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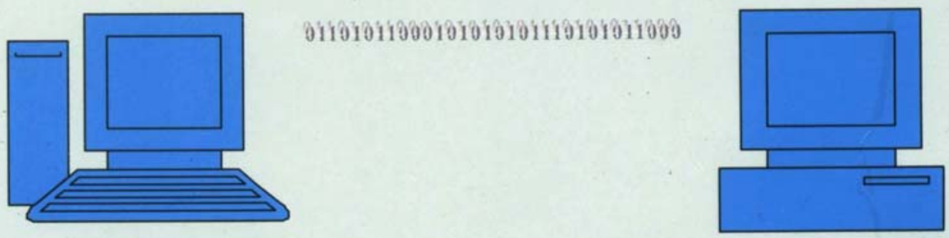

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Block Truncation Coding Based Histograms for Colour Image Retrieval

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Abstract: *This paper proposes new compressed-domain features named Block Truncation Coding (BTC)-based Histograms (BTCH) for colour image retrieval. Based on the YCbCr colour space, two feature extraction methods are given for each component of the colour image. The first one, BTCDH, is to calculate three histograms directly from three BTC-coded data sequences. The second one, BTCQH, is to scalar quantize BTC-coded higher and lower means with their corresponding scalar codebooks and to vector quantise the bitplane with a binary VQ codebook, and then calculate three index histograms from obtained three index sequences. The retrieval simulation results demonstrate the effectiveness of the proposed features.*

Key words: *Block Truncation Coding, Image Retrieval, Vector Quantisation, Feature Extraction.*

1. INTRODUCTION

With recent advances in multimedia technologies, a large amount of image and video data is becoming publicly available. However, without effective image retrieval it is impossible to make use of this information. In a content-based image retrieval (CBIR) system [1], instead of being manually annotated by keywords, images are indexed by their own visual content, such as colour [2], texture [3] and shape [4]. Recently, many researchers have shown great interests in image retrieval based on compressed-domains such as vector quantisation (VQ) [5], DCT [6], DCT-VQ[7], DWT [8] and Block Truncation Coding (BTC) [9]. Reference [5] extracts features directly from the codeword indices of the spatial-domain VQ compressed image. Reference [6] obtains the texture features directly from the middle and low-frequency DCT coefficients. Reference [7] extracts features based on the DCT transform domain VQ index histograms. Reference [8] retrieves the images in 3 progressive steps using four lowest resolution subbands based on DWT. Reference [9] derives the block colour co-occurrence matrix (BCCM) and the block pattern histogram (BPH) from the BTC compressed stream. To simply the feature description based on BTC, this paper presents new features simply denoted by BTC-based Histograms (BTCH) based on the YCbCr colour space. For convenience, the following descriptions only take into account one colour component.

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2. BLOCK TRUNCATION CODING

BTC is a simple and efficient lossy image compression technique, which has the advantage of being easy to implement. In the absolute moment BTC (AMBTC) [10] method, the gray-level image is divided into blocks of size $m = 4 \times 4$. The mean value $\overline{x}$ of the pixels in each block x is taken as the one-bit quantizer threshold, i.e., $\overline{x} = \frac{1}{m}\sum_{i=1}^{m} x_i$, and the two output quantisation level values are $\overline{x}_L = \frac{1}{m-q}\sum_{x_i \le \overline{x}} x_i$ and $\overline{x}_H = \frac{1}{q}\sum_{x_i > \overline{x}} x_i$, where $\overline{x}_L$ and $\overline{x}_H$ denote the lower mean and the higher mean respectively, q stands for the number of pixels whose values are larger than the mean value. Then the two-level quantisation is performed for the pixels in the block to form a bit plane so that '0' is stored for the pixels with values not larger than the mean, and the rest of the pixels are represented by '1'. The image can be reconstructed by assigning the value $\overline{x}_L$ to the '0' and $\overline{x}_H$ to the '1'. Thus a compressed block appears as a triple ($\bar{x}_L, \bar{x}_H, B$), where $\bar{x}_L, \bar{x}_H$ and B denote the lower mean, the higher mean and the bit plane respectively. In the following sections, two kinds of feature extraction methods for image retrieval are given.

3. HISTOGRAMS FROM SCALAR QUANTIZED MEANS AND VECTOR QUANTISED BITPLANES

To reduce the bit rate for each part of the BTC-coded triple data ($\bar{x}_L, \bar{x}_H$, B), one solution is to quantize the higher mean and the lower mean separately with corresponding predesigned scalar codebooks, each including 20 codewords, and also to vector quantise the bitplane B with a codebook including 24 16-dimensional binary codewords. Here the scalar codebooks for the higher and lower means and the VQ codebook for the bitplane are all generated by the LBG algorithm [11] based on the BTC-coded training images selected from the image database. After quantizing the BTC-coded data of all images in the database respectively, we compute three histograms by selecting 20 bins for the quantisation index sequences of $\bar{x}_L$ and $\bar{x}_H$ each and 24 bins for the quantisation index sequence of B. We denote this kind of features as BTCQH in short. Note that there are three colour components, thus we have in total 9 histograms with 192 dimensions, 64 dimensions for each colour component.

4. EXPERIMENTAL RESULTS AND CONCLUSIONS

To demonstrate the effectiveness of the proposed features, we compare our BTCDH and BTCQH features with traditional spatial-domain colour-histogram-based (SCH) features based on the same YCbCr colour space and the same feature dimension of 192. We use a standard database [12] in the experiment that is carried out on a Pentium IV computer with the 2.80GHz CPU. This database includes 1000 images of size 384×256 or 256×384, which are classified into ten classes, each class including 100 images. We first randomly select 2 images from each class to be the training images, and then we generate the required 3 codebooks for BTCQH as described in the previous section. For Y component images in the database, the encoding results show that the average encoding qualities based on BTC (2bits/pixel) and BTCQ (BTC with Quantisation) (($2\log_2 20 + \log_2 24) / 16 \approx 0.827$ bits/pixel) are 30.31dB and 25.80dB, respectively. Then we calculate the proposed 192-dimensional BTCDH feature vector and 192-dimensional BTCQH feature vector for each colour image respectively. For comparisons, we also extract three 64-bin colour histograms (i.e., a 192-dimensional feature vector) from each image based on the YCbCr colour space. To compare the performance more reasonably, we randomly select 5 images from each class, and thus in total 50 images, as the test query images. For each test query image, we perform the retrieval process based on each kind of features. For each number of returned images (from 1 to 1000), we average the recall and precision value over 50 test query images. The average P-R curve is shown in Fig. 1. Since each class only has 100 images, we also compare the performance for the first 100 returned images by providing the curves of average recall and precision vs. the number of returned images as shown in Fig. 2 and Fig. 3 respectively. Because the higher and lower means can reflect the rough colour and texture information and the bitplane can reflect the edge information, the proposed BTCDH and BTCQH features are much better than the traditional SCH features. BTCQ generates three representative codebooks for the image database and thus the higher mean, lower mean and bitplane distributions can be much better represented, so the proposed BTCQH features are much better than the proposed BTCDH features. In addition, we find that the better encoding quality doesn't guarantee the better retrieval performance, which is only based on the representation of the features. Future work will concentrate on how to adaptively extract different kinds of features from different (e. g., background and foreground) parts of the image.

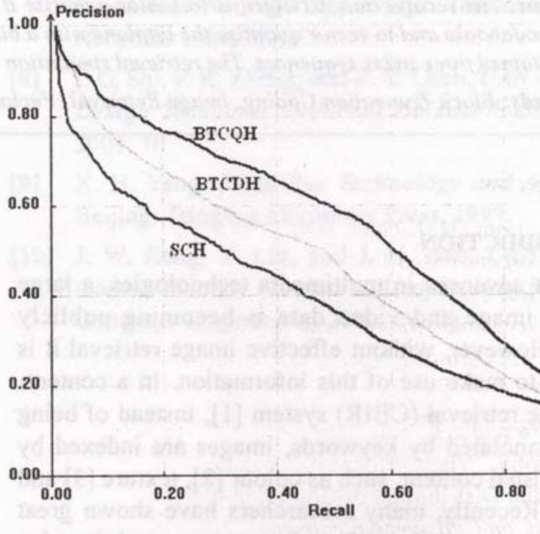

Figure 1: P-R Curves for Various Kinds of Features.

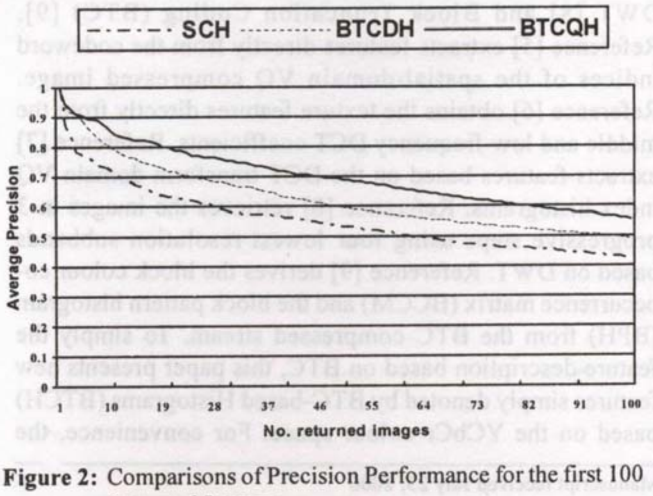

Figure 2: Comparisons of Precision Performance for the first 100 Returned Images.

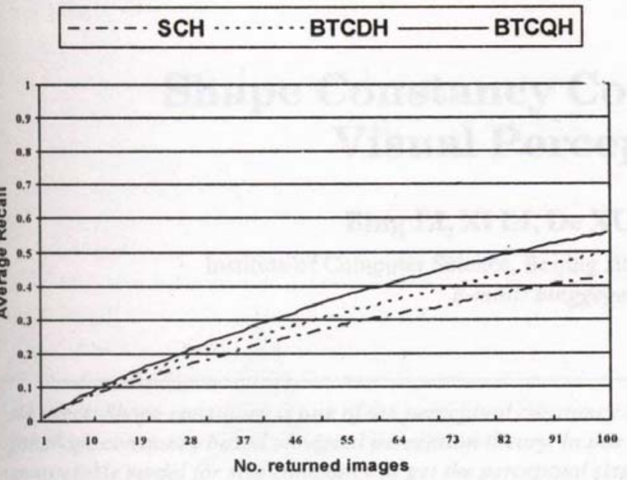

Figure 3: Comparisons of Recall Performance for the First 100 Returned Images.

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