Image Compression Using Maximum Minimum BTC (MMBTC)

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ABSTRACT

In this paper a new simple image compression scheme based on BTC scheme has been presented. the proposed scheme dependes on the maximum and minimum pixels in image blocks, this scheme has been compared with Block Truncation Coding (BTC) and Absolute Moment Block Truncation Coding (AMBTC) schemes and the experimental results show that the proposed scheme gives good results in a short time with lower computational complexity compared with BTC and AMBTC, in this research a Pentium 4 computer with 1.7 GHz speed has been used and the MATLAB programming language has been used.

Keywords: ***Image, Block Truncation Coding, Image compression, PSNR***

1. Introduction

The problem of how one stores and transmits a digital image has been a topic of research for more than 40 years and was initially driven by military applications and NASA. The problem, simply stated, is how does one efficiently represent an image in binary form? This is the image compression problem [1].

Interesting with images compression increased especially after the big revolution in the multimedia and the internet as well as the video image techniques [2]. Transmitting digital images plays a big role in modern communication systems and applications, to transmit an image it need a wide band width because of its huge size, therefore it was necessary to find efficient image compression techniques to reduce transmission band width and transmission time [3].

In recent years there has been a great deal of activity in formulating standards for image and video compression. The results being the JPEG and MPEG standards. Most of statistical image compression methods are implemented by segmenting the image into non-overlapping blocks, since dividing the images into blocks allows the image compression algorithm adapt to local image statistics ,block truncation coding (BTC) is an example of these methods .

In this paper we propose an image compression scheme based on BTC. This scheme is simple and very fast because it does not need many computations. Experimental results show that the proposed scheme gives good image quality with low computational complexity. In Section 2 we briefly outline the BTC and AMBTC methods. We describe the proposed image compression scheme in Section 3. The experimental results are discussed in Section 4. Finally we conclude this paper in Section 5.

2. Block Truncation Coding (BTC) and AMBTC

The basic concepts of BTC were born on March 1977 in the office of O. Robert Mitchell at Purdue University during a conversation between Mitchell and his Ph.D. student Edward J. Delp [4]. BTC is based on the conservation of statistical properties. Although it is a simple technique, BTC has played an important role in the history of image compression, Many image compression techniques have been developed based on BTC [5].In the BTC method, the given image is divided into a number of non-overlapping small blocks (normally 4 x 4 pixels). For each block the means ***m*** **,** ***m*** and the standard deviation σ are calculated using the following equations :

$$m = \frac{1}{k}\sum_{i=1}^{k} x_i \qquad (1)$$

$$\overline{m} = \frac{1}{k}\sum_{i=1}^{k} x_i^2 \qquad (2)$$

$$\sigma = \sqrt{\overline{m} - m^2} \qquad (3)$$

Where x_i represents the ***ith*** pixel value of the image block and ***k*** is the total number of pixels in that block.

Taking ***m*** as the threshold value a two-level bit plane is obtained by comparing each pixel value x_i with the threshold. If $x_i <$ ***m*** then the pixel is represented by '0',otherwise it is represented by '1'. By this process each block is reduced to a bit plane. The bit plane along with ***m*** and σ forms the compressed data.

In the decoder an image block is reconstructed by replacing '1's in the bit plane with ***H*** and the '0's with ***L***, which are given by:

$$H = m + \sigma\sqrt{\frac{p}{q}} \qquad (4)$$

$$L = m - \sigma\sqrt{\frac{q}{p}} \qquad (5)$$

Where ***p*** and ***q*** are the number of 0's and 1's in the compressed bit plane block respectively.

Lema and Mitchell [6] presented a simple and fast variant of BTC, named Absolute Moment BTC (AMBTC) that preserves the higher mean and lower mean of a block. In AMBTC method, an image is divided into a number of non-overlapping blocks. The mean ***m*** that represents the average gray level of the pixels in a block is calculated using equation (1). Pixels in that image block are then classified into two ranges of values. The upper range is those gray levels which are greater than or equal to the block average gray level (***m***) and the remaining are brought into the lower range. The mean m_H of higher range and the mean m_L of the lower range are calculated as:

$$m_H = \frac{1}{n}\sum_{x_i \geq m}^{k} x_i \qquad (6)$$

$$m_L = \frac{1}{k-n}\sum_{x_i < m}^{k} x_i \qquad (7)$$

Where *n* is the number of pixels whose gray level is greater than or equal to *m* . Then a two level quantization is performed for all the pixels in that block to form a bit plane so that 1 is stored for pixel values greater than or equal to *m* and the rest of the pixels are presented by "0".

The encoder writes m_H and m_L to a file. In the decoder, an image block is reconstructed by replacing the `1's with m_H and the '0''s by m_L. AMBTC faster than BTC because it requires less computation than BTC.

3. The Proposed Scheme

The proposed method is a very simple and very fast variant of BTC , it divides the image into a number of non-overlapping blocks, for each block the mean ***m*** is computed by using equation (1), then the maximum pixel value (***max***) and the minimum pixel value (***min***) in the block are selected .

As in BTC the two level quantization is performed for all pixels in that block to construct the bit plane ,so the "1" stored for pixel values that greater than or equal to the mean (***m***), and the other block pixels are represented by "0".The encoder writes the ***max*** and ***min*** values of the blocks to the compressed file .

In the decoder an image block is reconstructed by replacing the 1's with maximum pixel value (***max***) in that block and the 0's are replaced by the minimum pixel value (***min***).

Compression Algorithm

Step-1. Divide the given image into a set of non overlapping blocks with size 4 x 4 pixels.

Step-2. for each block do

- Select the maximum *(max)* and minimum *(min)* pixels in the block.
- Compute the block pixels mean (m) using equation (1).
- Construct the bit plane block by replacing the pixels with values greater than or equal to the

mean *m* by '1' and the rest of the pixels by '0'.

Decompression Algorithm

Step-1. Divide the bit plane image into a set of non overlapping blocks with size 4 x 4 pixels.

Step-2. for each bit plane $block_i$ do

- For each pixel in $block_i$ do
  If pixel =1 then Retrrived_pixel=Max_i
  Else Retrrived_pixel = Min_i
- Construct $Retrieved\_block_i$ using the Retrrived_pixels

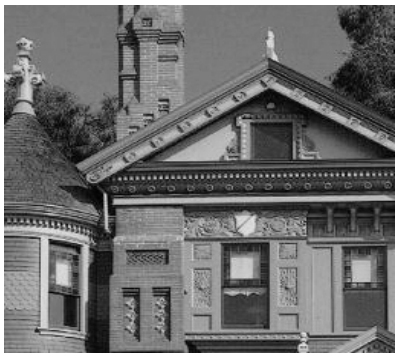
Step-3. Reconstruct the Decoded image using the Retrieved blocks.

Step-3. Reconstruct the bit plane image using the pit plane blocks.

4. Experimental results

To evaluate the performance of the proposed image compression scheme, four standard monochrome images of size 512 X 512 pixels had been taken ***"Man", "house", "boat"*** and ***"birds"*** which are shown Fig.1(a) to Fig. 1(d).

(a) Man



(b) house

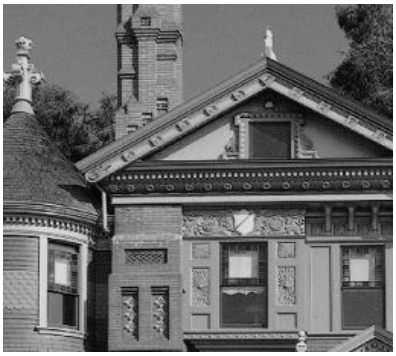
(c) boat

(d) birds

Fig. 1 Standard images used for experiment

The reconstructed images of MMBTC image compression scheme is given in Fig. 2(a) to Fig. 2(d)

(a) Man



(b) house

(c) boat

(d) birds

Fig. 2 The reconstructed Standard Images using MMBTC

Peak signal to noise ratio (PSNR) has been used to measure the difference between the original images and the compressed ones , PSNR is given by the following equation:

$$PSNR = 10\ Log_{10} \cdot \frac{255^2}{MSE} \quad (8)$$

Where MSE is the mean square error that is given by the following equation

$$MSE = \frac{1}{H \times W} \sum_{i}^{H} \sum_{j}^{W} \left(x_{ij} - \overline{x}_{ij} \right)^2 \quad (9)$$

Where H, W are the dimensions of the images ,x_{ij} is the original image pixel and x_{ij} is the compressed image pixel.

The following table shows the results of the three schemes : BTC , AMBTC and MMBTC.

Table 1: PSNR values for the three methods on Standard images

Image	Method PSNR		
	BTC	AMBTC	MMBTC
Man	22	29	32.4
house	18.9	26	29.4
boat	21	29	31.9
birds	24.5	32	34.5

As shown in the above table the results of MMBTC are better than the results of both BTC and AMBTC.

Table 2 shows the compression ratio for each of the three methods.

Table 2: Compression ratio for the three methods

Compression Method	Compression Ratio
BTC	0.375
AMBTC	0.312
MMBTC	0.312

Table 3 shows the average time in milliseconds for the three methods.

Table 3: Time average for the three methods

Compression Method	Time Average
BTC	20
AMBTC	10
MMBTC	8

As shown in table 2 the compression ratio of each AMBTC and MMBTC is the same and there is a very small difference between the compression ratio of them and the compression ratio of BTC, but from table 1, MMBTC is the best among them because it gives higher PSNR than both methods BTC and AMBTC .

And from table 3 the time average of MMBTC is smaller than time average of both BTC and AMBTC, and that means MMBTC is the faster among them.

5. Conclusion

A new image compression scheme based on BTC and the Maximum-Minimum pixels value has been proposed. Experimental results of our scheme on standard images show that it gives higher PSNR values than BTC and AMBTC, MMBTC scheme is faster than BTC and AMBTC because it has low computational complexity.

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ضغط الصور باستخدام تقنية BTC ذات الحد الأعلى و الأدنى

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المستخلص

في هذا البحث تم اقتراح طريقة جديدة وبسيطة لضغط الصور اعتمادا على تقنية BTC , حيث إنها تعتمد على القيم العليا و الـــدنيا لبيانات الصورة وقد تم تطبيق هذه الطريقة لضغط مجموعة من الصور وتمت مقارنتها مع طرق BTC و AMBTC وقد أظهـــرت النتائج بان الطريقة المقترحة تعطي نتائج جيدة بوقت قصير وبتعقيدات حسابية اقل مقارنة مع طرق BTC و AMBTC.

لقد تم استخدام حاسبة بنتيوم 4 مع سرعة 1.7 كيكا هرتز كما تم استخدام لغة ماتلاب MATLAB لانجاز هذا البحث.

الكلمات المفتاحية : صورة , Block Truncation Coding , ضغط الصور , PSNR.