Color image compression based on Luminance and Chrominance using Binary Wavelet Transform (BWT)and Binary Plane Technique (BPT)

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Abstract— **Image coding is the key and most prevalent component in multimedia communication and storage systems. In this paper image compression using binary wavelet transforms [1] and binary plane technique [2, 3] is proposed. This method is compared against the standard JPEG compression. Experimental results show improvement in compression ratio and PSNR for the reconstructed image.**

Keywords: Image compression, BWT, BPT, JPEG compression

I. INTRODUCTION

In a distributed environment large image files remain a major bottleneck within systems. Compression is an important component of the solutions available for creating file sizes of manageable and transmittable dimensions. Increasing the bandwidth is another method, but the cost sometimes makes this a less attractive solution. Platform portability and performance are important in the selection of the compression/decompression technique to be employed. Compression solutions today are more portable due to the change from proprietary high end solutions to accepted and implemented international standards. In most of the applications the exact restoration of stored image is not mandatory. This fact can help to make the storage more effective, and in this way we get the lossy compression methods. JPEG is evolving as the industry standard technique for the compression of continuous tone images. But this has a limitation for the color images that the application where the color integrity is important like correcting chromatic aberration is not suitable for JPEG data. In this paper a lossy image compression is proposed by considering the chrominance aberration correction.

In this proposed method the image is converted from RGB to YCbCr and lossless compression is done for the Y components while the lossy is done for the C_b, C_r components there by achieving high quality of reconstructed image.

II. BINARY WAVELET TRANSFORM

The wavelet-transform compression technique offers a better compression performance than the DCT-based JPEG compression standard. In addition, many features such as quality and resolution scalability can be achieved with a single bit stream. This would not be possible for the current JPEG. However, DCT-based JPEG has the clear advantage of a very low implementation complexity [4] over the wavelet-based technique. Wavelets representation is suggested in many of the image applications like edge detection, image coding, filtering and time frequency analysis due to its fastness and convenient tree structures. Most of the existing wavelet filters designed in the real field for gray level images have wide range of wavelet coefficients and bring out an expansion in the alphabet size of the symbols, leads to extra passes and bits for representing sign information of the wavelet coefficients. This expansion dramatically increases the model cost of the entropy coder for gray level images which are represented as eight alphabets. The most important feature of the BWT is the conservation of alphabet size of wavelet coefficients, which indicates that the transformed images have the same number of grayscale levels as the original images. In particular, for a K-bit grayscale image, the range of BWT coefficients is still maintained within [0, 2K-1]. Therefore, it is reasonable to expect that the compression efficiency of the BWT coefficients can be improved in that extra bits, originally used to code sign information of the transform coefficients which are saved to code more significant coefficients. The compression complexity might be reduced as the BWT contains simple exclusive-or (XOR) operations only and a maximum number of eight coding passes are involved during the encoding procedure [1].

III. LOSSLESS BINARY PLANE TECHNIQUE[2]

Lossless methods are characteristically chosen for applications where minute image particulars can be of utmost importance, for instance medical and space images or also in remote sensing etc.

According to the BPT, two files 'bit plane' and 'data tables', are to be created. The initial part 'bit plane' seizes the bit 0 for every a pixel alike to preceding pixel and the bit 1 for every pixel diverse from preceding pixel. The subsequent part i.e. 'data table' cling to the essential pixel values only, i.e. for a set of successive recurring values, one value is stored in the data table.

IV. LOSSY BINARY PLANE TECHNIQUE

This technique is based on spatial domain of the image and is suitable for compression of natural and synthetic images. The main objective of this technique is to take advantage of repeated values in consecutive pixels positions. For a set of repeated consecutive values only one value is retained. In the Binary Plane Technique two codes are used to build the Bit Plane. The codes are as given below.

Code 1 (one) is used to indicate that the current pixel is different from the previous pixel. In this case the current pixel is moved to the Data Table

Code 0 is used to indicate that the current pixel is exactly same as the previous pixel. This eliminates the storage of the current pixel.

For e.g. if the image file contains the following pixels

126 78 78 78 249 97 97 188 188 188 188 67 223 90 90 90

Then the bit plane file contains 1 1 0 0 1 1 0 1 0 0 0 1 1 1 0 0

The data file is as 126 78 249 97 188 67 223 90

In the *Lossy binary plane technique* a scalar quantization is done for the data table using equation (1)

$$(PP-TV/2)>=CP<=(PP+TV/2-1) \qquad (1)$$

Where PP-Previous pixel, CP-current Pixel, TV-Threshold value Then the range of data table will be modified as shown in the figure 1.

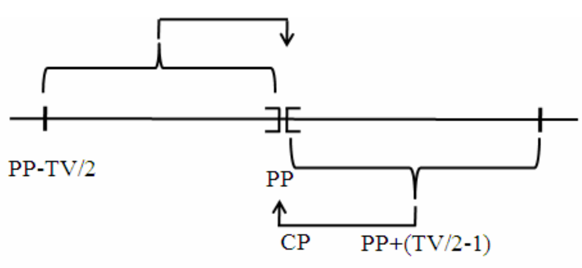

Figure1: Modification of the data table with threshold value

For eg: let us consider a numerical example ,if the image file contains the following pixels

26, 78, 79, 77, 75, 110, 111, 126, 188, 187
TV=8 ε [-4, +3]

TABLE 1: MODIFICATION OF DATA TABLE

CP	PP	Range	BP	DT
126	0	(-4 - 3)	1	126
78	126	(122 - 129)	1	78
79	78	(74 – 81)	0	----
77	78	(74 – 81)	0	----
75	78	(74 – 81)	0	----
110	78	(74 – 81)	1	110
111	110	(106 – 113)	0	----
126	110	(106 – 113)	1	126
188	126	(122 – 129)	1	188
187	188	(184 – 191)	0	----

Then the data table is 126 78 110 126 188
The Binary plane is 1 1 0 0 0 1 0 1 1 0

V. PROPOSED METHOD

The proposed method is shown in the figure 2

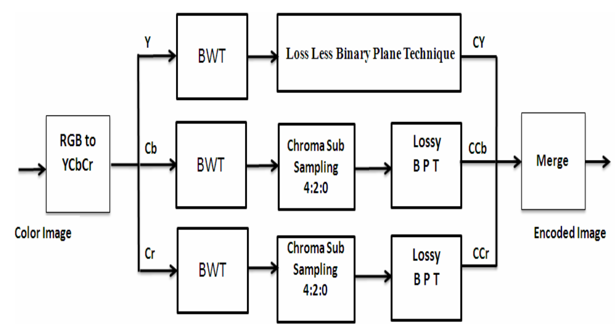

Figure 2: Block diagram for encoding of the proposed method

The given color image (RGB) is translated into YCbCr color space. All these components are decomposed using binary wavelet transform as stated in [1]. Chroma sub sampling of4:2:0 is done for decomposed Cb, Cr components which are followed by lossy mode binary plane compression .Decomposed Y components are subjected to lossless binary plane technique without sub-sampling. The resultant data tables are merged together to form the entire data table and the binary plane forming encoded image. The decoding procedure is shown in the figure 3

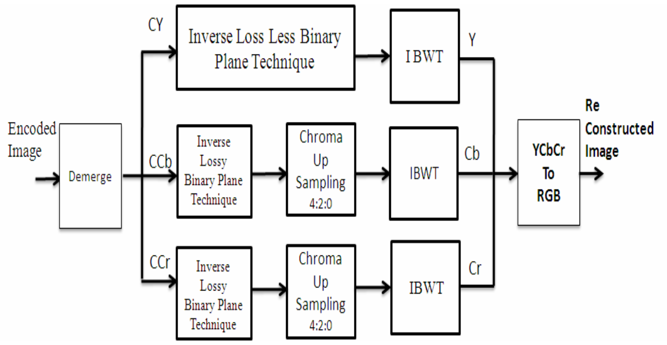

Figure 3: Block Diagram for decoding of the proposed method

vI. EXPERIMENTAL RESULTS

For this, an experimental analysis is done with the different raw images whose resolution is 128x128.Gruop 1 level based binary wavelet transform decomposition is implemented. The results obtained with the different thresholding values are tabulated.

Figure 4: Sample test images for the experiment

STEP BY STEP ALGORITHM EXECUTION

Figure 5: a)Original image b)YC_bC_r image c)Y-component d) Cb-component e)Cr-component f) Restored image with threshold 8 of CR=1.8895 and PSNR=32.0074

In this method of encoding sub sampling of 4:2:0 is done for C_b and C_r components followed by lossy BPT coding. Thus, obtained encoded stream is merged together to form a compressed set of the given image. The encoded image is again split up into Y, Cb and Cr components which are undergone for lossless and lossy BPT decoding followed by chroma up sampling. The inverse BWT is applied for details to restore them back to Y Cb and Cr components. These are again reconverted back into RGB to get a best view

TABLE 2: ANALYSIS OF COMPRESSION RATIO FOR VARIOUS THRESHOLD VALUES

THRESHOLD VERSUS CRR					
	TH 4	TH 8	TH 16	TH 32	TH 64
T 32	2.5039	3.789	5.97	10.38	16.009
WIND	1.6946	2.6768	4.3678	4.8998	51.125
SOAP	6.0339	19.5771	19.897	34.075	34.148
LENNA	1.4595	1.8895	2.6125	3.6987	5.985
SANTA	2.711	3.6171	35.6562	58.524	58.5245
KODIM	2.384	3.251	4.7123	6.9357	9.7632
COFFEBEEN	1.7054	2.6043	4.7096	34.077	51.0995
HWA	1.9378	2.5318	3.1032	3.5504	4.2304

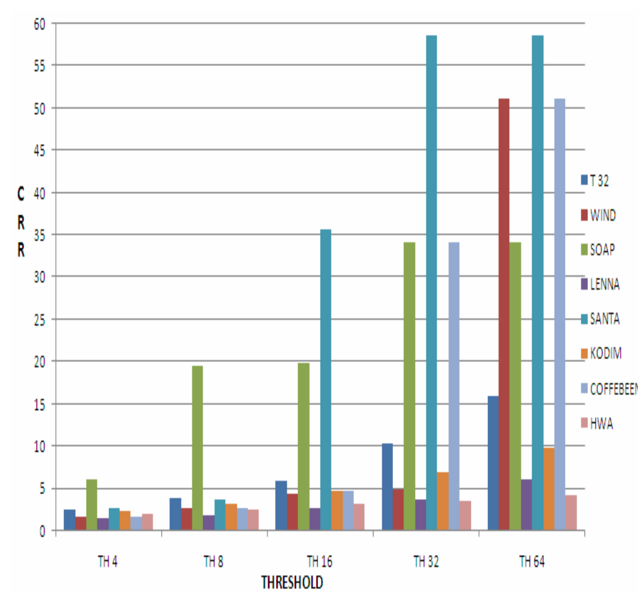

Figure 6: Graphical analysis of threshold Vs compression ratio

TABLE 3: ANALYSIS OF THRESHOLD VALUE AND PSNR FOR DIFFERENT IMAGES

THRESHOLD VERSUS PSNR					
	TH 4	TH 8	TH 16	TH 32	TH 64
T 32	33.716	33.156	32.74	32.26	32.2455
WIND	35.2303	34.4371	32.9037	32.5991	32.5991
SOAP	35.3007	34.6529	34.256	34.2555	34.39
LENNA	32.5446	32.0074	30.95	29.781	29.452
SANTA	35.7339	35.6562	35.5485	35.548	35.548
KODIM	33.7582	33.316	31.7653	31.3688	30.6999
COFFEBEEN	32.3445	31.9907	31.9481	31.9154	31.915
HWA	32.1057	32.1092	32.1031	32.0235	30.4725

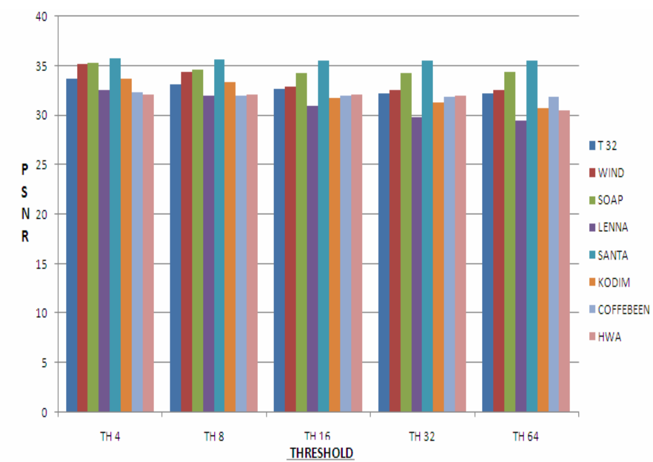

Figure 7: Graphical analysis of threshold Vs PSNR

VII. CONCLUSION

The Lossy Binary Plane Technique produces much higher compression rate than all the three techniques but introduces little loss. The loss is visually insignificant when the threshold value is 4 or 8. When the threshold is 16 or 32 the loss is visually observable. The memory requirements for processing the images in all of these techniques are significantly less compared to JPEG. The JPEG technique requires more memory because the entire image needs to be brought into memory. Proposed method require no complex calculations and processing of the data is performed only in terms of integers, so there is no chance of loss of precision. The JPEG technique requires complex calculations. The processing is done in terms of real numbers where there is possibility of loss of precision.

REFERENCES

[1] M.Ashok, Dr.T.Bhaskar Reddy, Dr.B.Eswara Reddy,"Binary wavelet transform for image representation",IJEST,vol3,no.8,Aug 2011,pg.no:6286-6290

[2] N. Subhash Chandra , M.Balraju, Dr. S.Mahaboob Basha , M. Rama Krishna Reddy ,Dr. T.Bhaskara Reddy,Dr.A.Govardhan,"Loss-less compression of images using binary plane, difference and huffman coding (bdh technique)",Journal of Theoretical and Applied Information Technology.

[3] S.Mahaboob Basha,Dr.B.Sathyanarayana and Dr. T. Bhaskara Reddy " Image Compression Using Binary Plane Technique",Library progress,vol1.27,no:1,June-2007,pg.no:59-64

[4] G. K Wallace, "The JPEG still picture compression standard.",IEEE Trans. Consumer Electron, Vol 38, No 1, Feb 1992.

[5] Baligar, V.P. Patnaik, L.M., and Nagabhushana, G.R. "High compression and low order linear predictor for lossless coding of grayscale images", Image Vis. Computer, 2003, 21, pp. 543–550

[6] Hong Pan, Li-Zuo Jin, Xiao-Hui Yuan, Si-Yu Xia, Jiu-Xian Li, and Liang-Zheng Xia ," A Binary wavelet based scheme for gray scale image compression" ICASSP ', Proceedings of the 2009 IEEE International Conference on Acoustics, Speech and Signal Processing.

[7] Lute kamstra, "The design of linear binary wavelet transforms and their application to binary image compression" IEEE International Conference on Image Processing III. Pg:241-244.

[8] Lute kamstra, " Non linear binary wavelet transforms and their application to binary image compression", IEEE International Conference on Image Processing III. Pg:593-596.

[9] N F law H.Oan,W C Siu, "Lossless image compression using binary wavelet transform IET image processing", Vol 1,no.4 2007

[10] Won-Gyu Kim, Oh-Jin Kwon, Myung-Ho Kang," A binary wavelet transform based authentication algorithm for binary Images"

[11] ITU-recommendations for JPEG compression standard http://www.itu.int/rec/T-REC-T.81/en

[12] N. Jayant," Signal Compression: technology targets and research directions," IEEE J. Select Areas Communications, Vol. 10, No.5, pp 796 – 818 , June 1992.

[13] Rafael C.Gonzalez, Richard E. Woods "Digital Image Processing" Second edition Pearson Education, Printice Hall.

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