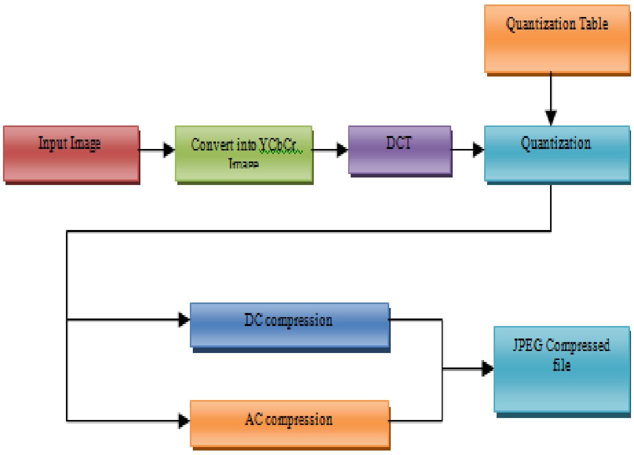


Figure. 1 Block diagram of JPEG compression

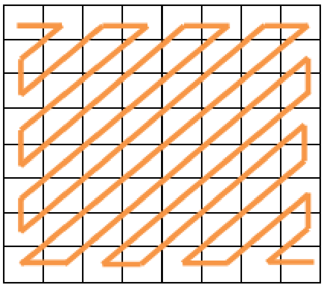


Figure.2 Zigzag scan order

The next procedure is entropy encoding. This procedure includes two parts. First, for DC, the quantized DC coefficients are calculated, after differential pulse code modulation (DPCM) are encoded using DC Huffman coding. DPCM is used to compute the difference between the current and previous DCT blocks [16]. Second, for AC, the two-dimensional (2D) array of AC coefficients can be transformed into a one-dimensional (1D) array using a zigzag scan order, which is shown in Fig. 2. These quantized AC coefficients in the 1D array are then converted into the run level coding form by variable length coding (VLC). Run shows the number of zeros before a non-zero element in this1D array, and level shows the value of a non-zero element. 1D array and level shows the value of a non-zero element.
Run shows the number of zeros before a non-zero element in this 1D array, and level shows the value of a non-zero element. Then these results are applied into AC Huffman coding. Finally, the output would be the DC Huffman encodes and AC Huffman encodes as a JPEG stream. Then, a head is combined with this JPEG stream to form a JPEG compressed file.

3. Proposed System

Our proposed retrieval method for retrieving JPEG compressed images is based on DCT coefficients. The method of feature extraction can be applied after obtaining the compressed image. We extract two DCT features, DC feature and AC feature, DC difference and AC correlation from compressed JPEG images.Our system does not need to full decoding of JPEG decompression, such as recoveries of DPCM decoding for DC coefficients, VLC decoding with AC Huffman table for AC coefficients, inverse quantization, and inverse DCT for each DCT block of the query image. The diagram of our JPEG compressed image retrieval system is shown in Fig. 3. The details of our method are as follows.

3.1. Feature extraction from quantized DC coefficients

The first feature extracted from the JPEG compressed image is DC difference which is the difference between two quantized DC coefficients drawn from the current block and the previous block. The first difference value is the original quantized DC coefficient in the first block, according to the JPEG compression standard. We can get difference values after doing DC Huffman decoding without doing the recovery of DPCM decoding [17].Our system performs DC Huffman decoding for the query image as same as the images in the database before extracting the first feature. After doing DC Huffman decoding on this image, the image size is (288 × 512), we can obtain (288 × 512)/64 difference values. Then, we construct a 1D array whose size is (n × m)/(8 × 8) to store the difference values. If the difference value is greater than or equal to zero, then we replace this difference value with ‘1’. Otherwise, we give this difference value is ‘0’. Finally, we get a vector whose elements are 0s and 1s, and then we use this vector as a DC feature of this JPEG compressed image.

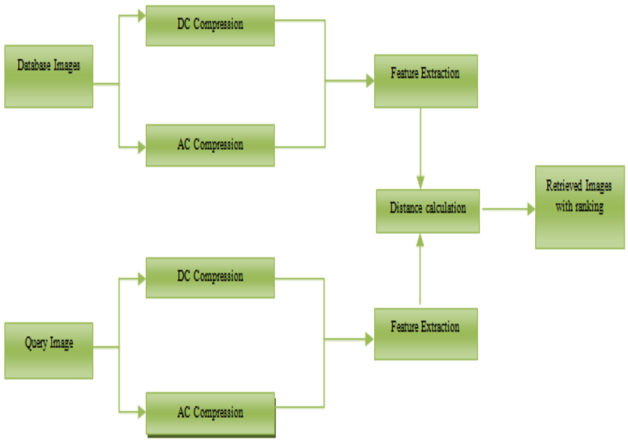


Figure.3 Block diagram of JPEG compressed image retrieval

3.2. Feature extraction from quantized AC coefficients

Our second feature extracted from the JPEG compressed image is AC correlation which is extracted from the first nine quantized AC coefficients of each block in the zigzag scan order. We use only nine AC coefficients as the feature of a block because they are enough to keep most of the information in the block. According to the JPEG compression standard, the nine AC coefficients located around the upper left corner can be extracted after AC Huffman decoding and variable length decoding. In this process, we need to do AC Huffman decoding and variable length decoding for both the query image and the images in the database. These nine decoded AC coefficients are considered the input of the second feature extraction procedure. Then we compute the difference between every pair of AC coefficients which are in the current position and the previous position (diff = AC i+1 – AC i), we get eight difference values. If the difference value is greater than or equal to zero, it will be converted to ‘1’.Otherwise it will be converted into ‘0’.The above process is applied for each block In order to reduce the storage space further, the eight difference values have been taken, eight binary values of each block are converted into one decimal value, and then a histogram model is used to represent these features. As the histogram value is ranging from 0 to 255, we obtain 256 values and they can be formed as an AC feature vector of this JPEG compressed image.

4. Distance Measurement

The two features extracted by our retrieval system include a bit stream formed by DC features and a histogram formed by AC features. In this part we measure the distances between query image and images in the database. The Eq. (1) measures the distance of DC features, and Eq. (2) measures the distance of AC features.

4.1. The first distance measurement can be derived as follows:

Assume that the number of blocks in an image is k. We can give a vector of k elements, (b1..........bk), to represent the first feature, which is the bit stream.

$$D_1^{qd} = \sum_{i=1}^{k}\left(b_i^q \oplus b_i^d\right) \text{ ----- (1)}$$

Here, D1qd stands for the first distance between the query image and an image in the database. bq and bd are two bit streams, where bq stands for the first feature of the query image and bd stands for the first feature of the image in the database. Both the binary values are applied into exclusive-OR operation.

4.2. The second distance measurement can be derived as follows:

Another vector of 256 elements (f0.......f255), which are in the histogram, represent the AC features.

$$D_2^{qd} = \sum_{i=0}^{255}\left(f_i^q - f_i^d\right) \text{ ----- (2)}$$

Here, as shown in Eq. (2), D2qd stands for the second distance between the query image and the image in the database. fq and fd are two histogram features, where fq stands for the second feature of query image and f d stands for the second feature of the image in the database. Calculate the difference for all the images.

5. Rank generation for retrieved images

The images in the database will be considered for retrieval of images if the distance between the query image and this image is shorter than or equal to a user-specified threshold. Then, the system will give the ranking for each retrieved image in order to show the similarity between the retrieved images from database and the query image. Assume that the number of retrieved images is r [18, 19]: The first kind of rankings comes from the first distance measurement. If the first distance measured between the query image and an image in the database is equal to or shorter than the threshold, this image will be considered a candidate image. Here user threshold is represented to user query image value, we sort these first distances measured between the query image and all the retrieved images in the database in increasing order [20]. According to the order of the sorted distances, the retrieved images are ranked starts from 1 to r

The second kind of ranking comes from the second distance measurement. The third kind, on the other hand, combines the first and the second distance measurements. To provide the third kind of ranking, we use the first feature (the DC difference) to filter out most of the unlikely images. Then the rest of the images are considered to be candidate images. Then we apply the second feature (the AC histogram) to rank all the candidate images. In fact, the accuracy rate of this retrieval system is already good after we only measured the distance using the first feature.

6. Experimental result and discussion

Our experiments are executed and tested by using WANG database that is a subset of the Corel database of 1000 images which were selected manually to form 10 classes with 100 images for each class. The images are of size 384 × 256. Fig.4, Fig.5, show our experimental results for the different query images.

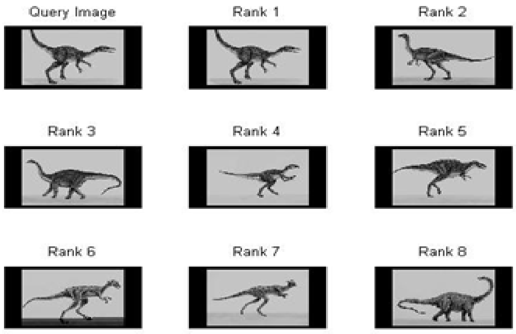


Figure.5.Images ranking for dinosaurs

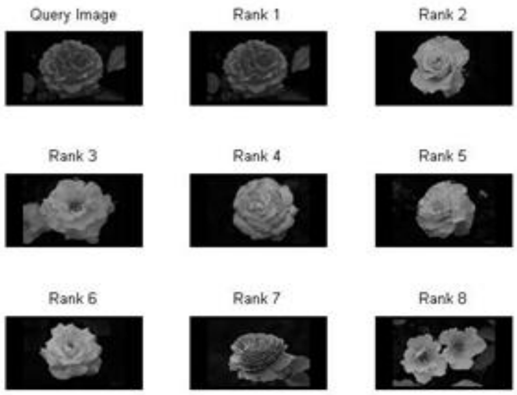


Figure.6.Images ranking for roses

6.1 Precision

The precision in image retrieval can be defined as: precision is the measurement of the retrieved relevant images to the query of the total retrieved images.

$$\text{precision} = A/B \qquad (3)$$

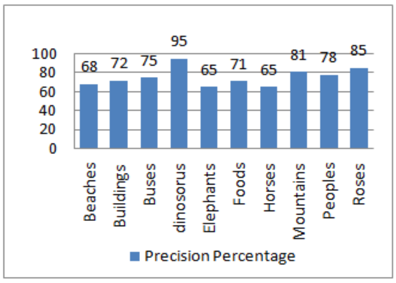
where A is ‘‘the relevant retrieved images’’ and B is ‘‘the total retrieved images.

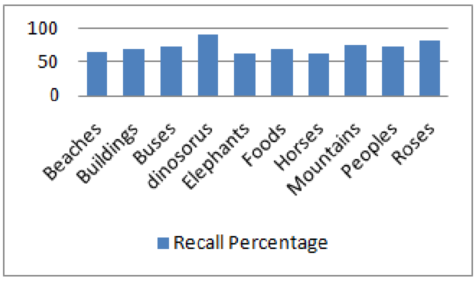
6.2 Recall

The recall in image retrieval can be defined as: Recall is the measurement of the retrieved relevant images to the total database images.

$$\text{Recall} = A/C \qquad (4)$$

where A is ‘‘the relevant retrieved images’’ and C is ‘‘the total number of relevant images in the database’’.





CONCLUSION

In this paper, we have proposed novel approach to direct JPEG compressed image retrieval technique. The DC difference and the AC correlation, both extracted directly from the JPEG-compressed domain, are the two features, which we used in our new system. The first feature, namely the DC difference, is the magnitude between two quantized DC coefficients, one for the current block and the other for the previous block. The second feature, that is the AC correlation, comes from the first nine quantized AC coefficients in each block. In order to further reduce the storage space, the features are taken to the histogram model. The distances between query image and database images have been calculated. This system will provide rank for each retrieved image, according to user specified threshold. Our proposed scheme is based on DCT coefficients, and it can directly compare two JPEG-compressed images in the compressed domain without doing full decoding. Our proposed system no needs full decoding, performs only partial entropy decoding process. As a result, we can accelerate the retrieval process and save a lot of time.

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