An algorithm for binary codebook design based on the average bitmap replacement error (ABPRE)

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Received 3, January, 2011
Accepted 20, May, 2011

Abstract:

In this paper, an algorithm for binary codebook design has been used in vector quantization technique, which is used to improve the acceptability of the absolute moment block truncation coding (AMBTC) method. Vector quantization (VQ) method is used to compress the bitmap (the output proposed from the first method (AMBTC)). In this paper, the binary codebook can be engender for many images depending on randomly chosen to the code vectors from a set of binary images vectors, and this codebook is then used to compress all bitmaps of these images. The chosen of the bitmap of image in order to compress it by using this codebook based on the criterion of the average bitmap replacement error (ABPRE). This paper is suitable to reduce bit rates (increase compression ratios) with little reduction of performance (PSNR).

Key words: Absolute Moment Block Truncation Coding, Vector Quantization, bitmap image and the criterion of the average bitmap replacement error (ABPRE).

Introduction:

Image compression is a device in many applications such as TV, video and audio applications. The advantage of the image compression is to increase the compression ratio (decrease the bit rate for storage or transmission purposes)[1,2].

The block truncation coding (BTC) is a type of lossy image compression technique for gray scale images. This method was originally proposed by Delp and Mitchell in 1979 [3], but vector quantization (VQ) method was proposed and carried out as early as 1975 by Hilbert [4].

The method proposed in this paper describes an image compression algorithm based on AMBTC using VQ technique (to compress the binary form of the coded image produced from the AMBTC). We consider an algorithm involve binary codebook design, where there are several methods for designing a codebook [2]. The aim is to propose a simple algorithm for binary codebook design to find a set of binary code vectors (i.e. codebook) for many images depending on randomly chosen to the code vectors from a set of binary vectors (bit maps of these images), and this codebook is then used to compress all bitmaps of these images. The chosen of the bit map of image in order to compress it by using this codebook based on the criterion of the average bitmap replacement error (ABPRE) [5]. This algorithm is appropriate to compress different images and increase the compression ratios(decrease the bit rates) with little reduction of performance (PSNR).

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Absolute moment block truncation coding:

The absolute moment block truncation coding, (AMBTC), is a type of lossy image compression technique for gray scale images. It divides the original images into blocks of typically $m=n \times n$ pixels. For each block the mean (T), high and low means are calculated, these values change from block to block. The last two values define what values the reconstructed or new block will have, in other words, the blocks of the compressed image will all have the same high and low mean of the original image blocks, these are performed as follows [3];

$$T = \frac{1}{m}\sum_{i=1}^{m} X_i \text{.....(1)}$$

$$T_1 = \frac{1}{q}\sum_{X_i >= T} X_i \text{.....(2)}$$

$$T_2 = \frac{1}{m-q}\sum_{X_i < T} X_i \text{.....(3)}$$

Where X_i are pixel elements of the original block and T_1 and T_2 are the high and low means, m is the total number of pixels in the block and q is the number of pixels greater than the mean.

$$P_i = \begin{matrix} 1 & if & X_i >= T \\ 0 & if & X_i < T \end{matrix} \text{.....(4)}$$

Where P_i are elements of the bitmap block, let F_i are elements of the reconstructed or decoding image which is made with two values "T_1" and "T_2" for each block.

$$F_i = \begin{matrix} T_1 & if & P_i = 1 \\ T_2 & if & P_i = 0 \end{matrix} \text{.....(5)}$$

Vector quantization algorithm:

There are two types of quantization- scalar and vector quantization. In first type, each input symbol is treated separately to find the output, while in second (i.e. VQ) the input symbols are clubbed together in groups (vectors), and processed to give the output [2]. The main system for this method is illustrated in Fig. 1 and as follows;

1. The encoder takes an input vector.
2. Then this vector is compared with all the code vectors in the codebook and best match is found.
3. The index (i) of the selected code vector is sent to the decoder, where the decoder has same codebook.
4. The decoder receives this index and outputs the code vector using a look-up table operation.

In other word, the aim of the best match in VQ design is to minimize the distortion between the input vectors X_j and the code vectors Y_j which is defined by this equation [2,4].

$$d(X,Y) = \sqrt{\sum_{j=1}^{m}(X_j - Y_j)^2} \text{-----(6)}$$

Where X_j and Y_j standard for the jth component of the vectors.

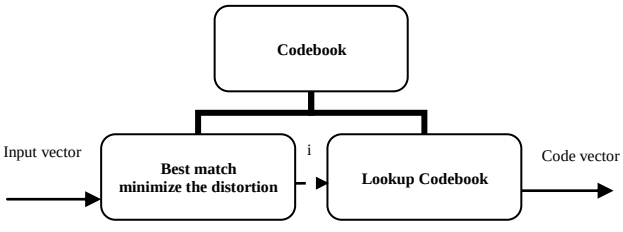

Fig.1: The coding and decoding in a vector quantize method.

A major matter in VQ is to design a codebook where many codebook design algorithms have been presented in order to reconstruct image of edges with no visible degradation. This is frequently depends on the block size, the size of the codebook and structure of the codebook [2].

The average bitmap replacement error (ABPRE):

The average bitmap replacement error (ABPRE) is a good criterion to determine the performance of the compressed method (proposed method) between bitmap P_i produced from applying the conventional AMBTC method on an image and that produced from coding the bitmap using VQ method [6] depending on our propose method V_i. For each 4x4 block, the difference in the bitmap (Δβ) is computed by;

$$\Delta\beta = \sum_{i=1}^{m} (P_i - V_i)^2 \text{.....(7)}$$

The BPRE for block is computed according on this condition;

If $\Delta\beta > 4$ then BPRE=1, otherwise BPRE=0, and the ABPRE for all image blocks is;

$$ABPRE = \frac{1}{nb} \sum_{i=1}^{nb} BPRE_i \text{.....(8)}$$

nb is no. of blocks in an image.

One can use another good performance criterion, such as the Mean Squared Error (MSE) and Peak Signal to Noise Ratio (PSNR) [3]. Where MSE between the decoding image (F_i) and original image (X_i) is defined as follows;

$$MSE = \frac{1}{M} \sum_{i=1}^{M} (X_i - F_i)^2 \text{.....(9)}$$

Where M is the number of elements in an image. The PSNR is defined as follows;

$$PSNR = 20\log_{10}\left[\frac{(255)}{\sqrt{MSE}}\right] \text{.....(10)}$$

The proposed method:

The aim of this paper is to find a set of code vectors (codebook) for different images. The following steps describe the method of binary codebook design for the images;

Step1. Initialization chose binary codebook size (no. of code vectors, N), block size and distortion threshold.

Step2. Apply AMBTC on many images and find the bitmap for each image.

Step3. The binary code vectors can be randomly chosen from the set of binary vectors of these bitmaps of different images.

Step4. Use the VQ method to further compress these bitmaps, Use the full search on each block in each bitmap using the binary codebook, which is designed in step 3,in order to finding out the closest binary code vector.

Step5. The ABPRE is computed for each image.

Materail and Methods:

In the present paper, we study the use of vector quantization in the AMBTC coding algorithm, this is more efficient than using a fixed AMBTC method. In fact, we have utilized vector quantization method to further minimize the bit rate, at the same time, maintain the quality of reconstruction image. Here the quality of the reconstruction image depends on the binary codebook used in VQ technique, where this binary codebook can be engender for many images depending on randomly chosen to the code vectors from a set of binary images vectors (bitmaps of these images), and this codebook is then used to compress all bitmaps. The chosen of the bitmap of image in order to compress it by using this codebook in high quality based on the criterion of the

average bitmap replacement error (ABPRE).

Results and Discussion:

The mentioned coding algorithm has been implemented on many images (i.e. Yasser, House, Jett and Moon), shown in fig. 2, they have been coded with the proposed method for generating binary codebook of size 64 code vectors, and the resulting of decoding bitmaps are much better when the values of criterion (i.e. the average bit map replacement error (ABPRE)) are smaller, where the smallest value of this criterion means that the proposed method causes less error and it is good for minimize the MSE and increase the PSNR (less distortion in decoding images or high quality) with low bit rate. From table 1, we have shown that the quality of reconstructed image (PSNR) of Jett image which has small ABPRE is always better than that of House, Moon images for the same codebook size (64 code vector), and these is better than Yasser image, see fig.2,3 and table 1. In other word, improving image quality and the criterion of the average bitmap replacement error (ABPRE) is a trade off mater.

Finally, by comparing the criterion values for different images, it can easily be seen that; a far better performance, (smallest value of the criterion), is achieved when our presented algorithm is performed on image which has high inter- pixel correlation (little variation among image points).

Fig.2; The standard images of a. Yasser, b. Hose, c. Jett d. Moon, of size 64 x 64.

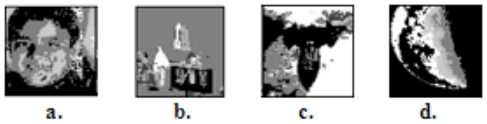

Fig.3; The reconstruction images using the proposed method, with block size 4 x 4 and 64 codebook size, a. ABPRE= 0.98 , b. ABPRE= 0.89, c. ABPRE= 0.50, d. ABPRE= 0.80.

Table 1, illustrate our conclusions for the coding results of the mentioned algorithm on many images.

Image	RMSE	ABPRE	PSNR(dB)
Yasser	13.99	.98	25.41
Hose	11.77	.89	26.0
Jett	1.11	.50	33.03
Moon	11.30	.80	26.57

References:

[1] Yoshida K. and Reif J.H.. 1994. " Optical computing techniques for image/video compression", Proceedings of the IEEE, 82(6):948-954.

[2] Du W. C. and Hsu W.-J.. 2003. " Adaptive data hiding based on VQ compressed images", IEEE Proc.-Vis. Image signal process., 150(4):233-238.

[3] Lema M. D. and Mitchell O. R.. 1984. " Absolute moment block truncation coding and its application to color images", IEEE Transactions on Communications, COM-32(10):1148-1157.

[4] Linde Y., Buzo A., and Gray R. M.. 1980. " An algorithm for vector quantizer design", IEEE Transactions on Communications, COM- 28(1): 84-95.

[5] Amarunnishad T. M., Govindan V. K. and Abraham T. Mathew. 2008. " Use of Fuzzy edge image in block truncation coding for image compression", International Journal of Signal Processing, 4(3): 215-221.

[6] Sindhu M., Rajkamal R.. 2009. " Images and Its Compression Techniques– A Review", International Journal of Recent Trends in Engineering, 2(4):71-75.

خوارزمية توليد كتاب تشفير ثنائي بالاعتماد على معيار ال ABPRE

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الخلاصه:

في هذا البحث, تم استخدام خوارزمية لتوليد كتاب تشفير ثنائي في تقنية تكميم المتجهات (التي استخدمت لتحسين قابلية طريقة (AMBTC)), حيث تم استخدام طريقة تكميم المتجهات لضغط ألـ bitmap (الناتجة من تنفيذ الطريقة الأولى (AMBTC). في هذا البحث, كتاب التشفير الثنائي يمكن أن يولد لمجموعة صور بالاعتماد على الاختيار العشوائي لمتجهات التشفير من مجموعة متجهات الصور الثنائية, ثم استخدم كتاب التشفير هذا لضغط كل الصور الثنائية bitmaps لتلك الصور. اختيار الصورة الثنائية لصورة ليتم ضغطها باستخدام كتاب التشفير هذا يكون على أساس المعيار ABPRE. هذا البحث مناسب لتقليل نسب البت (زيادة معدلات الضغط) مع انخفاض قليل أو مهمل لنسبه الإشارة إلى الضوضاء (PSNR).