COLOR CO-OCCURRENCE AND BIT PATTERN FEATURE BASED CBIR

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Abstract— Content Based Image Retrieval is most recently used technique for image retrieval from large image database. Content based image retrieval technique can be found in a number of different domains such as Data Mining, Education, Medical Imaging, Crime Prevention, Weather forecasting, Remote Sensing and Management of Earth Resources The reason behind using CBIR is to get perfect and fast result. There are many technique of CBIR used for image retrieval. This paper presents a technique for CBIR by exploiting the advantage of lowcomplexity ordered-dither block truncation coding (ODBTC) for the generation of image content descriptor. The color co-occurrence feature (CCF) and bit pattern features (BPF) are used to index an image. The CCF use CMY Color Model. The CCF and BPF of an image are simply derived from the two ODBTC quantizers and bitmap, respectively, by involving the visual codebook. Experimental results shows that the proposed method efficiently retrieve images compared to other methods.

Keywords- content-based image retrieval, color co-occurrence feature, Bit pattern feature

I.Introduction

An image retrieval system returns a set of images from a collection of images in the database to meet users' demand with similarity evaluations such as image content similarity, edge pattern similarity, color similarity, etc. An image retrieval system offers an efficient way to access, browse, and retrieve a set of similar images in the real-time applications. Research on content-based image retrieval has gained tremendous momentum during the last decade. A lot of research work has been carried out on Image Retrieval by many researchers, expanding in both depth and breadth. The term Content Based Image Retrieval (CBIR) seems to have originated with the work of Kato [1] for the automatic retrieval of the images from a database, based on the color and shape present. Since then, the term has widely been used to describe the process of retrieving desired images from a large collection of database, on the basis of syntactical image features (color, texture and shape). The techniques, tools and algorithms that are used, originate from the fields, such as statistics, pattern recognition, signal processing, data mining and computer vision.

Several approaches have been developed to capture the information of image contents by directly computing the image features from an image. Most of them are dealing with the MPEG-7 Visual Content Descriptor, including the Color Descriptors (CD), Texture Descriptor (TD), and Shape Descriptor (SD) to establish the international standard for the CBIR task. This standard provides a great advantage in the CBIR research field, in which some important aspects such as sharing the image feature for benchmark database, comparative study between several CBIR tasks, etc., become relatively easy to be conducted using these standard features.

The Block Truncation Coding (BTC) is an image compression method which requires simple process on both encoding and decoding stages. The BTC compresses an image in a simple and efficient way [2]. BTC firstly divides an input image into several image blocks, and each image block is subsequently represented with two specific quantizers to maintain its mean value and standard deviation identical to the original image block. The BTC produces two quantizers, namely high and low quantizers, and a bitmap image at the end of the decoding process. The BTC decoding performs the reverse procedure by simply replacing the bitmap information with the high or low quantizer.

The computational simplicity of the BTC and Halftoning-based Block Truncation Coding (HBTC) techniques have made it as an attractive tools in applications requiring fast real-time implementation. HBTC is an extended compression technique derived from BTC scheme, in which the BTC bitmap image is replaced with the halftone image. The main difference between the BTC and HBTC is on the image block quantizers determination. In contrast to the BTC scheme which tries to maintain its mean value and standard deviation in an image block, the HBTC quantizers are simply obtained from the minimum and maximum values found in an image block. The dithering-based BTC is an example of

HBTC, in which the bit pattern configuration of the bitmap is merely generated from the dithering approach (void-and-cluster halftoning).

The dithering-based BTC, namely Ordered Dither Block Truncation Coding (ODBTC) [3], [4], involves the low-pass nature of the Human Visual System (HVS) for achieving an acceptable perceptual image quality. It is based on the fact that the continuous and halftone images are perceived similarly by human vision when they are viewed from a certain distance. In encoding stage, the ODBTC scheme utilizes the dither array Look-Up-Table (LUT) to speed up the processing speed. The dither array in ODBTC method substitutes the fixed average value as the threshold value for the generation of bitmap image. The extreme values in ODBTC are simply obtained from the minimum and maximum value found in the image blocks. Given the high efficiency and low computational complexity of the ODBTC, some interesting applications have been developed based on it such as watermarking schemes [5], [6]. Thus, it offers a good solution for application requiring privacy and ownership protection.

In this paper, a new approach is proposed to index images in database using features generated from the ODBTC compressed data stream. This indexing technique can be extended for CBIR. ODBTC compresses an image into a set of color quantizers and a bitmap image. The proposed image retrieval system generates two image features, namely Color Co-occurrence Feature (CCF) and Bit Pattern Feature (BPF), from the above color quantizers and bitmap image, respectively.

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II. Related Work

Content Based Image Retrieval is the retrieval of images based on visual features such as color, texture and shape. Reasons for its development are that in many large image databases, traditional methods of image indexing have proven to be insufficient, laborious, and extremely time consuming. These old methods of image indexing, ranging from storing an image in the database and associating it with a keyword or number, to associating it with a categorized description, have become obsolete. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. Several CBIR systems currently exist, and are being constantly developed.

The Color Selection exploited CBIR system [7], facilitates query-by-color. It is based on 11 color categories, used by all people, while thinking of and perceiving color. Then the low frequency DCT coefficients that are transformed from YUV color space as feature vectors are used for retrieval of images [8]. This system allows users to select its dominant feature of query images so as to improve the retrieval performance. But the technique is sufficient for performing effective retrieval by introducing users' opinions on the query images.

In Region of Interest Image Indexing System [9], user can select the region of interest (ROI) and the system will search all the images in the database to find the all related regions among the database. A Universal Model for Content-Based Image Retrieval combine three feature extraction methods namely color, feature and edge histogram descriptor [10]. The image properties analyzed in this work are by usingcomputer vision and image processing algorithms. For color the histogram of images are computed, for texture co-occurrence matrix based entropy, energy, etc., are calculated and for edge density it is Edge Histogram Descriptor (EHD) that is found. For retrieval of images, a novel idea is developed based on greedy strategy to reduce the computational complexity. Such existing approaches required large storage space and lot of computation time to calculate the matrix of features

A new type of CBIR approach is presented in [11], in which the spatial pyramid and orderless bag-offeatures image representation were employed for recognizing the scene categories of images from a huge database. This method offers a promising result and outperforms the former existing methods in terms of the natural scene classification.

Jhanwar et al [12] presents a new technique for content based image retrieval using motif co-occurrence matrix (MCM). MCM is derived using a motif transformed image. The whole image is divided into 2*2 pixel grids. Each grid is replaced with the scan motif which minimize the localgradient while traversing the 2 * 2 grid forming a motif transformed image. MCM is then defined as a 3 dimensional matrix whose (i,j,k) entry denotes the probability of finding a motif i at a distance k from motif j in the transformed image. Conceptually the motif co-occurrence matrix is quite similar to color co-occurrence matrix (CCM). MCM performs much better than CCM since it captures the third order image statistics in the local neighborhood.

G. Qiu [13] presents Color image indexing using BTC. The method exploits the nature of BTC to generate the image feature in which an image block is merely represented using two quantized values and the corresponding bitmap image. In this work [13] two image features have been proposed, namely block color co-occurrence matrix and block pattern histogram, to index a set of images in database. This method utilizes the RGB color space.

S. Silakari [14] presents Color Image Clustering using Block Truncation Algorithm. This framework focuses on color as feature. Color Moment and Block Truncation Coding (BTC) are used to extract features for image dataset. Steps in Block Truncation Coding Algorithm: 1) Split the image into Red, Green, Blue Components. 2) Find the average of each component : Average of Red component , Average of Green component , Average of Blue component 4) Split every component image to obtain RH, RL, GH, GL, BH and BL images RH is

obtained by taking only red component of all pixels in the image which are above red average and RL is obtained by taking only red component of all pixels in the image which are below red average. Similarly GH, GL, BH and BL can be obtained. 5)Apply color moments to each splitted component i.e. RH, RL, GH, GL, BH and BL. 6) Apply clustering algorithm to find the clusters.

J. Huang [15] presents a new color feature for image indexing/retrieval called the color correlogram. The highlights of this feature are: 1) it includes the spatial correlation of colors, 2) it can be used to describe the global distribution of local spatial correlation of colors; 3) it is easy to compute, and 4) the size of the feature is fairly small. This new feature can outperform both the traditional histogram method and the recently proposed histogram refinement methods for image indexing/retrieval.

III Proposed Work

This section describe the proposed work of CBIR. The ODBTC employed in the proposed method decomposes an image into a bitmap image and two color quantizers which are subsequently exploited for deriving the image feature descriptor. Two image features are introduced in the proposed method to characterize the image contents, i.e., Color Co-occurrence Feature (CCF) and Bit Pattern Feature (BPF). The CCF is derived from the two color quantizers, and the BPF is from the bitmap image. Figure 1 shows the block diagram of proposed CBIR System.

A. ODBTC Encoding

The ODBTC algorithm is generalized for color images in coping with the CBIR application. The main advantage of the ODBTC image compression is on its low complexity in generating bitmap image by incorporating the Look-Up Table (LUT), and free of mathematical multiplication and division operations on the determination of the two extreme quantizers.

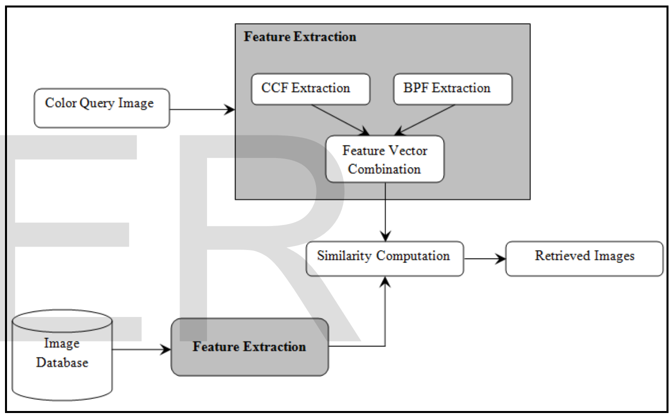

Figure 1 Block diagram of the proposed image retrieval method

Fig 2 shows the conceptual block diagram of the ODBTC encoding for a color image.

Given an original color image of size M × N; This image is firstly divided into multiple non-overlapping image blocks of size m × n, and each image block can be processed independently.

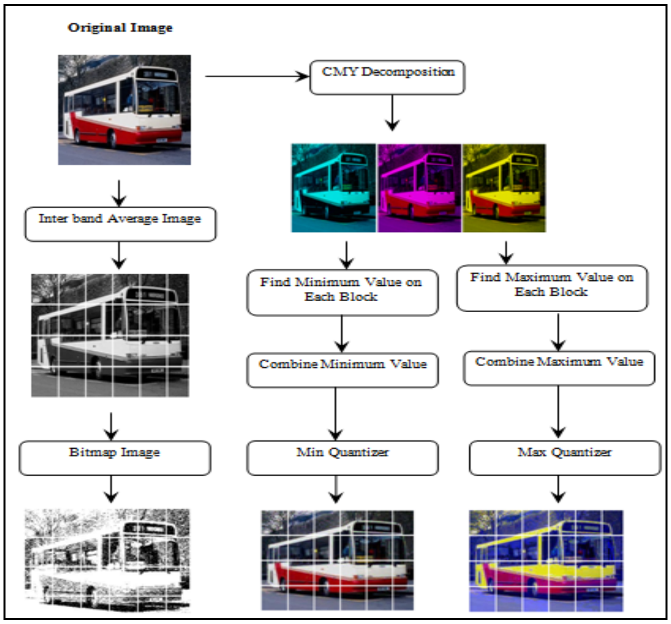

Figure 2 Block diagram of ODBTC encoding

Each block can be converted into inter band average image block. The inter band average image is transformed into bitmap image using threshold process.

The original image is decomposed into Cyan, magenta and yellow components. Compute minimum and maximum value for finding the minimum and maximum quantization image.

B. Color Co-Occurrence Feature (CCF)

The color distribution of the pixels in an image contains huge amount of information about the image contents. The attribute of an image can be acquired from the image color distribution by means of color co-occurrence matrix. This matrix calculates the occurrence probability of a pixel along with its adjacent neighbors to construct the specific color information. This matrix also represents the spatial information of an image.

Color Co-occurrence Feature (CCF) can be derived from the color co-occurrence matrix. Fig. 3 shows the schematic diagram of the CCF computation.

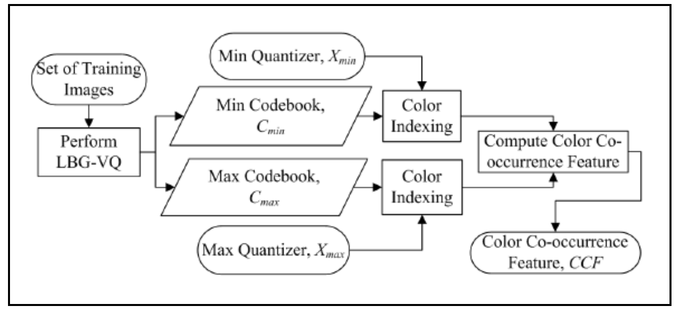

Figure 3 Block diagram for computing the color co-occurrence feature

The color co-occurrence matrix is a sparse matrix, in which the zeros dominate its entries. To reduce the feature dimensionality of the CCF and to speed up the image retrieval process, the color co-occurrence matrix can be binned along its columns or rows to form a 1D image feature descriptor. Thus, the feature dimensionality of the CCF is Nc, i.e., identical to the color codebook size.

C. Bit Pattern Feature (BPF)

Another feature, namely Bit Pattern Feature (BPF), characterizes the edges, shape, and image contents. Fig. 4 shows the schematic diagram for deriving the BPF. The binary vector quantization produces a representative bit pattern codebook from a set of training bitmap images obtained from the ODBTC encoding process.

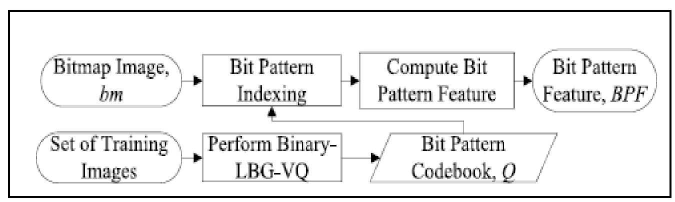

Figure 4 Block diagram for computing the bit pattern feature

The bitmap of each block is simply indexed based on the similarity measurement between this bitmap and the codeword.

The BPF is simply derived as the occurrence probability of the bitmap image mapped into the specific bit pattern codeword.

D. The Similarity Measure of the Features

The similarity between two images (i.e., a query image and the set of images in the database as target image) can be measured using the relative distance

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measure. The similarity distance plays an important role for retrieving a set of similar images. The query image is firstly encoded with the ODBTC, yielding the corresponding CCF and BPF. The two feature are later compared with the features of target images in the database. A set of similar images to the query image is returned and ordered based on their similarity distance score, i.e,. the lowest score indicates the most similar image to the query image. Formally, the similarity measurement between two images is defined as follows.

$$\delta(query, target) = \alpha_1 \sum_{t=1}^{N_c} \frac{|CCF^{query}(t) - CCF^{target}(t)|}{CCF^{query}(t) + CCF^{target}(t) + \varepsilon} + \alpha_2 \sum_{t=1}^{N_b} \frac{|BPF^{query}(t) - BPF^{target}(t)|}{BPF^{query}(t) + BPF^{target}(t) + \varepsilon},$$

where α1 and α2 denote the similarity weighting constants, representing the percentage contributions of the CCF and BPF in the proposed image retrieval system. A small number ε is placed at the denominator to avoid the mathematic division error.

IV Exprimental Result

Extensive experiments were conducted to examine the performance of the proposed method. The image descriptors are obtained from the ODBTC encoded data stream which is already stored in the database. First, CCF and BPF are computed over all images in the database. Subsequently, the system returns a set of similar images from the database based on their similarity distance. Finally, the image retrieval performance is tested when several images are turned as queries.

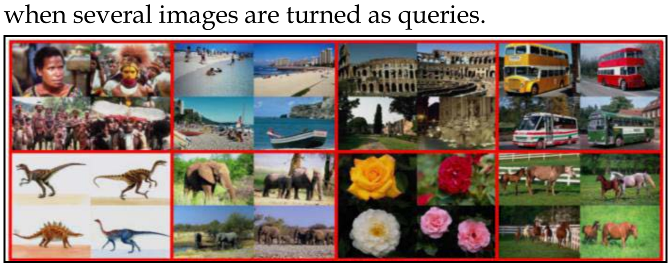

Figure 5 Sample Images in Database

Fig. 5 shows some sample images of each class in Corel image database.

Fig. 6 presents retrieval examples of the proposed scheme with the similarity weight constants set at {α1 = 1, α2 = 0}, {α1 = 0, α2 = 1}, and {α1 = 1, α2 = 1}. The first column of Fig. 6 denotes the query image, and the subsequent images from left to right are a set of returned images corresponding to the query image. As it can be seen, the combination of the CCF and BPF yields the better results in terms of the visual image appearances compared to using either CCF or BPF alone.

Figure 6 Proposed method with {α1 = 1, α2 = 0}, {α1 = 0, α1 = 1}, and {α1 = 1, α1 = 1}

V Conclusion

In this study, an image retrieval system is presented by exploiting the ODBTC encoded data stream to constructthe image features, namely Color Co-occurrence and Bit Pattern features. As documented in the experimental results, the proposed scheme can provide the best average precision rate compared to various former schemes in the literature. As a result, the proposed scheme can be considered as a very competitive candidate in color image retrieval application. For the further studies, the proposed image retrieval scheme can be applied to video retrieval. The video can be treated as sequence of image in which the proposed ODBTC indexing can be applied directly in this image sequence. The ODBTC indexing scheme can also be extended to another color space as opposed to the RGB triple space. Another feature can be added by extracting the ODBTC data stream, not only CCF and BPF, to enhance the retrieval performance. In the future possibilities, the system shall be able to bridge the gap between explicit knowledge semantic, image content, and also the subjective criteria in a framework for human-oriented testing and assessment.

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