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Survey of Digital Colour Image Compression using Block Truncation Code

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Abstract- In the present era of multimedia, the requirement of image/video storage and transmission for video conferencing, image and video retrieval, video playback, etc. are increasing exponentially. As a result, the need for better compression technology is always in demand. Modern applications, in addition to high compression ratio, also demand for efficient encoding and decoding processes, so that computational constraint of many real-time applications is satisfied. Two widely used spatial domain compression techniques are block truncation coding (BTC) and vector quantization (VQ). BTC method results in good quality image with high bit-rate, while the VQ is well known for low bit-rate but produces poor quality images. In further work of this paper is multi-level BTC includes BTC algorithm as well as vector quantization method for purpose of multi-level technique for gray and color image.

Keywords— Block Truncation Code (BTC), PSNR, Block Size, Compression Ratio

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 in tremendous storage, processing and communication requirements. Along these lines, the hypothesis of information pressure turns out to be increasingly essential for decreasing the information repetition to spare more equipment space and transmission data transfer capacity.

In software engineering and data hypothesis, information pressure is the way toward encoding data utilizing less number of bits or some other data bearing units. Pressure is valuable as it decreases the utilization of costly assets, for example, hard plate space or transmission data transfer capacity [1] [2]. BTC is a basic and quick lossy pressure method for dark scale pictures. The essential thought of BTC [3] is to perform minute protecting quantization for squares 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, BTC produces 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.

II. LITERATURE SURVEY

C.Senthil kumar et al. [1], In this paper, image compression plays vital role in saving memory storage space and saving time while transmission
images over network. The color and multispectral image is considered as input image for the image compression. The proposed technique with Enhanced Block Truncation Coding [EBTC] is applied on component of color and multispectral image. The component image is divided into various sub blocks. After evaluating mean values, the number of bits can be reduced by Enhanced Block Truncation Coding. Finally, compression ratio table is generated using the parameters such as MSE, SNR, PSNR, CR, BR and CT. The proposed method is implemented through standard color and multispectral images using MATLAB Version 8.1 R2013a.

Jing-Ming Guo et al. [2], Block truncation committal to writing (BTC) has been thought of extremely economical compression technique for many years. Moreover, this method can provide excellent processing efficiency by exploiting the nature parallelism advantage of the dot diffusion, and excellent image quality can also be offered through co-optimizing the class matrix and diffused matrix of the dot diffusion. According to the experimental results, the proposed DDBTC is superior to the former error-diffused BTC in

terms of various objective image quality assessment methods as well as processing efficiency.
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.

Jayamol Mathews et al. [3], 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. [4], 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. [5], 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.

S. No.	Title and Publication	Methodology	Advantage and disadvantage
1.	Color and Multispectral Image Compression using Enhanced Block Truncation Coding [E-BTC] Scheme, IEEE 2016	Image compression using enhance block truncation code	Good technique for gray scale image and less PSNR
2.	Improved Block Truncation Coding Using Optimized Dot Diffusion, IEEE 2014	Image compression using dot diffusion method	Image compression ratio is good but more computation time
3.	Modified BTC Algorithm for Gray Scale Images using max-min Quantizer, IEEE 2013	Image compression using modified BTC technique	Good PSNR for gray scale image and high MSE
4.	Digital Image Compression using Block Truncation Coding and Walsh Hadamard Transform Hybrid Technique, IEEE 2014	Image compression using BTC and walsh hadamard transform	Good MSE and low compression ratio
5.	Parallel Implementation of Hybrid Vector Quantizerbased Block Truncation Coding for Mobile Display Stream Compression, IEEE 2014	Image compression using hybrid vector quantization	Good image quality and higher bit rate

III. MATERIAL AND METHODS

- BTC-VQ 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 are, say, $P_1, P_2 \ldots\ldots\ldots\ldots, P_M$ 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

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

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

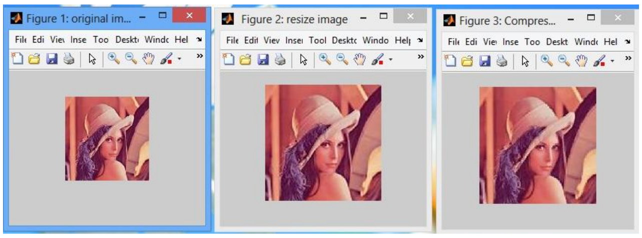
Hence, intensity $\hat{f}(x_i)$ of the pixels of the corresponding block in the reconstructed image is given by

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

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 multi-level BTC have been evaluated for a set of standard test images, viz., 'lena 256×256', 'cameraman 256×256', and 'bird 256×256'. Figure 5.1; show the Lena image of 4×4 block pixel. In this figure 1 (a) show the random image of the Lena image and resize the image of the 256×256 in the Lena image show in figure 1 (b). The compressed image is 4×4 block pixel of Lena image shown in figure 1 (c) respectively.



(a) (b) (c)

Figure 1: Multi-level BTC Algorithm applied on Lena Image of block size 4×4

Figure 2; show the Cameraman image of 4×4 block pixel. In this figure 2 (a) show the random image of the Cameraman image and resize the image of the 256×256 in the dog image show in figure 2 (b). The compressed image is 4×4 block pixel of Cameraman image shown in figure 2 (c) respectively.

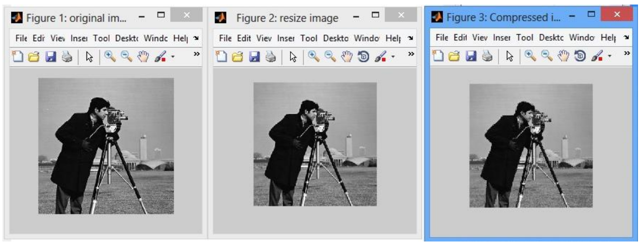


Figure 2: Multi-level BTC Algorithm applied on Cameraman Image of block size 4×4

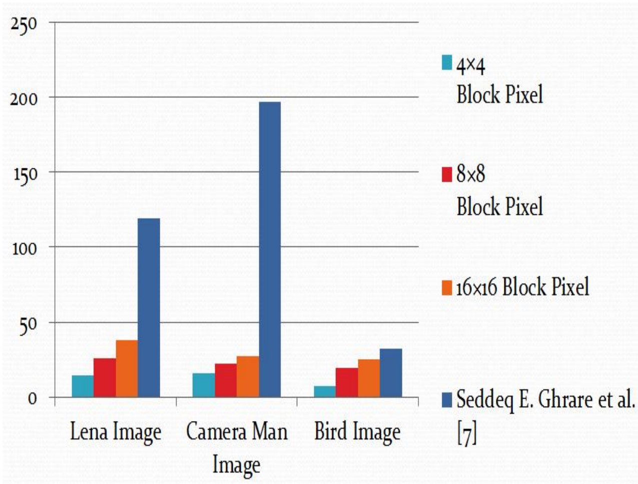


Figure 4: MSE for Different methods using Lena, Camera Man and Bird Image

Table 2: Experimental Results for Peak to Signal Noise Ratio (PSNR)

Image of Size 256*256	4×4 Block Pixel	8×8 Block Pixel	16×16 Block Pixel	Seddeq E. Ghrare et al. [7]
Lena Image	36.7432 dB	34.0577 dB	32.3318 dB	25.31 dB
Cameraman Image	36.0815 dB	35.2821 dB	33.7803 dB	25.20 dB
Bird Image	39.3053 dB	36.4129 dB	34.1411 dB	33.10 dB

Figure 3; show the Bird image of 4×4 block pixel. In this figure 3 (a) show the random image of the Bird image and resize the image of the 256×256 in the Bird image show in figure 3 (b). The compressed image is 4×4 block pixel of Bird image shown in figure 3 (c) respectively.

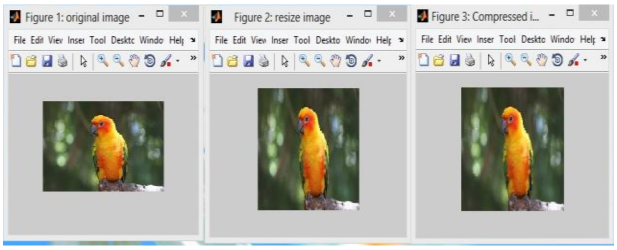


Figure 3: Multi-level BTC Algorithm applied on Bird Image of block size 4×4

Table 1: Experimental Results for Mean Square Error (MSE)

Image of Size 256*256	4×4 Block Pixel	8×8 Block Pixel	16×16 Block Pixel	Seddeq E. Ghrare et al. [7]
Lena Image	14.1763	25.7597	38.3286	119.24
Camera Man Image	16.1557	22.2821	27.4443	196.70
Bird Image	7.6926	19.4129	25.2992	31.96

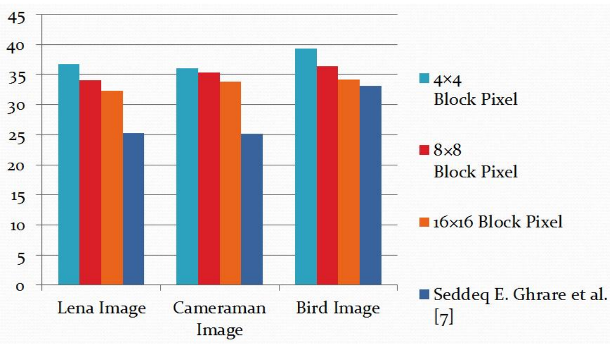


Figure 5: PSNR for Different methods using Lena, Camera Man and Bird Image

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. Two widely used spatial domain compression techniques are block truncation coding (BTC) and vector quantization (VQ). BTC method results in good quality image with high bit-rate, while the VQ is well known for low bit-rate but produces poor quality images. In his paper the study of different types of technique for image compression. In this paper implementation of the proposed algorithm and results are based on that algorithm is discussed for the different block size i.e. 4*4, 8*8 and 16*16.

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