Grayscale Image Compression Based on Min Max Block Truncating Coding

Mr.Hilal Almara'beh[1], Mr.Khalil Barhoum [2], Mr.Majdi Ahed[3]

[1] Computer Science Department, Isra University
Amman,11622, Jordan

[2] Computer Science Department, Isra University
Amman,11622, Jordan

[3] Software Engineering Department, Isra University
Amman, 11622, Jordan

Abstract

This paper presents an image compression techniques based on block truncating coding. In this work, a min max block truncating coding (MM_BTC) is presented for grayscale image compression relies on applying dividing image into non-overlapping blocks. MM_BTC differ from other block truncating coding such as block truncating coding (BTC) in the way of selecting the quantization level in order to remove redundancy. Objectives measures such as: Bit Rate (BR), Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), and Redundancy (R), were used to present a detailed evaluation of MM_BTC of image quality.

Keywords: *BTC, MM_BTC, Bit Rate, MSE, PSNR.*

1. INTRODUCTION

Image compression is an important tool to reduce the bandwidth and storage requirements of practical image systems such as multimedia, communication, medical images, education and business etc. The image compression techniques are categorized into two main classification namely lossy compression techniques and lossless compression techniques [1]. Lossy compression techniques lead to loss of data with higher compression [2] whereas the lossless compression ratio gives good quality of compressed images, but yield only less compression. BTC [3] is a lossy image compression technique, which reduce bit rate and preserving the low computational complexity [4].

The original algorithm of BTC preserves the mean and the standard deviation [5]. The truncated block of the BTC is the one-bit output of the quantizer for every pixel in the block.

In this paper we proposed a min max block truncating coding using the block diagonal for grayscale image compression which provides a better image quality.

2. BTC ALGORITHM

Block truncating coding (BTC) was introduced by Delp and Mitchell in 1979 [6]. In the BTC algorithm the input image is divided into non-overlapping block of size $m\times n$ pixels. Figure.1 shows the diagram of BTC for grayscale image compression.

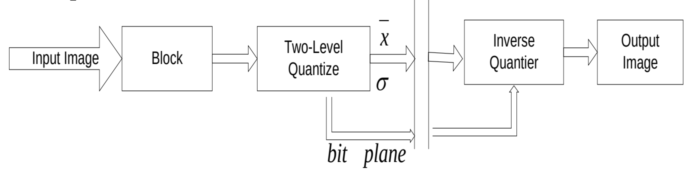

Figure 1.The original BTC System.

The BTC algorithm involves the following steps:

a. The input image is divided into non-overlapping block of size $m\times n$ pixels.

b. For a two level (1 bit) quantizer select mean ($\bar{x}$) and standard deviation (σ) values to represent each pixel in the block.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad (1)$$

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \qquad (2)$$

Where x_i represents the i^{th} pixel value of the image block and n is the total number of pixels in that block.

c. The two values $\bar{x}$ and σ are termed as quantizers of BTC. Taking $\bar{x}$ as the threshold value a two level bit plane is obtained by comparing each pixel value x_i with the threshold.

$$B = \begin{cases} 1 & x_i \geq \bar{x} \\ 0 & x_i \prec \bar{x} \end{cases} \quad (3)$$

Where B is a binary block used to represent the pixels.

d. Inverse quantizer of an image is reconstructed by replacing '1's in the bit plane with U and the '0's with L, which are given by:

$$U = \bar{x} + \sigma\sqrt{\frac{k}{y}} \quad (4)$$

$$L = \bar{x} - \sigma\sqrt{\frac{k}{y}} \quad (5)$$

Where k and y are the number of 0's and 1's in the compressed bit plane respectively.

3. MM_BTC ALGORITHM

The proposed method improves not only bit rate but also the performance of BTC. The MM_BTC simple as BTC but uses a maximum and minimum diagonal of a block. The MM_BTC algorithm involves the following steps:

1. The input image is divided into non-overlapping block of size $m \times n$ pixels.
2. For a two level (1 bit) quantizer select the maximum and the minimum diagonal values to represent each pixel in the block.

$$R = \frac{\max(x_{i=j}) + \min(x_{i=j})}{\sqrt{n}} \quad (6)$$

Where x represents the i[th] pixel value of the image block and n is the number of divided blocks (2, 4, 8, etc). And R is termed as quantizer of MM_BTC.

3. Binary block denoted by B is also used to represents the pixels. We can use "1" to represent a pixel whose gray level is greater than or equal to R and "0" to represents a pixel whose gray level is less than R.

$$B = \begin{cases} 1 & x_i \geq R \\ 0 & x_i \prec R \end{cases} \quad (7)$$

4. Inverse quantizer of an image is reconstructed by replacing '1's in the bit plane with U and the '0's with L, which are given by:

$$U = R\sqrt{\frac{k}{y}} \quad (8)$$

$$L = R\sqrt{\frac{k}{y}} \quad (9)$$

Where k and y are the number of 0's and 1's in the compressed bit plane respectively.

MM_BTC has two advantages over BTC; the first is in the case that the quantizer is used to transmit an image form sender to a receiver, it is necessary to compute at the sender the two quantities, the mean and the standard deviation for BTC while it needs to compute one quantity for MM_BTC. Second when we compare the necessary computation for deviation information, it is necessary to compute a sum of m values and each of them will be squared while in case of MM_BTC it is only necessary to compute the maximum and minimum diagonal of these m values.

4. OBJECTIVE QUALITY MEASURMETNS

Image quality measures are important roles in various images processing application. Once image compression system has been designed and implemented, it is important to evaluate the compression performance and perceptual quality. Objective measures [7, 8] of image quality metrics, some statistical indices are calculated to indicate the image quality, such as mean square error (MSE), peak signal to noise ratio (PSNR) and bit rate (BR).

4.1 Mean Square Error (MSE)

The mean square error represents the mean squared error between the compressed and the original image. If the reconstructed image is close to the original image, then *MSE* is small. This means the lower value of *MSE*, the lower error. *MSE* given by:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left[x(i,j) - y(i,j)\right]^2 \quad (10)$$

4.2 Peak Signal to Noise Ratio (PSNR)

The *PSNR* is an interactive measure and it is most commonly used as measure of quality of reconstruction of loss compression. If the reconstructed image is close to the original image, then PSNR is large value. This means the higher the *PSNR*, the better the quality of the compressed or reconstructed image. *PSNR* given by:

$$PSNR = 10.\log_{10}\left(\frac{255 * 255}{MSE}\right) \quad (11)$$

4.3 Bit Rate (BR)

The performance indicator of image compression can be specified in terms of compression efficiency. Compression efficiency is measured by the compression ratio or by the bit rate. The compression ratio *CR*, which means that the compressed image is stored using only *CR*% of the initial storage size; the bit rate is the number of bits per pixel required by the compressed image. Compression ratio given by:

$$CR = \frac{Size(x)}{Size(y)} \quad (12)$$

Where x is the original image and y is the compressed image.

And the bit rate given by:

$$BR = \frac{b}{CR} \quad (13)$$

Where b: the number of bits per pixel (bit depth) of the uncompressed image.

5. EXPERMENTAL RESULTS

We have taken the results of 6 images (512*512, 8 bit per pixels) Lena, Cameraman, Woman, Peppers, baboon and Lifting-body, obtained by running both the proposed method and BTC. Results are obtained in terms of bit rate, MSE, and PSNR when a block size 8*8. These values are listed in Table.1.

Table.1 Comparison results between MM_BTC and BTC

Image	Method	Bit Rate	MSE	PSNR
Lena	MM_BTC	1.04	15.7975	36.1449
	BTC	1.04	18.1300	35.5468
Cameraman	MM_BTC	1.04	15.6503	36.1856
	BTC	1.04	17.3780	35.7308
Woman	MM_BTC	1.04	8.6558	38.7564
	BTC	1.04	9.1936	38.4959
Peepers	MM_BTC	1.04	14.7380	36.4464
	BTC	1,04	17.0919	35.8029
Baboon	MM_BTC	1.04	24.2043	35.2014
	BTC	1.04	25.6533	34.0394
Lifting-body	MM_BTC	1.04	5.0843	41.0685
	BTC	1.04	6.3547	40.0998

The table assures that the image compression using Figure.3 Compressed images using MM_BTC MM_BTC provides better image quality than image compression using BTC. Figure.2 shows the original image, figure.3 shows the compressed image using MM_BTC and figure.4 shows the compressed image using BTC. Figure 5 and 6 shows a comparison chart of MSE and PSNR results.

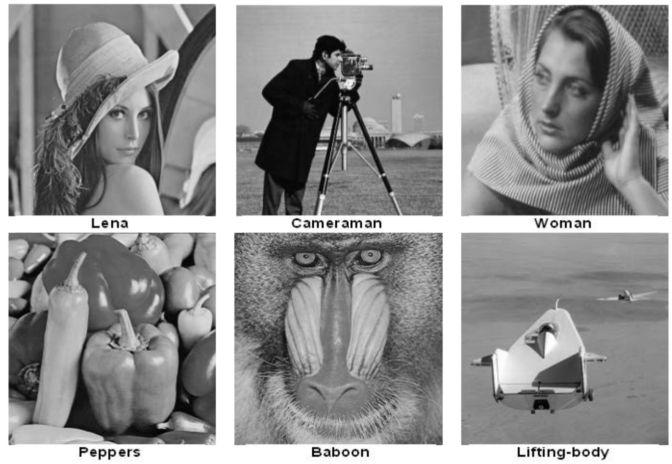

Figure.2 The original image

Figure.3 Compressed image using MM_BTC

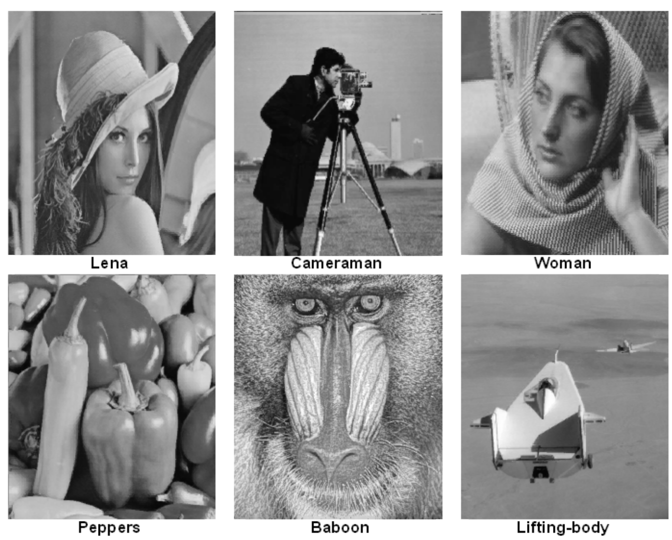

Figure.4 Compressed image using BTC

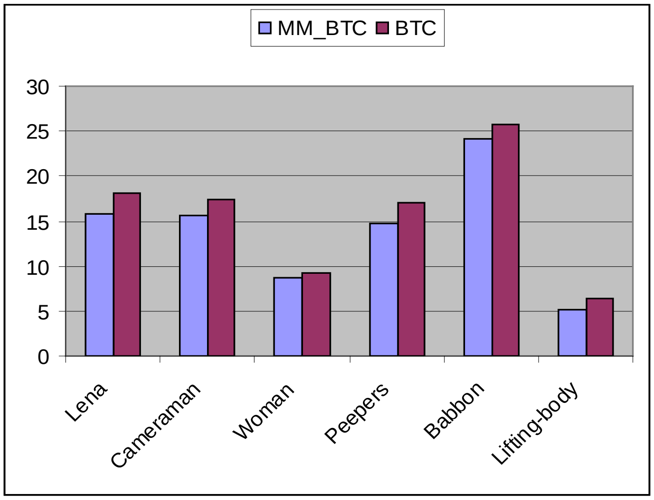

Figure.5 Comparison of the MSE results

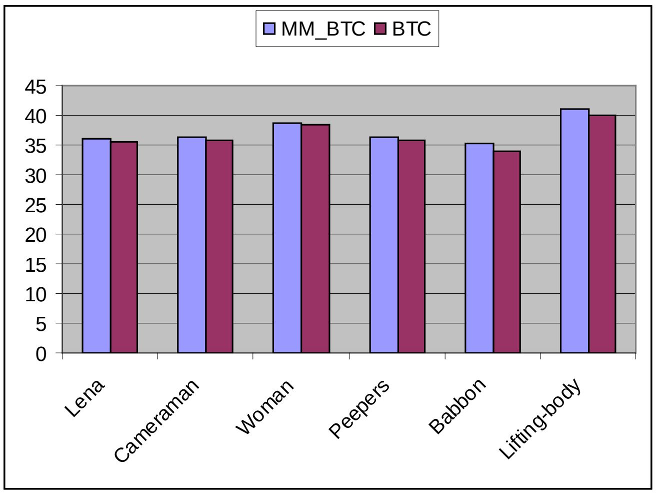

Figure.6 Comparison of the PSNR results

6. CONCLUSION

We have presented a new algorithm for compression of loss grayscale images which achieves good results than BTC. Image measures (bit rate, MSE and PSNR) were used to evaluate the image quality. The result shows that the proposed method provides better image compression than BTC.

REFERENCES

[1] Rafael C. Gonzalez, Richard Eugene; "Digital image processing", Edition 3, 2008, page 466.
[2] M. Ghanbari "Standard Codecs: Image Compression to Advanced Video Coding" Institution Electrical Engineers , ISBN: 0852967101,2003 , CHM , 430 pages.
[3] Delp, E. J., Saenz, M., and Salama, P., 2000, Block Truncation Coding (BTC), Handbook of Image and Video Processing, edited by Bovik A. C., Academic Press, pp. 176-181.
[4] C.Huang and Y.Lin,"Hybrid block truncating ",IEEE Signal Processing Letter, Vol. 4, No. 12,ppt.328-330,1997.
[5] A. M. Eskicioglu and P.S. Fisher, "Image quality measures and their performance," IEEE Trans. Communications, vol. 34, pp. 2959-2965, Dec. 1995.
[6] T.M. Amarunnishad, V.K. Govidan, and T.M. Abraham, "Block truncating coding using a set of predefined bit plans", In proc. Int. Conf. Computational Intellegence and Multimedia Applications (ICCIMA 2007), Dec, 2007, Sevikasi, Tamil Nadu, India, pp.73-78, IEEE,2007.
[7] Somasundaram, K. and I.Kaspar Raj."Low Computational Image Compression Scheme based on Absolute Moment Block Truncation Coding". May 2006. Vol. 13.
[8] W. J. Chen and S. C. Tai, "Postprocessing Techniques for Absolute Moment Block Truncation Coding" Proc. of ICS'98, Workshop on Image Processing and Character Recognition, pp. 125-130, Dec. 17-19, 1998, Tainan, Taiwan.

Hilal Almara'beh received the B.S degree in Computer Science from Isra University, Amman, Jordan, in 2000. He received the M.S. degree in Computer Science from Amman Arab University for Graduate Studies, Amman, Jordan, in 2005. He is currently a lecturer of Computer Science Department, Faculty of Information Technology, Isra University, Jordan. His research interests are image processing and video segmentation, semantic web, grid and cloud computing, and database systems.

Khalil Barhoum received the B.S degree in Computer Engineering from Technical University of Budapest, Hungary , in 1992. He received the M.S. degree in Computer Science from Newyork Institute of Technology, Newyork, USA, in 2005. He worked as an instructor at Heald College, USA, for five years, and he is currently a lecturer of Computer Science Department, Faculty of Information Technology, Isra University. His research interests are security in the software engineering life cycle, image compression, and semantic web.

Majdi Ahed received the B.S and M.S. degree in Computer Science from Jordan University, Amman, Jordan, in 1999, 2001 respectively. He worked as lecturer at Philadelphia University, Computer Science Department, Jordan, for five years, and he is currently a lecturer of Computer Science Department, Faculty of Information Technology, Isra University. His research interests are quality assurance, image processing, and semantic web.