Comparative study of Block Truncation Coding with EBTC

Aditya Kumar
Department Of Computer Science & Engineering
National Institute Of Technology, Hamirpur, India
adi.bond.adi @gmail.com

Pardeep Singh
Department Of Computer Science & Engineering
National Institute Of Technology, Hamirpur, India
pardeep@nitham.ac.in

***Abstract*—This comparison paper scrutinizes image compression using Block Truncation Coding. Many algorithms were selected likely the original Block Truncation coding, Absolute Moment Block Truncation Coding, a comparison survey was executed. These above techniques are divided image into non overlapping blocks. They distinguish in the direction of choosing the quantization level in order to remove redundancy. Objectives measures are used to evaluate the image degree of excellence such as Peak Signal to Noise Ratio, Mean Square Error, Weighted Peak Signal to Noise Ratio, compression ratio, Bit Rate etc. At the end, conclusions have shown that the Futuristic Enhanced Block Truncation Coding algorithm outperforms the Block Truncation Codingas well as Absolute Moment Block Truncation Coding. It has been show that the image compression using Futuristic Enhanced Block Truncation Coding provides better image quality than image compression using Block Truncation coding and Absolute Moment Block Truncation Coding at the closer bit rate.**

Keywords-compression, discrete cosine transforms,futuristic enhanced block truncation coding,gray-scale images,moment preserving, structural similarity index, VQ.

I. INTRODUCTION

Digital image[21] compression methods useful to alleviate the extent necessary to stockpile or transmit the image data by changing the way these images are represented.There are many techniques for compressing [10] [39] digital image data and each has its own merits and demerits [1]. BTC has been used for many years for compressing digital monochrome images. BTC for monochrome image compression was introduced by Delp and Mitchell [1] [2] [3] [14] [21]. It is a simple and lossy image compression technique. BTC has the advantage of being easy to implement compared to vector quantization [3] [56] and transform coding [4] [5]. The BTC method preserves the block mean [66] [71] and standard deviation [57]. In the encoding procedure of BTC the image is first divided into a set of non overlapping blocks then the first two statistical moments [10] [25] and the bit plane [5] are computed. In the decoder, each of the encoded image blocksis reconstructed using the bit plane and the two statistical moments. It achieves 2 bits per pixel (bpp) with low computational complexity.

Since 1970's the Block Truncation Coding (BTC) [2] [7] [4] has been investigated and used in many domain which deploy technique of image compression etc LCD overdrive, GUI [65] in PDA [70] like phone. Basically Block truncation coding (BTC) is a lossy compression [54] approach applicable for gray-scale images. It alleviates the file size but loses some information originally at present in the image. The main characteristic of this technique is that it has relatively good compression ratio as well as bit rate with a simple and comparatively fast algorithm [53]. This is not a loss-less scheme but captivating image coding technique due its straightforwardness, low computational cost and relatively high image visual quality. In this method sharp gray level transition [14] and textured areas [32] are reconstructed well where as smooth gray level transitions are less well preserved. Like other image compression methods, quality of the reconstructed image is scaled in terms of peak-signal-to-noise ratio (PSNR) [43] [59] [71] and degree of compression by bits-per-pixel (bpp) [13] [24].

In general, BTC has the advantage of achieving high image quality [11] [23] [50] while consuming little computational time. In addition, it can be applied to color imagery [2], moving imagery [5], and graphics [6].

The main drawback of BTC is that the required bit rate is high [36] [59]. The usual bit rate is 2 bit/pixel or a total of 32 bits per block (8 bits for each quantization level and 16 bits for the bit map) when each image block is of 4×4 pixels.

Besides, Hu et al. introduced another improved version of AMBTC based on quad tree segmentation [13]. Further by exploiting the inter-block correlation [45] [55] [67], Hu et al. designed the block search order coding technique to reduce the bit rate of MPBTC in 2003 [14] [24]. In MPBTC and AMBTC, the mean value of all pixels in each image block is taken for the threshold value to classify these pixels into two groups. Thegrouping information of each image block is recorded in a binary bit map. Then, the reconstructed levels for these two groups are calculated. The compressed codes of each image block are the two reconstructed levels and the bit map. Utilizing the mean value to classify the pixels in each block is the simplest way but it may not be optimal. Between the maximal and minimal pixelvalues in one block, there exists one optimal threshold that optimizes mean square error (MSE) for the compressed image block. In order to get theoptimal threshold value, we need to try all possible values out to find the best one. Obviously, optimal grouping BTC (OBTC) is both inefficient and time consuming. Yang and Lin proposed Economical BTC (EBTC) [16] to reduce the

UACEE
Globalize The Research
Localize The World

computational cost of OBTC. EBTC significantly reduces the execution time than that in OBTC.

After this introduction we have given related work in section II with Block Truncation Coding, Absolute moment Block Truncation Coding and Enhanced Block Truncation Coding and Futuristic Enhanced Block Truncation Coding, image characteristics in section III,image quality measurements in section IV, Experimental results in Vand finally the conclusion in last section VI.

II. RELATED WORK

In this section we will describe Block Truncation Coding, Absolute Moment Block Truncation Coding and Enhanced Block Truncation Coding.

Since the BTC was first introduced in 1979, a variety of extensions have been proposed in the past few years. Most of the methods dedicate themselves in creating better high and low means, as well as bitmap. Before elaborating the proposed method, the baseline BTC is firstly introduced as below.

The original image is first divided into $n\times n$blocks. Suppose m=n^2, and $x_1\, x_2 \ldots\ldots x_m$denote the pixels in a block. The first moment, second moments, and the variance of a block are

$$\bar{x} = \frac{1}{m}\sum_{i=1}^{m} x_i \tag{1}$$

$$\overline{x^2} = \frac{1}{m}\sum_{i=1}^{m} {x_i}^2 \tag{2}$$

$$\sigma = \overline{x^2} - \bar{x}^2 \tag{3}$$

Since the BTC inherently is a one bit quantize, we define.

$$\begin{cases} xi \geq x,\ output = a \\ xi < x,\ output = b \end{cases}$$

Where i =1, 2, 3……..m, and variables a and $b$denote low and high means respectively. The central idea of the BTC is to preserve the first and second moments when the pixels are substituted by low and high means. Hence, the variables a, bis obtained by solving the following two equations:

$$m\bar{x} = (m - q)a + qb \tag{4}$$

$$m\overline{x^2} = (m - q)\, a^2 + qb^2 \tag{5}$$

where qdenotes the number of pixels higher than x in the block. Solving for $a$and b, we obtain

$$a = \bar{x} - \sigma\sqrt{\frac{q}{m-q}} \tag{6}$$

$$b = \bar{x} + \sigma\sqrt{\frac{q}{m-q}} \tag{7}$$

Each block is represented by a, b and nxn bitmapwhere a and b are assigned with 8 bits, respectively and the bitmap requires n^2bits. Hence the bit rate of 2 bits/pixel is achievedwith block of size 4 × 4. The bit rates of any specified blocksize can be evaluated likewise. The BTC has a critical problemfor its rapidly decreasing in image quality when block size isincreasing.

Now second one algorithm for description is Absolute moment Block Truncation Coding. Lema and Mitchell [1] [2] presented a simple and fast variant of BTC, named Absolute Moment BTC (AMBTC) [10] that preserves the higher mean and lower mean of a block.

Absolute moment block truncation coding (AMBTC)] preserves x and the sample first absolute central moment

$$\bar{\alpha} = \frac{1}{m}\sum_{i=1}^{m} |x_i - \bar{x}| \tag{8}$$

Quantization levels are calculated from

$$a = \bar{x} - \frac{\bar{\alpha}}{2} \cdot \frac{m}{m-q} \tag{9}$$

$$b = \bar{x} + \frac{\bar{\alpha}}{2} \cdot \frac{m}{q} \tag{10}$$

One can show that a=x_l (lower mean) and b=x_h(higher mean), where

$$\overline{x_l} = \frac{1}{m-q} * \sum_{x_i < \bar{x}}^{m} |x_i| \tag{11}$$

$$\overline{x_h} = \frac{1}{q} * \sum_{x_i \geq \bar{x}}^{m} |x_i| \tag{12}$$

Furthermore, this selection minimizes the MSE value among the BTC-variants that use x as a quantization threshold. It can easily be shown that it is optimal for other selections of x_{th} too. The coding and decoding processes are very fast for AMBTC because square root and multiplication operations are omitted.

AMBTC has several advantages over BTC. One advantage is that the quantizer is used to transmit an image from transmitter to a receiver.It is necessary to compute at the transmitter the two quantities, the sample mean [1] [3] [10] and the sample standard deviation [10] for BTC and sample first absolute central moment for AMBTC. When we compare the necessary computation for deviation information, we will see that in case of standard BTC it is necessary to compute a sum of m values and each of them will be squared while in the case of AMBTC it is only necessary to compute the sum of these m values. Since the multiplication time is several times greater than the addition time in most digital processors [10] thus using AMBTC the total calculation time at the transmitter is significantly reduced.

While Enhanced Block Truncation Coding has greater PSNR than Block Truncation Coding. In this algorithm we divide an image into nxn block then calculate the mean, alpha variable and make a prime_list vector according to following way

Vector_list € {2^0<prim_num<2^n-1}, Where n is number of bits used for represent any pixels in the image (n is the bit depth)

$$\text{mean p} = \frac{1}{n}\sum_{i=0}^{n} p_i \tag{13}$$

$$\alpha = (prim\_num_{max} + prim\_num_{min})/2 \tag{14}$$

UACEE
Globalize The Research
Localize The World

Where $prim\_num_{max}$ and $prim\_num_{min}$ is an integer from vector which just greater and smaller than mean of the block.

After above step we calculate the counting of number of pixels that values n^+, n^- and n^* that are greater and smaller than threshold value of the block and between the range of $prim\_num_{max}$ and $prim\_num_{min}$ respectively.After this we calculate a value of two temporary variables

$$temp_1 = mean + \alpha\sqrt{\frac{n^+ \sim n^*}{n^- \sim n^*}} \quad (16)$$

$$temp_2 = mean \sim \alpha\sqrt{\frac{n^+ \sim n^*}{n^- \sim n^*}} \quad (17)$$

We scan the pixel value of block as a raster order. Firstly we work on first column of the block as a first case if pixel value of column is greater than the mean value of the block then we assign value $temp_1$ otherwise we assign value $temp_2$.

In the second case, excepting first column if pixel value is greater than one an half times of threshold value of current block then we assign (α + average of prime number mean and value of pixel)/2 otherwise we assign average of all prime number between mean and pixel and pixel value [2].

In the last case if pixel value is smaller than the one and half times of mean value then we assign then assign (α – average of prime number mean and value of pixel)/2 otherwise we assign average of all prime number between mean and pixel and pixel value.

Finally we discussed Futuristic Enhanced Block Truncation [1] Coding which preserve the first two statistical moments with different manner. Mean and alpha of this algorithm is calculated as equation 13 and 14 respectively. In this prime vector list is calculated as using of formula mention in Enhanced Block Truncation Coding [2].

In Futuristic Enhanced Block Truncation, we consider three cases to modify the pixel values in the block of an image. After dividing an image into non-overlapping blocks, according to first case of Enhanced Block Truncation Coding, Algorithm calculate the mean of first column if pixel value of greater than mean then its value is updated by 16 otherwise 17.

For example, let's suppose the imaginaryvalue of N_1, N_2, andN_3 is 35, 29 and 36 [1].Now value of mean m_1 and alpha value in the first case is 126.5000 and 120 respectively and finally for this case value of $temp_1$ and $temp_2$ is 128.0232 and 124.9768 respectively.

According to the FEBTC algorithm [1], the mean m_2 of the block leaving the first column is 125.1250. Now mean of the current block which pixel is greater than and smaller than the mean m_2, is m_3=126.7931 and m_4=123.3333.Now respective value of alpha is 120 and 120. Finally value of $temp_{11}$ =128.3163, $temp_{12}$= 125.2699, $temp_{31}$=125.6536, $temp_{32}$=121.0131.

When same procedure is applied to all the block then image and we get Figure 1 as compressed image for different block processing.

The Spatial frequencies (SFM) and values computed for the different standard images are given in Table I.

Test image Baboon has a lot of details and consequently large SFM. Large value of SFM means that image contains components in high frequency area. It returns that Baboon presents low redundant image, which is difficult for compression. Test image Lena are images has low details and consequently small SFM. Small value of SFM means that image contains components in low frequency area. It returnsLena presents high redundant image, which is easy for compression than Baboon.

Enhanced Block Truncation coding is an improved compression algorithm for gray scale image to reduce the correlation and spatial redundancy between pixels of an image. EBTC algorithm is useful to maintain the compression ratio and quality of an image. The reconstructed images have a bit rate 1.25bpp. This corresponds to 85% compression. Objectives measures were already used to evaluate the image quality such as: Peak Signal to Noise Ratio (PSNR), Weighted Peak Signal to Noise Ratio (WPSNR), Bit Rate (BR) and Structural Similarity Index (SSIM).

While FEBTC algorithm provides good image quality over BTC, AMBTC as well as EBTC without degrading another image quality measurement parameters.

III. IMAGE CHARACTERISTICS

The spatial frequency measurement (SFM) [9] indicates the overall activity level in an image. SFM is defined as follow:

$$SFM = \sqrt{R^2 + C^2} \quad (18)$$

$$SFM = \sqrt{\frac{1}{MN}\sum_{n=1,m=2}^{N,M}[x(m,n) - x(m-1,n)]^2} \quad (19)$$

$$SFM = \sqrt{\frac{1}{MN}\sum_{m=1,n=2}^{M,N}[x(m,n) - x(m,n-1)]^2} \quad (20)$$

Where R is row frequency, C is column frequency, x (m, n) denotes the samples of image, M and N are number of pixels in row and column directions, respectively. The large value of SFM means that image contains components in high frequency area. It returns that low redundant image, which is difficult for compression. Small value of SFM means that image contains components in low frequency area. It returns that high redundant image, which is easy for compression.

Table I

	Lena	Babbon	Peppers	Goldhill	Barb
SFM	14.0423561	36.514789	15.844786	16.166764	29.456856

VI. IMAGE QUALITY MEASUREMENTS

Image quality measures play important roles in various images processing application .Once image compression system has been designed and implemented, it is important to be able to evaluate its performance. This evaluation should be done in such a way to be able to compare results against other

UACEE
Globalize The Research
Localize The World

image compression techniques. The image quality metrics can be broadly classified into two categories, subjective and objective. Subjective image quality is a method of evaluation of images by the viewers who read images directly to determine their quality. In objective measures of image quality metrics, some statistical indices are calculated to indicate the image quality. In our work we will focus in objective[9]-[10] measures such as Peak Signal to Noise Ratio (PSNR), Weighted Peak Signal to Noise Ratio (WPSNR), Bit Rate (BR) and Structural Similarity Index (SSIM).

A. Peak Signal to Noise Ratio (PSNR)

The PSNR is most commonly used as a measure of quality of reconstruction of lossy compression It is an interesting measure for the loss of image information due to its simplicity and mathematical handiness. Peak signaltonoise ratio (PSNR) is a qualitative measuring analysis based on the meansquareerror of the reconstructed image.If the reconstructed image is close to the original image then MSE is small and PSNR takes a large value .PSNR is dimensionless and is expressed in decibel (db). Peak SignaltoNoise Ratio (PSNR) avoids this problem by scaling the MSE according to the image range .PSNR is defined as follow:-

$$\mathrm{MSE} = \frac{1}{MN} \sum_{i=1}^{M} * \sum_{j=1}^{N} [y(i,j) - x(i,j)]^2 \tag{21}$$

$$\mathrm{PSNR} = \left(10 \log \left(\frac{L^2}{\mathrm{MSE}}\right)\right) \tag{22}$$

Where L is the dynamic range of the pixel values (255 for 8-bit grayscale images).

B. Weighted Peak Signal to Noise Ratio (WPSNR)

The weighted PSNR (WPSNR) has been defined as an extension of the traditional PSNR. It weights each term of the PSNR by local "activity" factor (linked to the local variance)[10].weighted PSNR (WPSNR) take into account the local human visual system (HVS) sensitivity, it is a measure criteria which hold account of the neighbors of the studied pixels.

$$\mathrm{WPSNR} = \left\{10 \log \left(\frac{L^2}{(L(y-x)*\mathrm{NVF})^2}\right)\right\} \tag{23}$$

$$\mathrm{NVF} = \frac{1}{\left(1+\theta\alpha_x^2 \quad (i,j)\right)} \tag{24}$$

$$\alpha_x^2 = \frac{1}{(2L+1)^2} \sum_{m=-L}^{L} * \sum_{n=-L}^{L} [x(i+m, j+n) - \bar{x}(i,j)]^2 \tag{25}$$

$$\Theta = \frac{D}{\alpha_{xmax}^2} \tag{26}$$

Where α_{xmax}^2 is the maximum local variance of a given image and Dϵ [50, 150]is a determined parameter.

C. Bit Rate (BR)

The performance of image compression schemes can be specified in terms of compression efficiency. Compression efficiency is measured by the compression ratio or by the bit rate. Compression ratio is the ratio of the size of original image to the size of the compressed image.The bit rate is the number of bits per pixel required by the compressed image *CR* = size of original image / size of the compressed image. The compression ratio and bit rate are related. Let b be the number of bits per pixel (bit depth) of the uncompressed image, CR the compression ratio, and BR the bit rate. The bit rate ratio is given by

$$\mathrm{BR} = \frac{B}{CR} \tag{27}$$

D. Structural Similarity Index (SSIM).

Another listing of image quality measures is based on the hypothesis that the human visual system is highly acclimatized to extract structural knowledge from the viewing field [2] [10]. The error sensitivity theory, evaluates perceived errors to quantify image degradations, while this approach considers image degradations as perceived structural information variation. The structural Similarity (SSIM) index can be calculated as a function of three components: luminance, contrast and structure.

$$\mathrm{SSIM}(x,y) = [l(x,y)]^a . [c(x,y)]^b . [s(x,y)]^c \tag{28}$$

IV. EXPERIMENTAL RESULTS

In this section we discussed experimental analysis of Futuristic Enhanced Block Truncation Coding with AMBTC which were simulated at matlab7.0 Integrated Development Environment (IDE) like tool.

FEBTC and AMBTC closer bit rate and WPSNR results but FEBTC provides much better PSNR compare to AMBTC as well as BTC and EBTC. In this comparative study we take Barbara and baboon gray scale images for simulation analysis. Figure 1 and figure 2 shown that FEBTC optimized the performance of AMBTC for PSNR point of view. These both figure shown for 2x2 block processing to 512x512 block processing for same image. It is intuitively clear that 2x2 block processing provides better visual perception but lower bit rate. In the other hand 512x512 provides block processing better bit rate but lower PSNR value.

Comparative mean square errornormalized absolute error, Peak Signal to Noise Ratio, WeightedPeak Signal to Noise Ratio, compression ratio and bit rate shown in table III, table IV, table V, table VI, table VII and table VIII for Barbara, baboon and Lena gray scale image with different block processing. It is easy to understand that image compression with FEBTC gives better result compare to Absolute Moment Block Truncation Coding as well as Block Truncation Coding because greater Peak Signal To Noise Ratio provide better image quality.

Outcome after simulation is represented in tables shown that image compression with Futuristic Enhanced Block Truncation Coding provides better image quality with closer bit rate than Absolute Moment Block Truncation Coding.

Image quality has been improved with Futuristic Enhanced Block Truncation Coding. This algorithm also has draw back

UACEE
Globalize The Research
Localize The World

because its execution time is compare to AMBTC and BTC is low.

Many image quality measurement parameters are used in tables for judging the performance for Futuristic Block Truncation coding over other moment preserving algorithms. Thus FETBC algorithm is an optimized image compression algorithm for 2^n shades images.

O

riginal image barbara512.gif

Original image

2

*2 block Image Compression by AMBTC

2*2 block Image Compression by FEBTC

4

*4 block Image compression by AMBTC

4*4 block Image compression by FEBTC

8

*8 block Image compression by AMBTC

8*8 block Image Compression by FEBTC

1

6*16 block Image compression by AMBTC

16*16 block Image Compression by FEBTC

Figure 1 outcome of barbara512 gray scale image usi
different block

32

*32 block Image Compression by AMBTC

32*

32 block Image Compression by FEBTC

64

*64 block Image Compression by AMBTC

64*

64 block Image Compression by FEBTC

12

8*128 block Image Compression by AMBTC

128

*128 block Image Compression by FEBTC

25

6*256 block Image Compression by

256

*256 block Image Compression by

UACEE
Globalize The Research
Localize The World

AMBTC

51
2*512 block Image Compression by AMBTC

FEBTC

512
*512 block Image Compression by FEBTC

Table II Simulation results of Barbara512 using FEBTC

Block	MSE (Mean Square Error)	NAE (Normalized Absolute Error)	PSNR (Peak Noise to Signal Ratio)	WPSR (Weighted Peak Noise to Signal Ratio) in dB	Original size (in bytes)	Compressed size (in bytes)	Bits per pixel (Bit depth)	CR (Compression Ratio)	BR (Bit Rate)
2x2	44.12429	0.035673	346.12446	+31.11	289545	252988	8	0.873743	7.001011
4x4	74.576729	0.049337	29.404770	+24.84	289545	188448	8	0.650842	5.206735
8x8	115.423386	0.065336	27.507866	+22.51	289545	133493	8	0.461044	3.688352
16x16	168.332340	0.084589	25.869128	+20.82	289545	88975	8	0.307292	2.458340
32x32	252.786060	0.111099	24.103272	+18.84	289545	57637	8	0.199061	1.592485
64x64	349.096054	0.141509	22.701354	+18.21	289545	38533	8	0.133081	1.064650
128x128	446.387505	0.170402	21.633683	+17.28	289545	26903	8	0.092915	0.743318
256x256	606.573627	0.212284	20.301968	+18.66	289545	21444	8	0.074061	0.592488
512x512	642.413170	0.222461	20.052659	+24.12	289545	18533	8	0.064007	0.512059

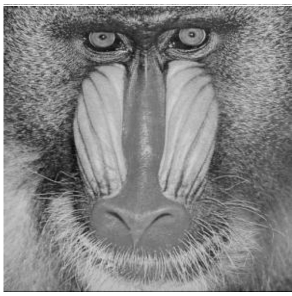
Table III Simulation results of Barbara512 using AMBTC

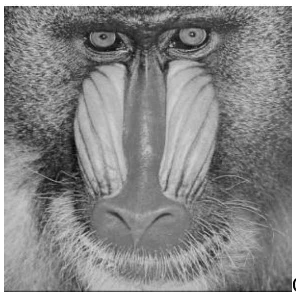
Block	MSE (Mean Square Error)	NAE (Normalized Absolute Error)	PSNR (Peak Noise to Signal Ratio)	WPSR (Weighted Peak Noise to Signal Ratio))	Original size (in bytes)	Compressed size (in bytes)	Bits per pixel (Bit depth)	CR (Compression Ratio)	BR (Bit Rate)
2x2	22.2693	0.0274	34.653738	+30.70	289545	252980	8	0.873716	6.989725
4x4	73.1450	0.0553	29.488956	+25.68	289545	188808	8	0.652085	5.216681
8x8	117.5386	0.0733	27.428999	+23.11	289545	133017	8	0.459400	3.675201
16x16	182.6093	0.0958	25.515575	+21.03	289545	89149	8	0.307893	2.463147
32x32	279.1751	0.1245	23.672037	+18.94	289545	56571	8	0.195379	1.563032
64x64	387.8737	0.1565	22.243900	+18.27	289545	37492	8	0.129486	1.035887
128x128	494.3864	0.1855	21.190138	+17.28	289545	26684	8	0.092158	0.737267
256x256	665.5335	0.2273	19.899105	+18.70	289545	21425	8	0.073995	0.591963
512x512	715.7957	0.2399	19.582913	+24.20	289545	18444	8	0.063700	0.509600

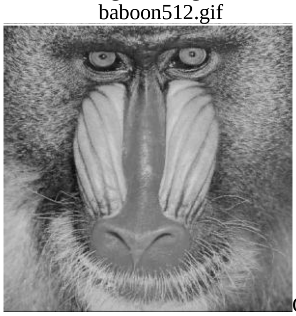
Table IV Simulation results of baboon512 using FEBTC

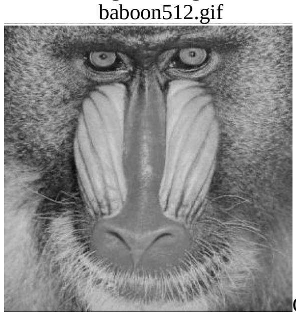
Block	MSE (Mean Square Error)	NAE (Normalized Absolute Error)	PSNR (Peak Noise to Signal Ratio)	WPSR (Weighted Peak Noise to Signal	Original size (in bytes)	Compressed size (in bytes)	Bits per pixel (Bit depth)	CR (Compression Ratio)	BR (Bit Rate)

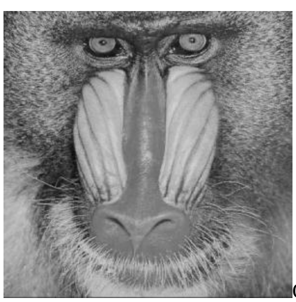
				Ratio))in dB					
2x2	130.837849	0.045274	32.176720	+24.53dB	308634	253190	8	0.820357	6.562854
4x4	162.659734	0.063195	26.829537	+22.77dB	308634	187024	8	0.605973	4.847787
8x8	214.360859	0.074296	24.819349	+21.86 dB	308634	135669	8	0.439579	3.516631
16x16	253.248817	0.083641	24.095329	+20.95 dB	308634	96785	8	0.313592	2.508732
32x32	283.200428	0.091478	23.609865	+20.51 dB	308634	68347	8	0.221450	1.771600
64x64	334.194954	22.890805	22.890805	+19.60 dB	308634	48487	8	0.157102	1.256816
128x128	381.350086	0.115051	22.317565	+18.63 dB	308634	35680	8	0.115606	0.924849
256x256	497.722179	0.140079	21.160934	+14.51 dB	308634	29249	8	0.094769	0.758154
512x512	523.563103	0.145549	20.941113	+14.66 dB	308634	24479	8	0.079314	0.634512

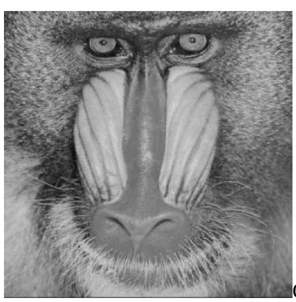

Ori
ginal image
baboon512.gif

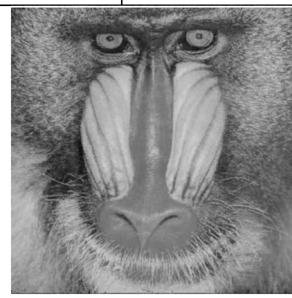

Ori
ginal image
baboon512.gif

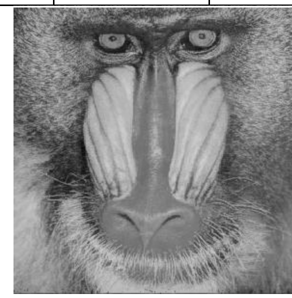

Co
mpressed image after AMBTC 2*2
block processing

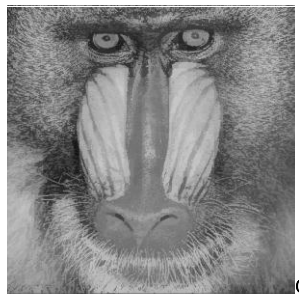

Co
mpressed image after FEBTC 2*2
block processing


Co
mpressed image after AMBTC 4*4
block processing


Co
mpressed image after FEBTC 4*4
block processing


Co
mpressed image after AMBTC 8*8
block processing


Co
mpressed image after FEBTC 8*8
block processing


Co
mpressed image after AMBTC
16*16 block processing

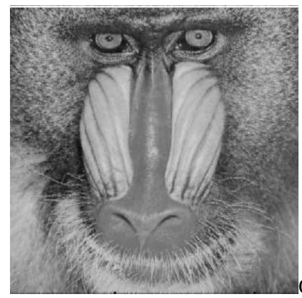
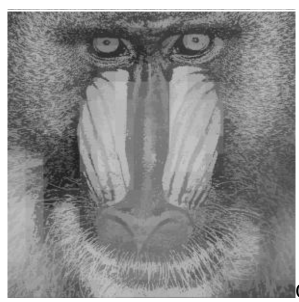
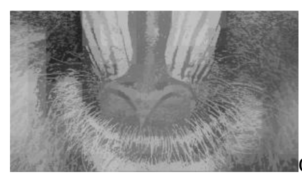
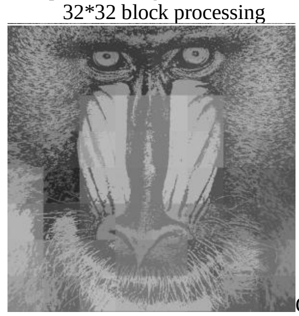
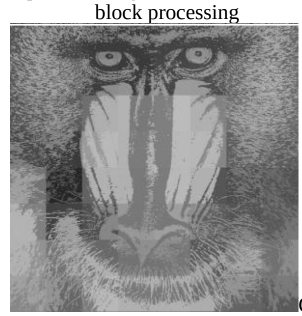

Co
mpressed image after FEBTC 16*16
block processing

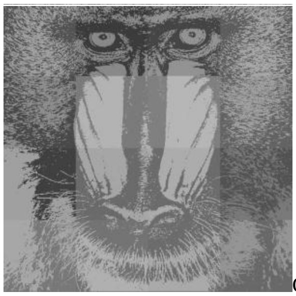
Figure 1 outcome of baboon512gray scale image usi
different bloc


Co
mpressed image after AMBTC
32*32 block processing

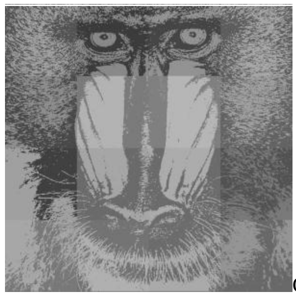

Co
mpressed image after FEBTC 32*32
block processing


Co
mpressed image after AMBTC
64*64 block processing

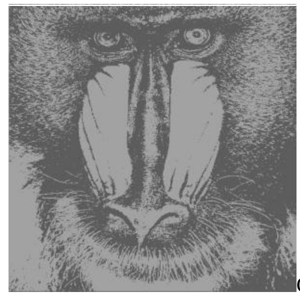

Co
mpressed image after FEBTC 64*64
block processing



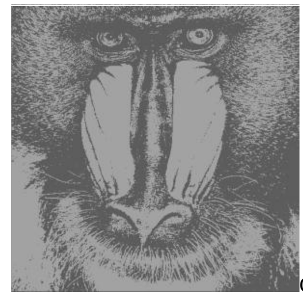
Co
mpressed image after AMBTC 128*128 block processing



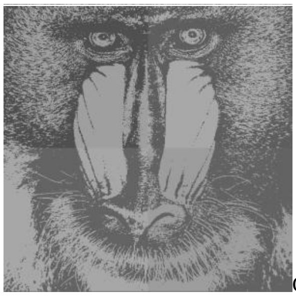
Co
mpressed image after FEBTC 128*128 block processing



Co
mpressed image after AMBTC 512*512 block processing



Co
mpressed image after FEBTC 512*512 block processing



Co
mpressed image after AMBTC 256*256 block processing

Co
mpressed image after FEBTC 256*256 block processing

Table V Simulation results of baboon512 using AMBTC

Block	MSE (Mean Square Error)	NAE (Normalized Absolute Error)	PSNR (Peak Noise to Signal Ratio)	Original size (in bytes)	Compressed size (in bytes)	Bits per pixel (Bit depth)	CR (Compression Ratio)	BR (Bit Rate)
2x2	39.3920	0.0317	32.176720	308634	253190	8	0.820357	6.562854
4x4	134.9356	0.0634	26.829537	308634	187024	8	0.605973	4.847787
8x8	202.6749	0.0797	25.062804	308634	135484	8	0.438980	3.511836
16x16	264.2472	0.0919	23.910699	308634	97064	8	0.314495	2.515964
32x32	309.6523	0.1014	23.222061	308634	68268	8	0.221194	1.769552
64x64	373.6326	0.1142	22.406356	308634	48004	8	0.155537	1.244296
128x128	428.4755	0.1263	21.811543	308634	35824	8	0.116073	0.928582
256x256	558.5703	0.1517	20.660025	308634	29236	8	0.094727	0.757817
512x512	579.0580	0.1561	20.503583	308634	24448	8	0.079214	0.633709

Table VISimulation results of baboon512 using FEBTC

Block	MSE (Mean Square Error)	NAE (Normalized Absolute Error)	PSNR (Peak Noise to Signal Ratio)	WPSR (Weighted Peak Noise to Signal Ratio))in dB	Original size (in bytes)	Compressed size (in bytes)	Bits per pixel (Bit depth)	CR (Compression Ratio)	BR (Bit Rate)
2x2	6.087902	0.014948	40.286127	+32.74	242648	225076	8	0.927582	7.420659
4x4	16.342972	0.0211096	35.997493	+26.63	242648	172468	8	0.710774	5.686196
8x8	33.798492	0.030150	32.841830	+23.16	242648	124680	8	0.513831	4.110646
16x16	64.825123	0.043652	30.013370	+20.47	242648	83749	8	0.345146	2.761168
32x32	104.255310	0.060333	27.949822	+18.82	242648	52685	8	0.217125	1.737002
64x64	164.330528	0.084955	25.973621	+17.66	242648	33082	8	0.136337	1.090699
128x128	250.731167	0.116779	24.138720	+16.26	242648	20010	8	0.082465	0.659721
256x256	340.241570	0.156767	22.812930	+17.83	242648	17003	8	0.070073	0.560582
512x512	377.344944	0.167772	22.363418	+19.83	242648	12818	8	0.052825	0.422604

UACEE
Globalize The Research
Localize The World

Table VII Simulation results of lena512 using AMBTC

Block	MSE (Mean Square Error)	NAE (Normalized Absolute Error)	PSNR (Peak Noise to Signal Ratio)	Original size (in bytes)	Compressed size (in bytes)	Bits per pixel (Bit depth)	CR (Compression Ratio)	BR (Bit Rate)
2x2	3.9547	0.0108	42.159687	242648	221156	8	0.911427	7.291418
4x4	18.7992	0.0252	35.389408	242648	171831	8	0.708149	5.665194
8x8	40.1238	0.0377	32.096784	242648	124439	8	0.512838	4.102700
16x16	75.2171	0.0538	29.367635	242648	83835	8	0.345500	2.764004
32x32	122.5958	0.0729	27.246047	242648	52808	8	0.217632	1.741057
64x64	190.1723	0.0989	25.339331	242648	32946	8	0.135777	1.086215
128x128	287.6894	0.1319	23.541565	242648	20097	8	0.082824	0.662589
256x256	392.3957	0.1732	22.193561	242648	16871	8	0.069529	0.556230
512x512	426.4725	0.1831	21.831893	242648	12826	8	0.052858	0.422868

V. CONCLUSION

In this literature survey, image compression using Futuristic Enhanced Block Truncation coding has been scrutinized. Four algorithms were selected specifically, the original block truncation coding (BTC), AMBTC and Enhanced block truncation coding (EBTC) and Futuristic Enhanced Block Truncation coding (FEBTC).These techniques are based on dividing the image into non overlapping blocks and uses a two-level quantize. These applications were applied to different gray level test image each contains 512x512 dimension with 8 bits/pixel (256 gray scale values). In the FEBTC and AMBTC The bit rate of reconstructed images, vary from 7.0 to 0.5 when we divide image into 2x2 to 512x512 blocks. Peak signal to noise ratioofFuturistic Enhanced Block Truncation coding is much better than AMBTC with closer bit rate and compression ratio as well as WPSNR. Objectives measures were used to evaluate the image quality such as Peak Signal to Noise Ratio (PSNR), Bit Rate (BR) etc. The results have put in appearance that the FEBTC algorithm outperforms the BTC as well as AMBTC. It has been put in appearance that the image compression using FEBTC provides better image quality than image compression using AMBTC with closer bit rate.

REFERENCES

[1] Aditya Kumar, Pardeep Singh," Futuristic Algorithm for Gray Scale Image based on Enhanced Block Truncation Coding," International Journal of Computer Information Systems (2229-5208), Vol. 2, No. 2, pp. 53-60, 2011.

[2] Aditya Kumar, Pardeep Singh," Enhanced Block Truncation Coding for Gray Scale Image," International journal of Computer Technology and Application, Vol 2 (3), 525-530, 2011.

[3] David Solomon, "Data Compression The complete reference," 2nd edition, Springer 2001, Newyork.

[4] E.M. Rafael C. Gonzalez, Richard Eugene; "Digital image processing".

[5] Bibhas Dhara, Bhabatosh Chanda,"Color image compression based on block truncation coding using pattern fitting principle," Journal Pattern Recognition archive, Volume 40 Issue 9, September, 2007,Elsevier Science Inc.New York, NY, USA, Edition 3, 2008, page 466.

[6] Aditya Kumar, Pardeep Singh," Aggrandize Bit Plane Coding using Gray Code Method," International Journal of Computer Applications (0975 – 8887), Volume 20– No.6, April 2011.

[7] Rhoma, A.M Abobaker," Mean square error minimization using interpolative block truncation coding algorithms ,"2nd International Conference on Education Technology and Computer (ICETC), 2010.

[8] Pham, D. Premkumar, A. Madhukumar, " Error Detection and Correction in Communication Channels Using Inverse Gray RSNS Codes," IEEE Transactions on Communications.

[9] Yu, Luo H,"Colour image retrieval using pattern co-occurrence matrices based on BTC and VQ, "Publication Year: 2011, Page(s): 100 – 101.

[10] J. Wang and J.W. Chong. High performance overdrive using improved motion adaptive codec in LCD. IEEE Trans. Consumer Electronics, vol. 55, no. 1, pp. 20-26 Feb 2009.

[11] P. Franti, P. Nevalainen, and T. Kaudoranta, "Compression of Digital Image by Block Truncation Coding: A Survey," Computer Journal, Vol. 37, No. 4, pp. 308-332, 1994.

[12] K.Somasundaram and I.Kaspar Raj, "An Image compression Scheme based on Predictive and Interpolative Absolute Moment Block Truncation Coding", GVIP Journal, Volume 6, Issue 4, December, 2006.

[13] Aditya Kumar, Pardeep Singh," A Wavelet Tranform Algorithm for 2^n shades image," International journal of Computer Technology and Application, Vol 2 (3), 525-530, 2011.

[14] Y.C. Hou, S.F. Tu, and Y.H. Chang,"Block truncation coding by using genetic algorithm," Int. Commun.Control, SignalProcess. pp.1273–1278, Mar. 2008

[15] O. R. Mitchell, and E. J. Delp, "Multilevel Graphics Representation Using Block Truncation Coding," *Proc. IEEE*, Vol. 68, pp. 868-873, 1980.

[16] M. D. Lema and O. R. Mitchell, "Absolute Moment Block Truncation Coding and Its Application to Color Image," IEEE Transactions on Communications, Vol. 32, pp. 1148-1157, 1984.

UACEE
Globalize The Research
Localize The World

[17] J. Wang, K.Y. Min and J.W. Chong,"A hybrid image coding in overdrive for motion blur reduction in LCD,"Proc. of 6th Int. Computer Entertainment Computing, pp. 263 – 270, Sep.2007.

[18] J. Someya, N. Okuda, and H. Sugiura, "The suppression of noise on a dithering Image in LCD overdrive," IEEE Trans. Consumer Electron., vol. 52, no. 4, pp. 1325-1332, Nov. 2006.

[19] J. Someya and N. Okuda, "Motion adaptive CODEC feed-forward - driving for LCD overdrive," Journal of the SID, 13/6, pp. 517- 524, 2005.

[20] Wu Y., Coll D.C., BTC-VQ-DCT Hybrid Coding of Digital Images. IEEE Transactions on communications, vol. 39 (9), pp. 1283-1287, September 1991.

[21] E.M. Rhoma, A.M Abobaker," Mean square error minimization using interpolative block truncation coding algorithms ,"2nd International Conference on Education Technology and Computer (ICETC), 2010.

[22] Yu, Luo H,"Colour image retrieval using pattern co-occurrence matrices based on BTC and VQ, "Publication Year: 2011, Page(s): 100 – 101.

[23] G. Chopra, A.K Pal," An Improved Image Compression Algorithm Using Binary Space Partition Scheme and Geometric Wavelets".IEEE Transactions on Image, 2011.

[24] D. Chen and A. C. Bovik, "Visual Pattern Image Coding," IEEE Trans. on Communication., Vol. 38, No. 12, pp. 2137-2146, 1990.

[25] P. Nasiopoulos, R. K. Ward, and D. J. Morse, "Adaptive Compression Coding," IEEE Trans. on Commun., Vol. 39, No. 7, pp. 1245-1254,1991.

[26] Y. C. Hu, "Improved Block Truncation Coding for Image Compression," IEE Electronics Letters, Vol. 39, No. 19, pp. 1377-1379, 2003.

[27] S. I. Olsen," Block truncation and planar image coding," Pattern Recognition Letters, 21:1141–1148, 2000.

[28] Y. K. Wang and G. F. Tu., "Block truncation coding with adaptive decimation and interpolation," In Proc. SPIE International Conference on Visual Communication and Image Processing 2000 (VCIP 2000), volume 4067, pages 430– 437, Perth, Australia, 2000.

[29] Delp and O. R. Mitchell, "Image Coding Using Block Truncation Coding," IEEE Transactions on Communications, Vol. 27, pp. 1335-1342, 1979.

[30] D. J. Healy, and O. R. Mitchell, "Digital Video Bandwidth Compression Block Truncation Coding", IEEE trans. on Communications,., Vol. 29, pp. 1809-1817, 1981.

[31] Alcaim A., Oliveira L.V.,"Vector Quantization of the Side Information in BTC Image Coding,"Proc. ICCS/ICITA 92, Singapore, 1, 345-349. In (1992).

[32] Kamel M., Sun C. Guan L.,"Image Compression by Variable Block Truncation Coding with Optimal Threshold,". IEEE Transactions on Signal Processing, 39, 208-212. (1991).

[33] Monet P., Dubois E. (1993) Block Adaptive Quantization of Images. IEEE Transactions on Communications, 41, 303-306.

[34] J.W. Han, Y.J. Yoon, T.S. Wang, M.C.Hwang, and S.J. Ko.," Vector quantizer based block truncation coding for color image compression in LCD overdrive,"IEEE Transaction Consumer Electronics, pp. 1–4, April 2008.

[35] K. Nakanishi, S. Takahashi, and H. Oura, "Fast response 15-in. XGA TFT-LCD with feed-forward driving (FFD) technology for multimedia applications," SID Symposium Digest of Technical Papers, vol. 32, no.1, pp. 488-491, May 2001.

[36] J. Someya, M. Yamakawa, and E. Gofuku, "Reduction of memory capacity in feed-forward driving by image compression," SID Symposium Digest of Technical Papers, vol. 33, no.1, pp. 72-75, May 2002.

[37] Aditya Kumar, Pardeep Singh, "An Image Compression Algorithm for Gray Scale Image,"IEEE International Conference on Emerging Trends in Networks and Computer Communications(ETNCC- 2011)

[38] M. D. Lema and O. R. Mitchell, "Absolute Moment Block Truncation Coding and Its Application to Color Image," IEEE Transactions on Communications, Vol. 32, pp. 1148-1157, 1984.

[39] J. Shukla, M. Alwani, A.K.Tiwari," A survey on lossless image compression methods", 2010 2nd International Conference on Computer Engineering and Technology (ICCET).

[40] Nak-Kwon Lim, Dae-Young Kim, Haeyoung Lee," Interactive progressive image transmission for real time applications," IEEE Transactions on Consumer Electronics,2010.

[41] J.M. Guo and M.F. Wu. ,"Improved Block truncation coding based on the void-andcluster dithering approach," IEEE Transactions on image processing, vol. 18, no. 1, pp. 211-213, Jan. 2009.

[42] Y. V. Ramana and C. Eswaran, "A New Algorithm for BTC Bit Plane Coding," IEEE Transaction. on Communications., Vol. 43, No. 6, pp. 2010-2011, 1995.

[43] J. Someya, N. Okuda, and M. Yamakawa, "Reducing the memory of compression feed-forward driving for a new LCD controller," Journal of the Society for Information Display, vol. 12, no.1, pp. 37-44, Mar. 2004.

[44] T.M. Amarunnishad, V.K. Govindan, and T.M. Abraham," Block truncation coding using a set of predefined bit planes," In Proc. Int. Conf. Computational Intelligence and Multimedia Applications, Dec. 2007, vol. 3, pp. 73–78.

[45] J. Someya, N. Okuda, and H. Sugiura, "The suppression of noise on a dithering image in LCD overdrive," IEEE Transactions on Consumer Electronics, vol. 52, no. 4, pp. 1325-1332, Nov. 2006.

[46] J. W. Han, M. C. Hwang, and S.J. Ko, "Vector quantizer based block truncation coding for color image compression in LCD overdrive," IEEE Transactions on Consumer Electronics, vol. 54, no. 4, pp. 1839-1845 ,Nov. 2008.

[47] J. Wang and J. W. Chong, "High performance overdrive using improved motion adaptive codec in LCD," IEEE Transactions Consumer Electronics, vol. 55, no. 1, pp. 20-26, Feb. 2009.

[48] Y.V.Ramana, and C. Eswaran," A new algorithm for BTC image bit plane coding "IEEE Trans on Communications. Vol. 43, No.6, pp. 2010-2011, June 1995.

[49] Gahroudi, M.R., and Sarshar, M.R.: 'Image retrieval based on texture and color method in BTC-VQ compressed domain'. 9th Int. Symp. on Signal Processing and Its Applications, Sharjah, United Arab Emirates, February 2007, pp. 1–4.

[50] D. Halverson, N. Griswold, and G. Wise, "A Generalized Block Truncation Coding Algorithm for Image Compression," IEEE Trans. on Acoustics Speech Signal Processing, Vol. 32, pp. 664-668, 1984.

[51] Doaa Mohammed, Fatma Abou-Chadi,"Image Compression Using Block Truncation Coding," Cyber Journals: Multidisciplinary Journals in Science and Technology, Journal of Selected Areas in Telecommunications (JSAT), February Edition, 2011.

[52] C.S. Huang and Y. Lin. ,"Hybrid block truncation coding,". IEEE Signal Processing Letter, vol. 4, no. 12, pp. 328–330, Dec. 1997.

[53] K. R. Rao and P. Yip, Discrete Cosine Transform: Algorithms, Advantages, Applications. New York: Academic, 1990.

[54] Zeng B., "Two Interpolative BTC Image coding Schemes,"Electronics Letters, vol. 27, (13), pp. 1126-1128, June 1991.

[55] M. Rabbani and R. Joshi, ''an overview of the JPEG 2000 still image compression standard,'' Signal Process. Image Commun. 17, pp. 3–48, 2002.

[56] Yu-Chen Hu, "Low complexity and low bit-rate image compression scheme based on Absolute Moment Block Truncation Coding", Vol. 42 No. 7 (2003) pp 1964-1975.

[57] Mitchell H.B., Dorfan M,"Block Truncation Coding Using Hopfield Neural Network," Electronics Letters, 28, 2144-2145. (1992).

[58] Y. Linde, A. Buzo, and R. M. Gray. An algorithm for vector quantization. IEEE Transactions on Communications, 28:84 – 95, 1980.

[59] T. P. Chen, B. Zeng, and M. L. Liou, "Visual Pattern BTC with Two Principle Colors for Color Images," Proceedings of the 1995 IEEE International Symposium on Circuit and Systems, Vol. 1, pp. 235-238, 1995.

UACEE
Globalize The Research
Localize The World

[60] Y. G. Wu and S. C. Tsai, "An Efficient BTC Image Compression Technique," IEEE Trans. On Consumer Electronics, Vol. 44, No. 2, pp. 317-325, 1998.

[61] Y. C. Hu, "Low-Complex and Low-bit-rate Image Compression Scheme Based on AMBTC," Optical Engineering, Vol. 42, No. 7, pp. 1964-1975, 2003.

[62] Y. C. Hu, "Improved Block Truncation Coding for Image Compression," IEE Electronics Letters, Vol. 39, No. 19, pp. 1377-1379, 2003.

[63] C. Y. Yang and J. C. Lin, "EBTC: An Economical Method for Searching The Threshold of BTC Compression," *Electronic Letters*, Vol. 32, No. 20, pp. 1870-1871, Sep. 1996.

[64] Pham, T.Q., and van Vliet, L.J.: 'Separable bilateral filtering for fast video preprocessing'. Proc. 2005 IEEE Int. Conf. on Multimedia and Expo, Amsterdam, The Netherlands, 2005, Vol. CD1–4

[65] Y. K. Wang and G. F. Tu. Block truncation coding with adaptive decimation and interpolation. In Proc. SPIE International Conference on

[66] Visual Communication and Image Processing 2000 (VCIP 2000), volume 4067, pages 430–437, Perth, Australia, 2000.

[67] J. Someya and N. Okuda, "Motion adaptive CODEC feed-forward driving for LCD overdrive," Journal of the Society for Information Display, vol. 13, no.6, pp. 517-524, Jun. 2005.

[68] J. Wang, K. Y. Min, and J. W. Chong, "A hybrid image coding in overdrive for motion blur reduction in LCD," Proc. of 6th Int. Computer Entertainment Computing (ICEC'07), Shanghai, China, Sep. 2007, pp. 263 – 270.

[69] D. L. Lau, G. R. Arce, and N. C. Gallagher, "Digital color half toning via generalized error-diffusion and vector green-noise masks," IEEE Trans. Image Process., vol. 9, no. 5, May 2000.

[70] Y. C. Hou, S. F. Tu, and Y. H. Chang, "Block truncation coding by using genetic algorithm," in Proc. International Commun., Control, Signal Process., Mar. 2008, pp. 1273–1278.

[71] Uchiyama, T., Takekawa, N., Kaneko, H., Yamaguchi, M., and Ohyama, N.: 'Multispectral image retrieval using vector quantization'. Proc. IEEE Int. Conf. on Image Processing, Thessaloniki, Greece, 2001, Vol. 1, pp. 30–33.

[72] Y. C. Hu, "Low-Complex and Low-bit-rate Image Compression Scheme Based on AMBTC," Optical Engineering, Vol. 42, No. 7, pp. 1964-1975, 2003.

AUTHORS PROFILE

Aditya Kumar received his B. Tech. degree from Ajay Kumar Garg Engineering College, Ghaziabad, India. He is currently pursuing M. Tech. at the Department of Computer Science & Engineering, National Institute of Technology, Hamirpur (HP) India.His research interests include Image compression and Digital Image processings. He is currently working on Image Compression Techniques..

Pardeep Singh is working as Assistant Professor in the department of Computer Science & Engineering of National Institute of Technology, Hamirpur (HP) India. He is perusing PhD from the parent institute. His research area is speech processing. He is a member of International Association of Computer Science and Information Technology (IACSIT) and International Association of Engineers (IAENG).

.

UACEE
Globalize The Research
Localize The World