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Color Image Compression Using Block Truncation Coding For Fast Decoding

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ABSTRACT: Blok truncation coding (BTC) has been considered a highly efficient compression technique for decades. In the present era of multimedia, the requirement of color image storage and transmission for video conferencing, image and video retrieval, video playback, etc. Block truncation coding (BTC) is a lossy image compression technique which uses moment preserving quantization method for compressing digital color level image. A modified BTC using max-min quantization is proposed in this paper to overcome the mentioned drawbacks.

KEYWORDS: Image compression, Block Truncation coding, Modified Block Truncation coding

I. INTRODUCTION

The rising multimedia technology and growth of GUI based software have made digital image data an inherent part of modern life. When a 2-D light intensity function is sampled and quantized to create a digital image, the amount of data generated may be large in volume that it results intremendous storage, processing and communication requirements. Therefore, the theory of data compression becomes more and more important for reducing the data redundancy to save more hardware space and transmission bandwidth.

In computer science and information theory, data compression is the process of encoding information using less number of bits or some other information bearing units. Compression is useful as it helps to reduce the consumption of expensive resources such as hard disk space or transmission bandwidth [1] [2]. BTC is a simple and fast lossy compression technique for gray scale images. The basic idea of BTC [3] is to perform moment preserving quantization for blocks of pixels. The input image is divided into non-overlapping blocks of pixels of sizes 4×4, 8×8 and so on. Mean and standard deviation of the blocks are calculated. Mean is considered as the threshold and reconstruction values are determined using mean and standard deviation.

Then a bitmap of the block is derived based on the value of the threshold which is the compressed or encoded image. Using the reconstruction values and the bitmap the reconstructed image is generated by the decoder. Thus in the encoding process, BTCproduces a bitmap, mean and standard deviation for each block. It gives a compression ratio of 4 and bit rate of 2 bits per pixel when a 4×4 block is considered. This method provides a good compression without much degradation on the reconstructed image. But it shows some artifacts like staircase effects or raggedness near the edges. Due to its simplicity and easy implementation, BTC has gained wide interest in its further development and application for image compression.

To improve the quality of the reconstructed image and for the better compression efficiency several variants of BTC have been developed during the last many years. Absolute Moment Block Truncation Coding (AMBTC)[4] preserves the higher mean and lower mean of each block and use this quantity to quantize output. AMBTC provides better image quality than image compression using BTC. Moreover, the AMBTC is quite faster compared to BTC. The algorithm is computationally faster because it involves simple analytical formulae to compute the parameters of the edge feature in an image block. Reconstructed images are of good quality in accordance with human perceptual experience. The algorithm represents the image in terms of its binary edge map, mean information, and the intensity information on both sides of the edges.

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II. LITRATURE SURVEY

Jing-Ming Guo et al. [1], Block truncation committal to writing (BTC) has been thought of extremely economical compression technique for many years. How- ever, its inherent artifacts, interference impact and false contour, caused by low bit rate configuration are the key issues. To cope with these, Associate in nursing improved BTC, particularly dot-diffused BTC (DDBTC), is planned during this paper. Moreover, this technique will givewonderful process potency by exploiting the character similarity advantage of the dot diffusion, and wonderful image quality also can be offered through co-optimizing the category matrix and subtle matrix of the dot diffusion. Per the experimental results, theplanned DDBTC is superior to the previous error-diffused BTC in terms of variedobjective image quality assessment strategies still as process potency. Additionally, the DDBTC additionally shows a major image quality improvement scrutiny thereupon ofthe previous ordered-dither BTC.
Jayamol Mathews et al. [2], with the emerging multimedia technology, image data has been generated at high volume. It is thus important to reduce the image file sizes for storage and effective communication. Block Truncation Coding (BTC) is a lossy image compression technique which uses moment preserving quantization method for compressing digital gray level images. Even though this method retains the visual quality of the reconstructed image with good compression ratio, it shows some artifacts like staircase effect, raggedness, etc. near the edges. A set of advanced BTC variants reported in literature were studied and it was found that though the compression efficiency is good, the quality of the image has to be improved. A modified Block Truncation Coding using max-min quantizer (MBTC) is proposed in this paper to overcome the above mentioned drawbacks. In the conventional BTC, quantization is done based on the mean and standard deviation of the pixel values in each block. In the proposed method, instead of using the mean and standard deviation, an average value of the maximum, minimum and mean of the blocks of pixels is taken as the threshold for quantization. Experimental analysis shows an improvement in the visual quality of the reconstructed image by reducing the mean square error between the original and the reconstructed image. Since this method involves less number of simple computations, the time taken by this algorithm is also very less when compared with BTC.
Seddeq E. Ghrare et al. [3], with the continuing growth of modern communication technologies, demand for image data compression is increasing rapidly. Techniques for achieving data compression can be divided into two basic approaches: spatial coding and Transform coding. This research paper presents a proposed method for the compression of digital images using hybrid compression method based on Block Truncation Coding (BTC) and Walsh Hadamard Transform (WHT). The objective of this hybrid approach is to achieve higher compression ratio by applying BTC and WHT. Several grayscale test images are used to evaluate the coding efficency and performance of the hybrid method and compared with the BTC and WHT respectively. It is generally shown that the proposed method gives better results.
Ki-Won Oh et al. [4], this paper presents a parallel implementation of hybrid vector quantizer-based block truncation coding using Open Computing Language (OpenCL). Processing dependency in the conventional algorithm is removed by partitioning the input image and modifying neighboring reference pixel configuration. Experimental results show that the parallel implementation drastically reduce processing time by 6~7 times with significant visual quality improvement.

III. MATERIAL AND METHODS

- Modified BTC Method

The encoding method of VQ is time consuming, whereas its decoding method uses table look-up method and is very fast. This method results in higher compression ratio, though quality of the reconstructed image is usually not as good as BTC. BTC is a simple and fast method, which enables high quality reconstruction but bit-rate is also high. Comparatively, the encoder of BTC is faster than that of VQ, while its decoder is little slower. A compromise between these two methods gives a fast decoder, maintains good quality for reconstructed image with moderate bit-rate. Again, this hybrid method can also be used in image feature extraction. That means the compressed data due to this method can directly be used to compute image features like, edge [5-6], and so on.
The method of selection of the best fit pattern for an image block B of size $n \times n$ is as follows. For an image block B, let the pixels coordinates are $x_1, x_2, \ldots\ldots\ldots x_{n2}$ and the corresponding pixel intensities are $f(x_i)$. Available patterns

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are, say, $P_1, P_2 ...., P_M$ of size $n \times n$ and the levels present in a pattern are represented by t where $1 \le t \le Q$. Thus, any pattern is represented as

$$km_1 = k'(A-d)+(k-k')(A+d) \quad (1)$$

$$km_2 = k'(A-d)^2 + (k-k')(A+d)^2 \quad (2)$$

Solving for A and d we get

$$A = m_1 + \frac{\sigma(2k'-k)}{2\sqrt{k'(k-k')}} \quad (3)$$

$$d = m_1 + \frac{\sigma k}{2\sqrt{k'(k-k')}} \quad (4)$$

Hence, intensity $\hat{f}(x_i)$ of the pixels of the corresponding block in the reconstructed image is given by

$$\hat{f}(x_i) = \begin{cases} A+d & if\ x_i \in C_1 \\ A-d & if\ x_i \in C_1 \end{cases} \quad (5)$$

It is clear that a = A − d and b = A + d, where a and b are the quantization levels for partition.

IV. EXPERIMENTAL ANALYSIS

Performance of the MBTC and BTC-PF has been evaluated for a set of standard test images, viz., ‘lena256’, ‘cameraman’, and ‘lena512’. The first two images are of size 256×256 and other image is of size 512×512. MBTC and BTC-PF is compared with conventional BTC. Table I shows the comparative performance results of BTC, MBTC and BTC-PF. The performance is measured based on three parameters PSNR and CR. From Table I, it is seen that performance of the method MBTC and BTC-PF is better than BTC algorithm on the basis of the two performance measures. For all the test images with 4×4, 8×8 and 16×16 blocks, though the compression ratio is same as that of BTC, PSNR and values are high when compared with BTC. It shows an enhancement in the visual quality of the reconstructed image.

In certain images where the edges are not very distinct because of the inherent blurriness of the pixel values due to the nature of the images, the edge positions may or may not be accurate.

Figure 1: (a) Original Image ‘Lena’; reconstructed image (4×4 block) using (b) BTC, (c) MBTC

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Figure 2: (a) Original Image ‘Lena’; reconstructed image (8×8 block) using (b) BTC, (c) MBTC

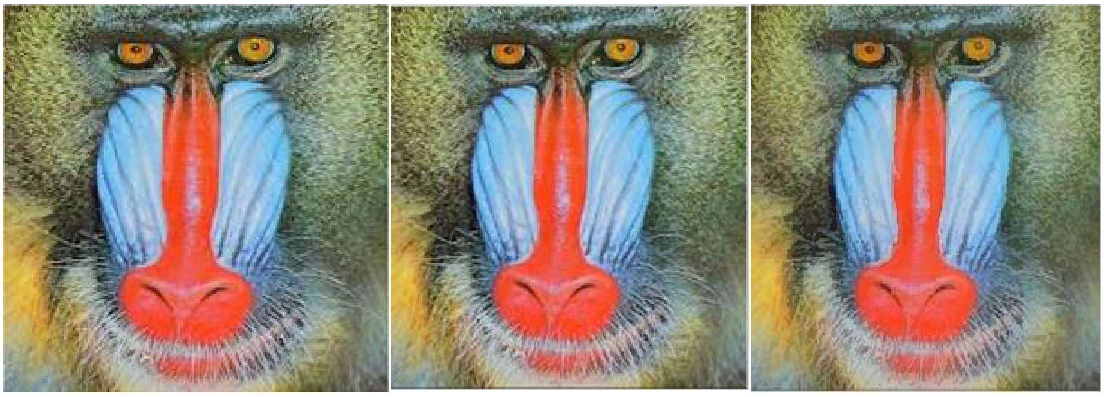

Figure 3: (a) Original Image ‘barb’; reconstructed image (4×4 block) using (b) BTC, (c) MBTC

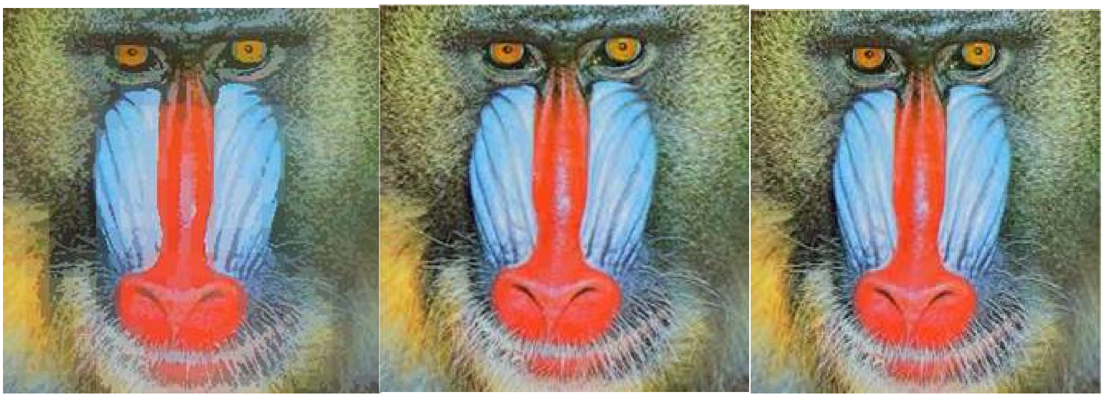

Figure 4: (a) Original Image ‘barb’; reconstructed image (8×8 block) using (b) BTC, (c) MBTC

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TABLE I: Comparative Performance Results Of BTC, MBTC and BTC-PF Algorithms

Image	Method	Block Size 4		Block Size 8		Block Size 16	
		PSNR	MSE	PSNR	MSE	PSNR	MSE
Lena (256×256)	BTC	26.1870	12.8857	23.2611	21.4482	21.2497	30.1592
	MBTC (Gray scale)	31.0293	13.7957	28.0011	22.5287	25.7397	31.9996
	MBTC (Color scale)	36.5018	14.6657	34.2859	24.4283	32.8552	33.9596
Cameraman (256×256)	BTC	24.2787	24.3667	22.0288	34.4583	20.608	40.9996
	MBTC (Gray scale)	29.7992	24.8611	27.5040	36.4483	25.3539	42.9793
	MBTC (Color scale)	30.5689	24.9657	28.2531	38.4783	26.1245	43.9596
Barb (256×256)	BTC	29.0602	33.5816	25.7395	46.3119	23.1014	55.3655
	MBTC (Gray scale)	33.6711	34.4756	30.4800	47.4129	27.8683	57.9645
	MBTC (Color scale)	32.6905	35.2716	31.2441	49.2119	30.4005	59.7625

Table II: Comparison Result of the previous algorithm and proposed algorithm

Image of Size 512*512	Previous Algorithm C. Senthilkumar et al. [1]		Proposed Algorithm	
	PSNR(dB)	Compression Ratio (CR)	PSNR (dB)	Compression Ratio (CR)
Satellite Image	34.17	18.3%	46.44	23.57%
Lena Image	38.45	32.6%	44.84	59%
Baboon Image	35.97	54.54%	41.06	70.95%
Class Image	36.53	29.26%	33.1539	33.50%
Bike Image	37.20	38.88%	44.85	51.47%
Real Image	39.41	27%	42.81	41.32%

V. CONCLUSION

The objective of this paper is to develop an image compression method for which the decoder would be very efficient. Such method is suitable in situations where image or image is compressed once but decoded frequently.It is clear that the decoding time due to spatial domain based compression is much less than that of the sub-band compression techniques. The performance can be attributed to the use of the inherent parallelism of the dot diffusion and the proposed co-optimization procedure over the class matrix and diffused matrix.

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