Image Compression for Color and Multispectral Image using Enhanced BTC

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ABSTRACT
Image Compression is a technique to reduce the number of bits required to represent and store an image. The Block Truncation Coding (BTC) is a streamlined and competent application for image compressions. Even though Simple BTC can apply to make enough compression on gray scale image, it needs to extend another improved version called Enhanced Block Truncation Coding (E-BTC) for color and multispectral image compression[1]. The given color and multispectral image are converted into component image and transformed into matrix format. Then the component image is divided into blocks. After finding block sum value, mean value and variance, the number of bits required to represent an image can be reduced by E-BTC model. The compressed binary values are stored in a table with reconstructed parameters. The binary values with parameters are passed to inverse E-BTC to reconstruct the sub image. The proposed algorithm is repeated for all remaining blocks and all are merged to get completely reconstructed image. Finally, compression ratio table is generated. This proposed E-BTC algorithm is tested and implemented on various parameters such as MSE, SNR, PSNR, BR and CR values. These experiments are carried out on the standard color image and multispectral image without loss of data as well as the quality of the image using MATLAB R2013a version 8.1.

Keywords
Enhanced Block Truncation Coding (E-BTC), multispectral image, component image, SumValue, MeanValue, Mean Square Error (MSE), SNR, Peak Signal to Noise Ratio (PSNR), BRand CR.

1. INTRODUCTION
Color image can be modeled as three band monochrome image data where each band of data corresponds to a different color[11]. Multispectral image are images of the same object taken in different bands of visible or infrared region of the electromagnetic spectrum. Images that are acquired for remote sensing applications are generally known as multispectral in nature. Multispectral image typically contains information outside the normal human perceptual range [04]. This type of image may include infrared, ultraviolet, x-ray, acoustic or radar data. These are not images in the usual sense because the information is not directly visible by the human system.

If more than three bands of information are in the multispectral images, the component classification is applied to separate different component sub image. Most of the satellites currently in orbit collect image information in 2 to 14 spectral bands; Source of these types of images include underwater sonar system, air bone radar, infrared imaging, medical diagnostics imaging system. The basic concept of BTC is one of the most successful techniques that have been used in image compression. It is also used for data reduction and feature extraction analysis [3].

Data compression has been a major issue in today's everywhere commodity computing and communication environment. The main goal of compression is to store higher amount of data using lesser amount of memory space so that the data can be sent over a networks with fewer memory but higher speed and efficiency.

In this paper Section I introduces the basic concept of color and multispectral image compression. Section II describes literature review. Section III discusses Block Truncation Coding pitfalls. Section IV focuses on theoretical foundation for BTC. Section V explains proposed methodology of research work. Section VI explains the experimental results and conclusion was presented in Section VII.

2. LITERATURE REVIEW
Image compression addresses the problem of reducing the amount of data required to represent a digital image. The underlying basis of the reduction process is the removal of redundant data. From a mathematical viewpoint, these amounts are transforming a 2-D pixel array into a statistically uncorrelated data set. The transformation is applied prior to storage or transmission of the image. At some later time, the compressed image is decompressed to reconstruct the original image or an approximation of original image. Many great contributions have been made in this area, such as block truncation coding, multilevel block truncation coding. These methods only focus on the gray scale data compression. Many compression methods have already reported by the investigators. Some of the representative and popular approaches related to this work will be discussed.

Pravin B. Pokleet et al. presented comparative of various image compression techniques to assess the progress made in the field of image compression effects on different images for different compression with its principles and types of compression and different algorithms used for image compression [11].

Delphi et al. proposed to improve the transmission rate and storage space for compression of image is very necessary [10]. For compression of image many tools and methods are applied. They developed Block Truncation Coding (BTC) was easy to implement. The bit rate obtained by BTC is 2 bpp but the quality of reconstructed image is very low.

Somasundram et al. proposed method the feature of inter-pixel correlation was exploited to further reduce the requirement of bits to store a block [15]. The proposed method gives very good performance in terms of bit-rate and PSNR values when compared to the conventional BTC.

3. PITFALLS IN EXISTING BTC SYSTEM

Block Truncation Coding (BTC)-Method

Block truncation coding (BTC) is a simple and fast lossy compression technique for gray scale images in 1979 Developed by Delp and Mitchell [09]. The original of BTC preserves the standard mean and standard deviation. Various methods have been proposed during last 30 years such as BTC, standard BTC, Absolute Moment Block Truncation Coding (AMBTC)[13].

BTC-Disadvantages

BTC supports for binary image compression and gray scale image compression. Since entire image requires large memory, BTC divides into block size 8 x 8, 16 x 16 pixels. The transform is not applied to the entire image at a scratch, but the selection of sub image is applied over fixed block with size 8x8, 16x16 pixels. BTC can perform complexity mathematical task to evaluate variance, standard deviation, statistical moments a, b.

Hence it needs to overcome those short coming problem. The existing BTC should be extended to multispectral image as well as color images which is called Enhanced Block Truncation Coding (E-BTC).

4. THEORETICAL FOUNDATION BTC METHOD

Image compression is used to reduce the amount of memory required to store an image without much affecting the quality of an image. There are several different methods to compress an image file. Block Truncation Coding is one of the simple and fast compression methods. The Block Truncation Coding is a lossy compression method with set of non-overlapping blocks.

Block truncation coding works by dividing the image into as well as small sub blocks of size 2×2 pixels and then reducing the number of gray levels within each block[08]. The basic form of BTC divides the whole image into 'n' blocks and codes each block using a two-level quantizer[14]. The two level a and b are selected using the mean $\bar{X}$ and standard deviation (σ) of the gray levels within block and are preserved. The $\bar{X}$ and σ are calculated using (9) and (10)

$$\bar{X} = \frac{1}{m}\sum_{i=1}^{m} xi \qquad (9)$$

$$\sigma = \sqrt{\frac{\sum y_i - {x_i}^2}{m}} \qquad (10)$$

In BTC, two statistical moments a and b are computed using (11) and (12) and are preserved along with the bit plane for reconstructing the image.

$$a = \bar{X} - \sigma\sqrt{\frac{q}{m-q}} \qquad (11)$$

$$b = \bar{X} + \sigma\sqrt{\frac{m-q}{q}} \qquad (12)$$

Where q is the number of pixel values greater than or equal to $\bar{X}$, and (m-q) is the number of pixels whose gray levels are less than $\bar{X}$ while reconstructing the image, the 'o' in the bit plane is replaced by a and the '1' in the bit is replaced by b.

5. PROPOSED ENHANCED BTC METHOD

In the proposed research work of E-BTC is to reduce to separate the image component, the bit size per pixel, and to improve the quality of the image. This work proposes both multispectral and color images. The E-BTC divides image into small as well as sub block with size 2×2 and performs all tasks without mathematical computational parameters so that maximum time consuming is saved. The proposed diagram and algorithms for E-BTC and inverse E-BTC are as follows.

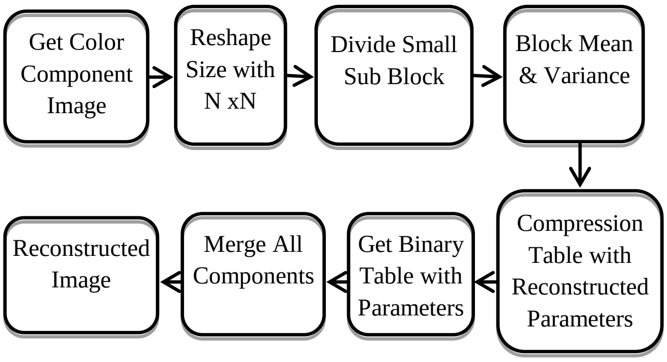

Fig 1: Proposed Compressed and Decompressed

Algorithm for E-BTC

Step 1: Assume 512x512 image with gray levels from 0 to 255.

Step 2: Select sub block size.

Step 3: Get sub block size value from original image.

Step 4: Calculate mean value, variance, a, b.

Step 5: For each block size, construct bit level matrix.

Step 6: Calculate preserve parameters such as q and m.

Step 7: Store Compression Block Table 1.

Step 8: Simulate this process until the last Block.

Step 9: End.

Proposed Algorithm for Inverse E-BTC

Step 10: Get mean, variance, q, m, Binary matrix table.

Step 11: Get a, b from compression table.

Step 12: Calculate reconstructed parameter a, b.

Step 13: Replace 'a' for '1' and 'b' for '0'.

Step 14: Make reconstruction block table 1.

Step 15: Repeat the same task until last block.

Step 16: Get the reconstructed image.

Step 17: Compare proposed experimental ratio with existing BTC compression methods.

Step 18: End.

A compressed block storage contains four values $(mean, a, b, B)$, where mean is average of pixels, a, b are the reconstructed parameters and B is bit plane, giving the quantization of the pixel values.

The following table has the structure for different image with different component named as compressed block storage table. Each component is having multiple block storage. This table supports to access the content to recover the reconstruction of original image.

Table 1. Compressed Block Storage

C / **I**	**C1**	**C_2**	**....**	**C_n**
I_1	${}^1_1b_1 \cdots {}^1_1b_m$	${}^1_2b_1 .. {}^1_2b_m$	...	${}^1_nb_1 \cdots {}^1_nb_m$
I_2	${}^2_1b_1 \cdots {}^1_1b_m$	${}^2_2b_1 \cdots {}^2_2b_m$	...	${}^2_nb_1 \cdots {}^2_nb_m$
....	....	....	....	....
I_j	${}^j_1b_1 \cdots {}^j_1b_m$	${}^j_2b_1 \cdots {}^j_2b_m$	...	${}^j_nb_1 \cdots {}^j_nb_m$

The above structure table is also used for reconstructed image block storage. This also contains the same parameters mean, a, b, B.

6. RESULTS AND DISCUSSION

The sample original multispectral image is shown in Fig 2. Its separated multispectral image is shown in Fig 3[3].The image to be tested on compression is shown Fig 4.It shows original input image and different block size compressed – Reconstructed image. The difference between the original image and reconstructed image is called Mean Square Error and is calculated using (13). The quality of the reconstructed image called the Peak Signal to Noise Ratio (PSNR) and Signal to Noise Ratio (SNR) is calculated using equations (14), (15). The compression efficiency is measured by Compression Ratio (CR) using equation (16) or by the Bit Rate (BR) using equation (17).

$$\text{MSE} = \frac{1}{N}\sum_{i=1}^{N}(y_i - x_i)^2 \qquad (13)$$

$$\text{PSNR} = 10log_{10}\left[\frac{MSE}{255^2}\right] \qquad (14)$$

$$\text{SNR} = 10log_{10}\left[\frac{MSE}{255^2}\right] \qquad (15)$$

$$CR = \frac{no.of bytesreq.torepresent the original image}{no.of bytesreq.torepresent compressed image} \qquad (16)$$

$$\text{BR=B/CR} \qquad (17)$$

where y_i is the reconstructed pixel value, x_i is the original pixel value and N is the number of pixels in an image. B is number of bits per pixel.

Fig 2: Original Multispectral Image

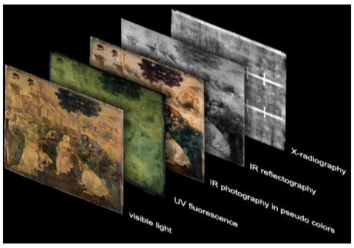

Fig 3: Separated Multispectral Image

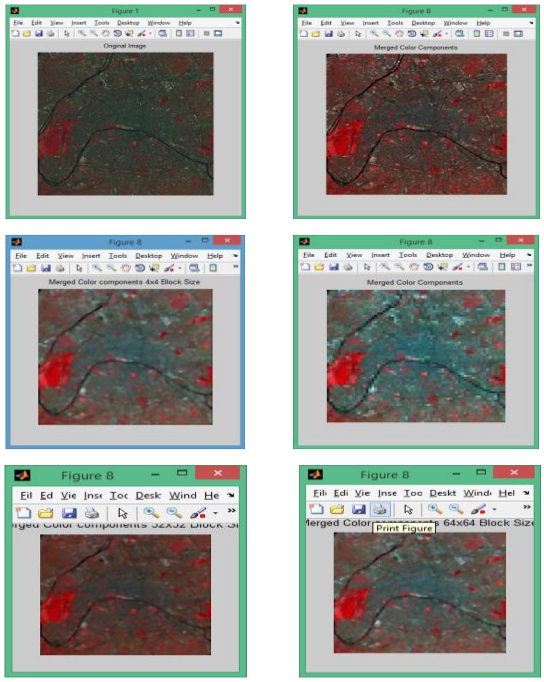

Fig 4: Original Input Image and Different Block Size Compressed-Reconstructed Image

Table 2. Compression Parameters MSE, PSNR, BR Values with Proposed Methods

IMG	**BTC**			**AMBTC**			**MLBTC**			**E-BTC (Proposed)**		
	MSE	**PSNR**	**BR**	**MSE**	**PSNR**	**BR**	**MSE**	**PSNR**	**BR**	**MSE**	**PSNR**	**BR**
IMG 1	4.56	32.07	3.15	4.56	32.13	2.85	4.55	32.70	2.50	4.54	34.17	2.21
IMG 2	4.66	37.14	3.50	4.66	37.48	2.25	4.61	37.68	2.02	4.53	31.26	1.36
IMG 3	4.73	32.77	3.45	4.52	33.15	2.85	4.51	33.81	2.65	4.36	33.97	1.25
IMG 4	4.83	30.68	3.68	4.63	30.94	2.31	4.60	31.47	2.01	4.46	34.53	1.25
IMG 5	4.61	34.62	3.07	4.52	34.85	2.25	4.51	35.39	2.45	4.36	30.20	0.84
IMG 6	4.87	35.41	3.75	4.79	35.55	2.19	4.76	36.11	2.15	4.10	40.41	0.56

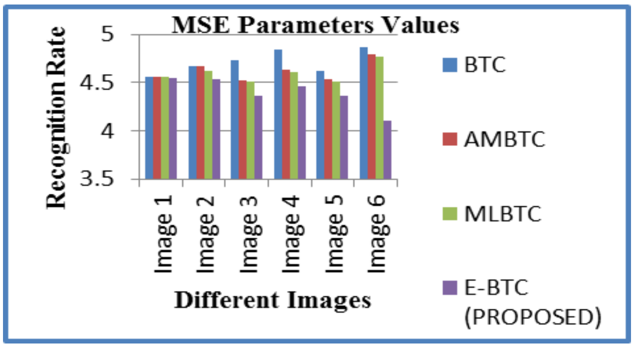

Fig 5: MSE Parameter Values for Six Different Images

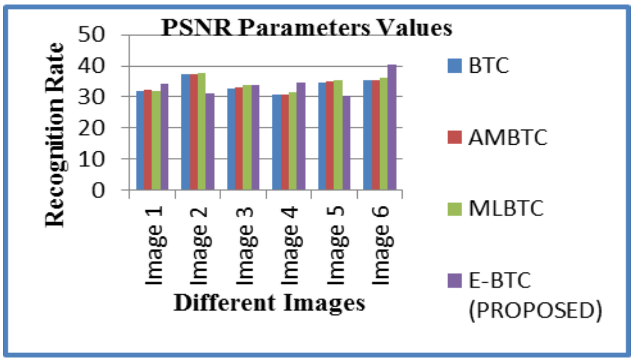

Fig 6: PSNR Parameter Values for Six Different Images

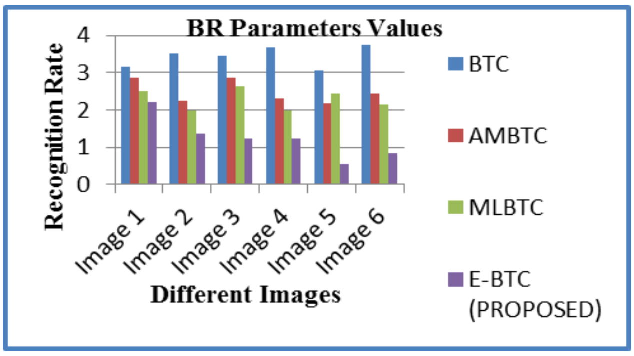

Fig 7: BR Parameter Values for Six Different Images

7. CONCLUSION

Due to the limit in the storage medium and transmission bandwidth on multispectral image, the image which is to be used must be within the lesser size. To overcome this issue, an image processing technique called image compression technique E-BTC is employed.

The proposed technique of E-BTC is applied on different six color and multispectral images for compression [7][10].In the conventional existing methods of BTC, AMBTC, MLBTC and proposed of this research work method in E-BTC are tested on these input images. The comparative analysis of existing and proposed method results is presented in Table 2.

The obtained results from six images for MSE, PSNR and BR for different charts are presented in the above figures 5-7. The chart shows reasonable value for MSE, PSNR value and low value in BR. The results value ensures good compression ratio without loss of data as well as the quality of the image

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