Multilevel Splitting of Images to Improve Coding Efficiency for AMBTC

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***Abstract*— *Image compression has become inevitable as we deal with lot of images which are to be transmitted or stored. Image compression techniques are helpful for reducing the cost associated with transmission and storing of images. Absolute Moment Block Truncation Coding (AMBTC) is one of the fast moment preserving lossy image compression techniques. In this paper, the performance of existing AMBTC is improved in terms of Compression Ratio by multi-level splitting of image into multi-sized blocks. The feature of `inter-pixel redundancy is exploited to improve the coding efficiency. The proposed scheme works out well for benchmark images of varying gray level distribution.*

Keywords*— *AMBTC, Compression ratio, image compression, inter-pixel redundancy, multi-level split.

I. INTRODUCTION

Image compression technique is used to compress digital images. Reduction of data redundancy reduces the cost associated with storage and transmission of data [1]. Generally raw digital images occupy a large amount of memory which leads to massive digital image storage for image archiving in a variety of applications and also takes more time for transmitting such images. Hence image compression techniques have become inevitable now-a-days.

The image compression techniques are categorized into two main types namely lossy and lossless compression techniques [2]. Lossless compression techniques avoid loss of data while compressing images with less compression rate. But the lossy compression techniques yield higher compression rates with acceptable loss of data [3]. In lossy image compression technique, the compressed image is only an approximation of the original image, where it is suitable for Human Visual System.

In the proposed method, a lossy compression technique called Absolute Moment Block Truncation Coding (AMBTC) is enhanced to improve the coding efficiency. AMBTC is a variant of Block Truncation Coding (BTC) [4]. In BTC, the input image is split up into blocks of size 4 x 4 pixels and each block is transformed into Bitplane with 1s and 0s by computing the Mean using the equation (1). The standard deviation is computed using the equation (2).

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

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

where x_i represents the i^{th} pixel value of the image block and m represents the total number of pixels in the block. Two quantizing values q_1 and q_2 are computed using the Mean and the Standard Deviation, and are preserved. Two quantizing values q_1 and q_2 are computed using the equations (3) and (4).

$$q_1 = \overline{X} - \sigma\sqrt{\frac{p}{m-p}} \qquad (3)$$

$$q_2 = \overline{X} + \sigma\sqrt{\frac{m-p}{p}} \qquad (4)$$

Where p is the number of pixels greater than or equal to $\overline{X}$ of the image block.

In proposed method, the higher Mean $\overline{X}_H$ and lower Mean $\overline{X}_L$ are preserved instead of the mean value. Pixels in an image blocks are classified into two groups of values. One group (High mean) comprising of gray levels which are greater than or equal to the mean $\overline{X}$ and the remaining gray levels are brought into another group (Low mean). The computational complexity of BTC is reduced by computing quantizing values which also leads to improved quality of decoded images [5]. The High mean of $\overline{X}_H$ and Low mean of $\overline{X}_L$ are calculated using the equations (5) and (6).

$$\overline{X}_L = \frac{1}{m-q} \sum_{X<x} x_i \qquad (5)$$

$$\overline{X}_H = \frac{1}{q} \sum_{X \geq x} x_i \qquad (6)$$

In the decoding phase, each 1 in the Bitplane is coded with High Mean and the zeros are replaced with Low Mean. The performance of any compression technique is measured in terms of Compression Ratio, Peak Signal to Noise Ratio (quality of the reconstructed image) and, Encoding and Decoding Speed [6]. In the proposed method, multilevel splitting of input image is done to improve the coding efficiency by categorizing the image blocks into Shade and Edge blocks.

The difference between the original image and the reconstructed image is called Mean Square Error (MSE) and is calculated using the equation (7). The Quality of the reconstructed image is measured using Peak Signal to Noise Ratio (PSNR) [7]. PSNR is the inverse of MSE and is calculated using the equation (8).

$$MSE = \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left[I(i,j) - K(i,j) \right]^2 \qquad (7)$$

Where I(i, j) is the reconstructed pixel value, K(i, j) is the original pixel value and m, n is the number of Pixels in an image.

$$PSNR = 10 \log_{10} \left(\frac{255^2}{MSE} \right) \qquad (8)$$

The remaining paper is organized as follows: Proposed method is explained in Section 2, Results are discussed in Section 3 and Section 4 gives the conclusion.

II. PROPOSED METHOD

The input image is initially split up into blocks of size 8x8 pixels. For each block, the Mean is computed and the magnitude SD is computed using the equation (9).

$$SD = \sum_{i=1}^{k} \left(\overline{X} - x_i \right) \qquad (9)$$

If SD is greater than a threshold value ***th***, the block is classified into an Edge block (high detail block) else the block is a Shade block (low detail block). For Shade blocks, respective Mean values are preserved. An Edge block is further split up into blocks of size 4x4 pixels leading to four quadrants. Each quadrant [8] is again classified into Edge or Shade block. For Shade blocks, the Mean Values are preserved and for each Edge block, Bitplane, High Mean and Low Mean values are generated. Preserving Mean Values alone for the Shade blocks improves the Coding Efficiency of the proposed method.

Proposed Algorithm

Step 01: Split the Input Image into blocks of size 8x8 blocks.

Step 02: For each 8x8 block, perform the following:

Step 03: Categorize the block as Edge or Shade.

Step 04: If Shade block, preserve the Mean of the block and go to Step 2

Step 05: Split the 8x8 block into four quadrants each of size 4x4 blocks**.**

Step 07: For each quadrant, perform the following:

Step 08: Categorize each quadrant as either Shade or Edge block.

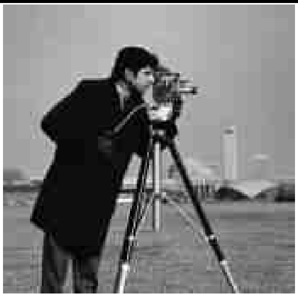
Step 09: If Shade, preserve the Mean of the quadrant. Go to Step 7.

Step 10: Generate Bitplane and compute High Mean and Low Mean.

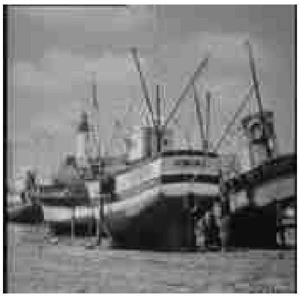
Step 11: Store or Transmit the compressed image in the form of Mean Values for Shade blocks and HighMean and LowMean values for Edge blocks.

III. RESULTS AND DISCUSSION

The proposed method is tested benchmark images such as Cameram, Lena, Airplane, Baboon and Lena. . The input images taken for the study are given in Fig. 1. All the images are of varying gray level distribution. With AMBTC, the bits per pixel (bpp) obtained is 2 which is the same for all images. Because, irrespective of the type of image, for each input block, a bitplane of size 16 bits is generated and two quantizers Q1 and Q2, each of size 8 bits are computed. Hence an original input block of size 128 bits is compressed to just 32 bits which leads to 2 bpp. But in the proposed method, for an input block of size 8x8 pixels, if it is categorized as a Shade block, only the Mean value of size 8 bits is preserved and the Bitplane is omitted for such block. Hence the bpp for a shade block os size 8x8 pixels is only 0.125. If the 8x8 block is categorised as Edge block, it is split up into 4 quadrants. For each Shade block, the bpp is 0.5 and for each Edge block, the bpp is 2. The average bpp obtained for the proposed method is 1.42 which is a significant improvement in the compression ratio. The bpp values obtained for all images are different as the number of Edge and Shade blocks vary for each block. The results in terms of bpp obtained with the AMBTC and proposed methods are given in Table 1.


(a)Lena *(b) Cameraman* *(c) Bridge*



(d) Boats *(e) Kush* *(f) Baboon*

Fig. 1: Input images taken for the study

From Table 1, it is also observed that the PSNR obtained with the proposed method is more or less same as that of the existing AMBTC method. When the compression rate is increased, there will be a decrease in quality of the reconstructed images. With the proposed method, the average bpp has been reduced to 1.46 from 2.00. This is a significant improvement in compression rate. Though the bpp is improved to a greater extent, there is no degradation in the quality. The quality (PSNR) has been reduced only by 0.06, which is a negligible value.

The proposed method is tested with Lena, Cameraman, Boats, Bridge, Baboon and Kush images The results obtained in terms of PSNR and bpp with the proposed method are compared with that AMBTC method in Table.1. The results are generated for two different threshold values.

TABLE 1. Comparison of bpp values with respect to AMBTC and proposed method.

IMAGES	**AMBTC**		**Proposed**	
	PSNR	**bpp**	**PSNR**	**Bpp**
Cameraman	36.15	2.00	35.92	1.05
Airplane	34.54	2.00	35.18	1.32
Baboon	37.73	2.00	37.57	1.81
Kush	36.94	2.00	36.67	1.69
Lena	36.69	2.00	36.40	1.44
Average	**36.41**	**2.00**	**36.35**	**1.46**

IV. CONCLUSION

The proposed method is an improved version of AMBTC in terms of compression ratio. A two-stage compression is achieved with the proposed method by multi level splitting of blocks. By categorizing the blocks in to Shade and Edge blocks, the bit rate is reduced to greater extent. A compression rate of 81.75% has been achieved with the proposed method. The quality of reconstructed images depends on the selection of threshold values. This technique is best suitable for hand-held devices and may also be extended to color images.

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