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ENHANCED AMBTC COMPRESSION TECHNIQUES FOR COLOR IMAGES

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Abstract- Image Compression methods have become inevitable now-a-days as the cost associated with storage and transmission of images is increasing in multi fold. Image Compression techniques are classified into two categories namely Lossy and Lossless techniques. Lossless techniques compress images without much loss of data and compressed images are the exact replica of the input images, whereas the reconstructed images of Lossy techniques are the approximation of input images. AMBTC is one of the Lossy techniques used for compressing images and it is very simple to implement and efficient in performance. In this paper, we have proposed an enhanced AMBTC color image compression technique. In this proposed method, multilevel compressionis achieved using the variants of AMBTC such as Bitmap Omission, Improved AMBTC, Interpolation and Quantization Subtraction and the performance is improved both in terms of quality of the reconstructed image and reduced storage cost. Color images are taken for the study. Simulated results show that the proposed method produces better visual quality and compression rate than that of the existing techniques.

Keywords: AMBTC, Bitrate, Interpolation, Quantization Subtraction, PSNR.

INTRODUCTION

Block Truncation Coding (BTC) for compressing gray scale images was introduced by Delp and Mitchell in 1979. BTC is a lossy image compression technique for compressing the digital images. Main advantages of this method are simple, fault tolerance, high compression efficiency and high quality of the image [1]. BTC is suitable for real-time and low-computational cost multimedia applications [2].Variants of BTC such as Bitmap Omission technique, Pattern flipping technique [3] and bitmap interpolation technique [4, 5] are introduced to improve the Coding Efficiency. Some hybrid image coding techniques such as Combining both Vector Quantization and BTC schemes have been introduced [6, 7]. Thirdapproach is to reduce the spatial similarity of neighboring pixels or blocks, some prediction technique such as Predictive Coding Technique [8], Variable rate Quadtree Segmentation technique [9]. But the drawback of Quadtree segmentation and

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Predictive coding technique is the staircase effects and blocking artifacts effects. To solve the staircase and blocking artifacts effects, some other techniques are introduced such as fuzzy BTC [10], optimal pixel grouping scheme [11], fuzzy logic bitmap technique [12], halftoning techniques[13] and combining differential pulse code manipulation with BTC[14] has been introduced.

The rest of this paper is organized as follows. The related works are discussed in Section 2. The detailed description of the proposed scheme is given in Section 3. Experimental results and discussions are explained in Section 4.Conclusion is given in Section 5.

2. Related Works

BTC is also applied to the color images. In 1984, Lema and Mitchell proposed a color image compression using AMBTC (CAMBTC) [15]. This scheme gives better image quality but the bitrate is 6bpp. Several techniques are developed to reduce the storage cost of color image compression. In 1992, Wu et al. introduced a common single bitmap for all three components [16]. In this scheme, the compressed code contains one common bitmap and six quantization levels, which leads to 4 bpp. In 1997, Yang et al. proposed a new method based on Moment preserving and block truncation coding techniques [17]. In 2000, Chang et al. proposed a colour image compression scheme based on Two-Layer Absolute Moment Block Truncation Coding (TLAMBTC) [18].In 2007, Bibhas et al. proposed a color image compression based on BTC using pattern fitting (CBTC_PF) [19]. In 2008, Y.C Hu et al. proposed a predictive color image compression scheme based on AMBTC, where Block Prediction technique, Bitmap Omission technique and Coding of Quantization levels are used to reduce the storage cost of smooth and complex blocks [20]. In 2011, Y.C Hu et al. proposed a novel variable sized block encoding with threshold control for Color Image Quantization (CIQ). In this scheme, Quadtree Segmentation technique and Threshold Control Policy are used to reduce the similarity between the color pixels. It gives adaptive bitrates while keeping the image quality without using multiple color palates [21].

In 2014, Yu-Chen Hu et al.'s proposed a two image coding techniques based on single bitmap block truncation coding. In this first scheme (FS), a new technique is introduced named as optimal rule, is used to generate the common bitmap for three components. The optimal rule performance is better than that of three other common bitmap generation techniques such as Majority rule, Luminance rule and Weighted rule. In this FS, Quantization Level Recalculation (QLRC) technique is used to recomputed the quantization levels based upon the common bitmap (BM_c) to maintain the quality of color images. In this FS, bitrate of the color image is achieved as 4 bpp. Further reduce the bitrate introduced second scheme (SS). In this SS, block prediction technique and bitmap omission technique is used to reduce the bitrate of color images. The 4 bpp is reduced to near around 3 bpp [22]. In 2014, Jayamol Mathews et al. had been proposed a new approach to color image compression based on HSV model using

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improved BTC algorithm with k-means Quad Clustering (IBTC-KQ). In this scheme, RGB plane is converted into HSV plane to reduce the high correlation between the RGB planes.Each HSV plane is encoded by IBTC-KQ method. In this scheme, the size of the block is varied based on the plane to improve the quality and reduce the bitrate. This method is compared to other RGB model and it shows better performance both in quality and compression ratio. This method involves less number of simple computations and is suitable for real time transmission [7]. In 2014, Wu-Lin Chen et al. proposed a novel color image compression scheme based on AMBTC. In this scheme, Quadtree segmentation and bitmap omission technique are used to cut down the bitrate of the color images. In this scheme, selection of control threshold values (THQT and THBO) set the image quality and bitrate. The small value of THQT and THBO gives better image quality and high bitrate. In this scheme, control the threshold value range gives better image quality with low bitrates [9].

In 2016, Li et al. proposed a novel color image compression scheme based on Binary Ant Colony Optimization (BACO) technique. In this scheme, first, color image is compressed by BTC algorithm to get three individual bitmap and three pair of quantization values of RGB components. Second, a near-optimized common bitmap is generated with minimum distortion of entire color image. In this method gives better visual quality and less computational complexity then the existing schemes [23]. In 2018, Zhang Lige et al. proposed an improved single bitmap block truncation coding (SBBTC) scheme based on W-plane method using parallel computing and hill climbing algorithm. This scheme is better than that of the other existing schemes in visual quality and time consumption [24]. In 2019, Rajeev Kumar et al. had been proposed a new enhanced AMBTC color image compression. In this scheme uses the characteristics of Human Visual System (HVS) to enhance the quality of the color images. In this scheme, color image is converted into YCbCr image and then each components are divided into non-overlapping blocks.in this method, Luminance Component is encoded by 4-Level AMBTC method and it's contain four quantizers and 32-bit bitmap and the remaining components (Cb& Cr) are encoded by 2-Level AMBTC method. It's containing two quantizers and 16-bit bitmap. Further reduce the bitrate, interpolation techniques used to compress 16-nit bitmap into 8-bit bitmap. An experimental result of this scheme gives high image quality but the bitrate is also high. Main drawback of this scheme is compressed color image is vary from original image because of YCbCr color conversion [25].

3. PROPOSED METHOD

In this proposed method, color images are compressed in four sub sequent levels using AMBTC based compression techniques such as Bitmap Omission technique, and two-level AMBTC compression technique, Interpolation and Quantization Subtraction.The RGB color image is first divided into Red, Green and Blue components. Each plane is divided into non-overlapping blocks

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of size 4 x 4 pixels and is classified into low-detailed, medium-detailed and high-detailed blocks based on the difference (D) of two quantization values.Mean, HMean and LMean values are calculated using the equations (1-3) and the difference (D) is calculated using the equation (4).

$$Mean = \frac{1}{16}\sum_{i=1}^{16} x_i \qquad (1)$$

$$HMean = \frac{1}{p}\sum_{x_i \geq Mean} x_i \qquad (2)$$

$$LMean = \frac{1}{(16-p)}\sum_{x_i < Mean} x_i \qquad (3)$$

$$D = HMean - LMean \qquad (4)$$

where p is number of pixel values is greater than or equal to Mean.

Three indicator bit pairs; '00', '01'and '10' are used to represent low-detailed, medium-detailed and high-detailed blocks respectively. If the D value is less than or equal to a Threshold (TH1), then the block is low-detailed block.

For a low-detailed block, only Mean is stored and the Bitmap is omitted. Hence a low-detailed block is replaced with the Mena of the Block. In Figure-1, the difference is 5, and then the block is low-detailed block. We store only Mean value (84) with indicator bit '00'.

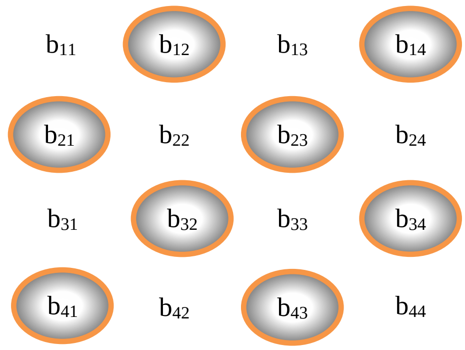
If the D value is greater than the Threshold (TH1) and less than or equal to Threshold (TH2), then the block is Medium-Detailed block. In a medium detailed block, 16 bit-bitmap (BM_{16}) is generated using the equation (5).

$$BM_{16} = \begin{cases} 1 & if\ x_i \geq Mean \\ 0 & Otherwise \end{cases} \qquad (5)$$

The 16 bit Bitmap (BM_{16}) is then reduced into 8-bit Bitmap by dropping the bits in the positions encircled in the Figure 2(b) by exploiting the feature of Inter-pixel redundancy.

$$\begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \\ b_{41} & b_{42} & b_{43} & b_{44} \end{bmatrix}$$

(a) Original Bitmap



(b) Circled Bits are dropped

Figure 2: Interpolation Method

In the Figure 2, (a) shows that the original bitmap block and (b) shows that the circled bits are dropped then the 16 bits are reduced into 8 bit.

In a medium-detailed block, contains two quantization values (*HMean & LMean*) and 8-bits Bitmap. To improve the coding efficiency, the Quantization Subtraction method is used, where for each medium-detailed block, the difference D is stored as second quantizer and hMean is stored as first quantizer. In the decoding process, *LMean* value is calculated using the equation (6).

$$Lmean = Hmean - D \qquad (6)$$

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The reconstructed block (*RB*) calculated based on 8-bit Bitmap using the equation (7).

$$RB = \begin{cases} LMean & if\ BM == 0 \\ HMean & if\ BM == 1 \end{cases} \qquad (7)$$

The reconstructed block (*RB*) contains only 8 values and the remaining 8 values of *RB* are calculated using the equation (8).

$$RB = \begin{cases} (p_{i,j-1} + p_{i,j+1} + p_{i+1,j})/3 & if\ i == 1 \&\& j == 2 \\ (p_{i,j-1} + p_{i+1,j})/2 & if\ i == 1 \&\& j == 4 \\ (p_{i-1,j} + p_{i,j+1} + p_{i+1,j})/3 & if\ i == 2 \&\& j == 1 \\ (p_{i-1,j} + p_{i,j-1} + p_{i,j+1} + p_{i+1,j})/4 & if\ (i == 2 \&\& j == 3) \| \\ & (i == 3 \&\& j == 2) \\ (p_{i-1,j} + p_{i,j-1} + p_{i+1,j})/3 & if\ i == 3 \&\& j == 4 \\ (p_{i-1,j} + p_{i,j+1})/2 & if\ i == 4 \&\& j == 1 \\ (p_{i-1,j} + p_{i,j-1} + p_{i,j+1})/3 & if\ i == 4 \&\& j == 3 \end{cases} \qquad (8)$$

In Figure 3, (a) shows that the input block, the difference is 9 then the block is medium-detailed block, (b) shows that the 16-bit Bitmap, (c) shows that the 16-bit Bitmap is reduced into 8-bit bitmap using interpolation method, (d) shows that the reconstructed block of 8-bit bitmap and (e) shows that the reconstructed block using interpolation method.

$$\begin{bmatrix} 122 & 133 & 104 & 115 \\ 117 & 109 & 111 & 106 \\ 118 & 114 & 109 & 105 \\ 120 & 112 & 118 & 104 \end{bmatrix} \begin{bmatrix} Mean = 112 \\ HMean = 116 \\ LMean = 107 \\ D = 116 - 107 = 9 \\ TH1 = 5 \& TH2 = 10 \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 \end{bmatrix}$$

(a) *Input* Block $(b)16-bit\ Bitmap$

$$\begin{bmatrix} 1 & - & 0 & - \\ - & 0 & - & 0 \\ 1 & - & 0 & - \\ - & 1 & - & 0 \end{bmatrix} \begin{bmatrix} 116 & - & 107 & - \\ - & 107 & - & 107 \\ 116 & - & 107 & - \\ - & 116 & - & 107 \end{bmatrix} \begin{bmatrix} 116 & 110 & 107 & 107 \\ 113 & 107 & 107 & 107 \\ 116 & 102 & 107 & 107 \\ 116 & 116 & 110 & 107 \end{bmatrix}$$

$(c)8-bit\ Bitmap$ (d) *Reconstructed* 8 − *bit* Block (e) *Reconstructed Block*

Figure 3: Example of Medium-detailed block

If D value is greater than Threshold2 (TH2) then the block is high-detailed. In a high detailed block, fourlevels AMBTC compression method is used as four level Quantizers are calculated using the equations(9-12).

$$Q1 = \frac{1}{p_1} \sum_{x_i < LMean} x_i \qquad (9)$$

$$Q2 = \frac{1}{p_2} \sum_{x_i > LMean \&\& x_i < Mean} x_i \qquad (10)$$

$$Q3 = \frac{1}{p_3} \sum_{x_i > Mean \&\& x_i \le HMean} x_i \qquad (11)$$

$$Q4 = \frac{1}{p_4} \sum_{x_i > HMean} x_i \qquad (12)$$

In this block, 32 bit Bitmap is computed using the equation (13) based on the four-level quantizers.

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$$BM_{32} = \begin{cases} 00 & if\ x_i < LMean \\ 01 & if\ x_i \geq LMean \&\& x_i < Mean \\ 10 & if\ x_i \geq Mean \&\& x_i \leq HMean \\ 11 & if\ x_i > HMean \end{cases} \quad (13)$$

Then the 32-bit Bitmap is reduced to 16-bit Bitmap using interpolation method.In a high detailed block contains four quantization values (*Q1, Q2, Q3 and Q4*) and 16-bit Bitmap with indicator bit ‘10’.Further reduce the bits of two four quantization values using quantization subtraction method as follows:

$$\|Q4\ \|Q4 - Q3\ \|Q3 - Q2\ \|Q2 - Q1\ \| is\ formed\ as \|\ Q_4\ \|\ D_1\ \|\ D_2\ \|\ D_3\ \|$$

In a decoding process of high detailed block, reform the quantizer values as follows:

$$Q4\ \|\ Q3 = Q4 - D1\ \|\ Q2 = Q3 - D2\ \|\ Q1 = Q2 - D3\ \|$$

The reconstructed block (RB) of high detailed block is calculated based on the 16-bit bitmap using the equation (14).

$$RB = \begin{cases} Q_1 & if\ BM_{32} == 00 \\ Q_2 & if\ BM_{32} == 01 \\ Q_3 & if\ BM_{32} == 10 \\ Q_4 & if\ BM_{32} == 11 \end{cases} \quad (14)$$

The reconstructed block contains only 8 values and the remaining eight values are calculated using the equation (8).

In figure 4, Input block as shown in Figure 4(a). In the Input block, difference is 29 then the block is high-detailed. The 32-bit bitmap is formed as shown in figure 4(b). The 32-bit bitmap is transformed into 16-bit bitmap using interpolation method as shown in figure 4(c). The reconstructed block of 16-bit bitmap values as shown in figure 4(d). Remaining values of reconstructed block are calculated using interpolation method as shown in figure 4(e).

$$\begin{bmatrix} 122 & 133 & 104 & 115 \\ 117 & 109 & 90 & 87 \\ 118 & 114 & 85 & 84 \\ 120 & 102 & 83 & 82 \end{bmatrix} \begin{bmatrix} Mean = 104 \\ HMean = 117 \\ LMean = 88 \\ D = 117 - 88 = 29 \\ TH1 = 5 \& TH2 = 10 \\ Q_1 = 84, Q_2 = 96 \\ Q_3 = 112, Q_4 = 123 \end{bmatrix} \begin{bmatrix} 11 & 11 & 10 & 10 \\ 10 & 10 & 01 & 00 \\ 11 & 10 & 00 & 00 \\ 11 & 01 & 00 & 00 \end{bmatrix}$$

(a) Input Block (b) 32 – bit Bitmap

$$\begin{bmatrix} 11 & - & 10 & - \\ - & 10 & - & 00 \\ 11 & - & 00 & - \\ - & 01 & - & 00 \end{bmatrix} \begin{bmatrix} 123 & - & 112 & - \\ - & 112 & - & 84 \\ 123 & - & 84 & - \\ - & 96 & - & 84 \end{bmatrix} \begin{bmatrix} 123 & 116 & 112 & 98 \\ 119 & 112 & 98 & 84 \\ 123 & 104 & 84 & 84 \\ 110 & 96 & 88 & 84 \end{bmatrix}$$

(c) 16 – bit Bitmap (d) Reconstructed 16 – bit Block (e) Reconstructed Block

Figure 4: Example of high-detailed block

Encoding Algorithm

Step 1: The input color image I is divided into three planes such as Red, Green and Blue component plane.

Step 2: Divide each plane into non-overlapping blocks of size 4*4.

Step 3: Compute *Mean* and two quantization values (*LMean and HMean*) for each block using the equations (1-3).

Step 4: Find the difference (D) using the equation (4).

Step 5: If $D \leq TH1$, then the block is low detailed, we store mean values with indicator bit '00'.

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Step 6: If $D > TH1 \, and \, D \leq TH2$, then the block is medium detailed.

Step 6.1: Generate the 16-bit bitmap using equation (5).

Step 6.2: The 16-bit bitmap is reduced to 8-bit Bitmap using interpolation method.

Step 6.3: The quantization subtraction method is used to reduce the bit of quantization values.

Step 6.4: In a medium detailed block, we store two quantization values and 8-bit bitmap with indicator bit '01'.

Step 7: If $D > TH2$, then the block is high detailed.

Step 7.1: Compute the four quantizer values (Q_1, Q_2, Q_3 and Q_4) using the equations (9-12).

Step 7.2: Generate the 32-bit Bitmap using the equation(13).

Step 7.3: The 32-bit Bitmap is reduced to 16-bit Bitmap using interpolation method.

Step 7.4: Reduce the bit of four quantizer values using quantization subtraction method.

Step 7.5: In a high detailed block, we store four quantizers, 16-bit bitmap with indicator bit '10'.

Step 8: Repeat this step 2-7 until all two blocks and planes are presented.

Decoding Algorithm

Step 1: Read the indicator bit.

Step 2: If the indicator bit '00', then the block is low detailed. Replace all the pixel values as mean.

Step 3: If the indicator bit '01', then the block is medium detailed.

Step 3.1: Get the quantizer (HMean & LMean).

Step 3.2: Regenerate the 8-bit bitmap into 16-bit Bitmap using interpolation method.

Step 4: If the indicator bit '10' then the block is high detailed.

Step 4.1: Get the quantizer (Q1, Q2, Q3 and Q4) based on the reverse process of quantization subtraction method.

Step 4.2: In a high detailed block, regenerate the 16-bit Bitmap into 32-bit Bitmap using interpolation method.

Step 5: Repeat the steps 1 to 4 until all the blocks are processed.

4. Results and Discussion

All experiments are performed with the benchmark color images of size 512 x 512 pixels. The input images are Lena, F16, Boats, Baboon, Sailboat, House, Goldhill, Barbara, Peppers, Girltoy, Tiffany and Splash. Figure 5 shows the input images taken for the study. The algorithms are implemented using MATLAB R2014b. The Hardware used is, the Intel® Pentium® 1.90 GHZ processor with 8GB RAM.

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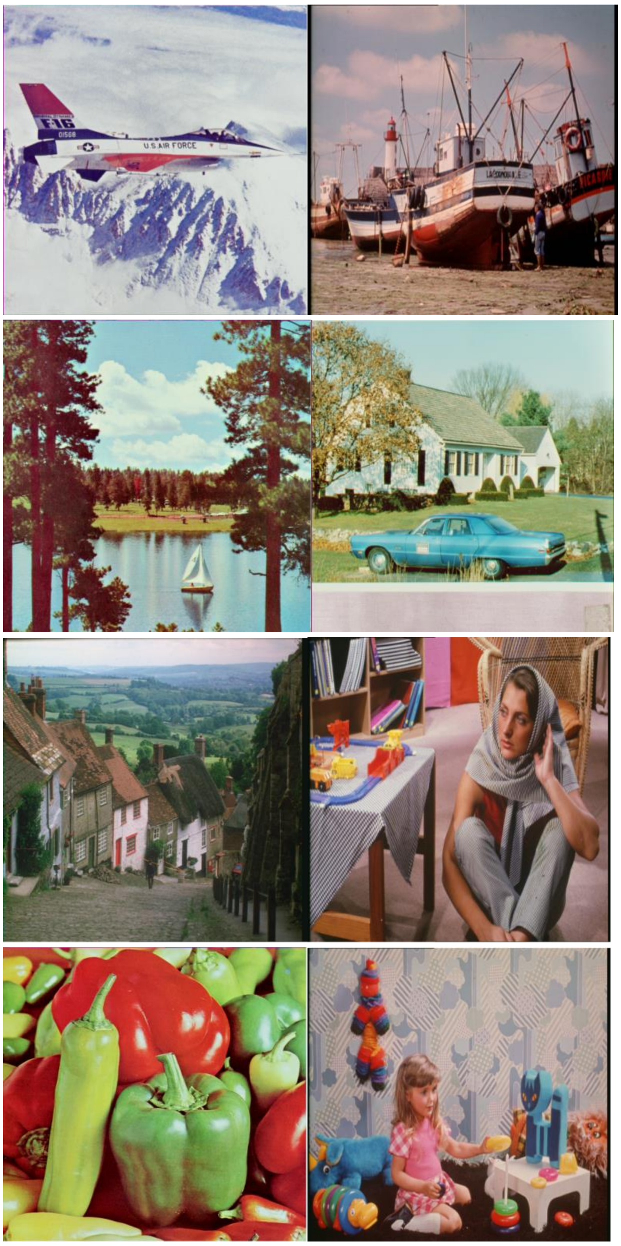

Figure 5. Input Images taken for study

Quality Measurements

The quality measurement factor of compressed color images are Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). The MSE and PSNR of a color images are computed using the equations (15-19).

$$PSNR = 10\log_{10}\left[\frac{255^2}{MSE_{CI}}\right] \quad (15)$$

Here,

$$MSE_{CI} = \frac{1}{3}\left(MSE_R + MSE_G + MSE_B\right) \quad (16)$$

$$MSE_R = \frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(IR_{ij} - IR'_{ij}\right)^2 \quad (17)$$

$$MSE_G = \frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(IG_{ij} - IG_{ij}\right)^2 \quad (18)$$

$$MSE_B = \frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(IB_{ij} - IB_{ij}\right)^2 \quad (19)$$

Where IR,IG,IB denotes the original pixel value of red, green and blue components of the color image and IR',IG',IB' denotes the compressed pixel value of the corresponding components of color image. The experimental

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result of the proposed method is shown in Table 1. In the proposed method, threshold value (TH1 and TH2) range varies from 5 to 25. The value of the threshold can be varied according to the user requirement. If the user wants to high image quality (PSNR), then a lower threshold range is used. However, if the user wants to high compression ratio, then a high threshold range is used.

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Experimental result of image quality (PSNR) and bitrate (BPP) of the proposed method with various threshold Range

Images	**Proposed Method**							
	Range1		**Range2**		**Range3**		**Range4**	
	Th1=5, Th2=10		**Th1=10, Th2=20**		**Th1=5, Th2=20**		**Th1=10, Th2=25**	
	BPP	**PSNR**	**BPP**	**PSNR**	**BPP**	**PSNR**	**BPP**	**PSNR**
Lena	3.63	37.98	2.78	37.04	2.80	36.88	3.67	37.57
F16	3.15	38.70	2.72	38.00	2.72	37.84	3.14	38.34
Boats	3.33	37.78	3.01	37.20	3.01	36.99	3.28	37.42
Baboon	4.52	32.40	4.22	32.23	4.21	32.13	4.43	32.26
Sailboat	4.05	34.92	3.40	34.55	3.43	34.44	3.99	34.63
House	3.77	36.52	3.31	35.97	3.31	35.78	3.72	36.20
Goldhill	3.84	37.80	3.15	36.66	3.17	36.44	3.79	37.17
Barbara	3.78	35.31	3.39	34.94	3.38	34.81	3.75	35.12
Peppers	3.83	36.64	2.87	36.06	2.90	35.96	3.85	36.33
Girltoy	3.66	39.12	3.04	37.81	3.05	37.56	3.59	38.43
Tiffany	3.35	38.80	2.65	37.97	2.65	37.84	3.34	38.43
Splash	2.81	41.02	2.27	39.86	2.28	39.77	2.87	40.71
Average	**3.64**	**37.25**	**3.07**	**36.52**	**3.08**	**36.37**	**3.62**	**36.88**

From Table 1, average of the result shows that Threshold Range3 (TH1=5 &TH2=20) gives better performance of PSNR and BPP of other Threshold ranges.

Images	CAMBTC [15]		SBM_BTC [16]		OSBM_BTC [22]		TLAMBTC [18]		QT_BTC [9]		E_AMBTC [25]		Proposed	
	PSNR	BPP	PSNR	BPP	PSNR	BPP	PSNR	BPP	PSNR	BPP	PSNR	BPP	PSNR	BPP
Lena	37.65	6.00	36.68	4.00	36.50	4.00	32.75	1.38	37.39	4.76	43.41	5.21	37.98	3.63
Airplane	37.87	6.00	37.20	4.00	37.32	4.00	33.75	1.39	37.44	3.20	44.10	5.32	38.70	3.15
House	35.48	6.00	34.59	4.00	34.71	4.00	31.91	1.48	35.35	4.44	41.58	5.48	36.52	3.77
Pepper	37.54	6.00	35.96	4.00	35.82	4.00	32.21	1.40	37.36	5.27	41.96	5.33	36.64	3.83
Splash	41.17	6.00	39.94	4.00	39.72	4.00	35.28	1.33	40.06	2.83	46.00	5.27	41.02	2.81
Tiffany	39.46	6.00	34.35	4.00	38.17	4.00	34.25	1.37	39.07	4.47	43.51	5.27	38.80	3.35
Average	**38.20**	**6.00**	**36.45**	**4.00**	**37.04**	**4.00**	**33.36**	**1.39**	**37.78**	**4.16**	**43.43**	**5.31**	**38.28**	**3.42**

Table 2. Comparison of the PSNR and BPP of the Proposed method with Other Existing Techniques

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Comparative results of CAMBTC [15], SBM_BTC [16], OSBM_BTC [22], TLAMBTC [18], QT_BTC [9], E_AMBTC [25] and proposed method are given in Table 2. The average PSNR and BPP of CAMBTC are 38.20 and 6 bpp. In SBM_BTC [16] and OSBM_BTC [22], PSNR values are 36.45 dB and 37.04 with 4bpp. Compare to SBM_BTC, OSBM_BTC gives better image quality with same bitrate. In TLAMBTC [18], gives lowest bitrate (1.39 bpp) with acceptable image quality (33.36 dB). In TLAMBTC, some staircase effects appear in the compressed images.In QT_BTC [9], gives good image quality (37.78 dB) with 4.16 bpp. In E_AMBTC [25], gives highest image quality (43.43 dB) with highest bitrate 5.31 bpp. In E_AMBTC scheme, some more colors are added to compressed images compare to original color image. In overall performance, the proposed method gives better image quality with lowest bitrate. The average of PSNR and BPP of the proposed method are 38.28 dB and 3.42 bpp. The visual comparison of the existing and proposed methods of the Lena image is shown in Figure 6.

Original Image

CAMBTC
PSNR =37.65
BPP=6.00

SBM_BTC
PSNR =36.68
BPP=4.00

OSBM_BTC
PSNR =36.50
BPP=4.00

TLAMBTC
PSNR =32.75
BPP=1.38

QT_BTC
PSNR =37.39
BPP=4.76

E_AMBTC
PSNR =43.41
BPP=5.21

Proposed Method
PSNR =37.98
BPP=3.63

Figure 6.Visual Comparison of Existing and Proposed method in Lena Image

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5. CONCLUSION

In this paper, a new enhanced AMBTC color image compression technique is proposed. In this proposed method, 4-Level AMBTC, 2-Level AMBTC, Bitmap omission technique, Interpolation and Lossless Quantization Subtraction methods are used to improve the image quality and reduce the storage cost of the color images. The proposed method gives better image quality and bitrate of other existing techniques. Many existing color image compression techniques, some color conversion techniques are used to enhance colors. But in our proposed method, no color conversion technique is used. The experimental result shows that, proposed method gives good image quality (38.28 dB) with lowest bitrate (3.42 bpp).

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