Journal of Signal Processing
Volume 4 Issue 3

Efficient Wavelet Coding Technique in DWT-DCT for Color Image Compression

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DOI: *http://doi.org/10.5281/zenodo.1494882*

Abstract

This paper presents a changed crossover wavelet calculation to pack shading picture. After wavelet disintegration, low recurrence coefficients are compacted into T-Matrix utilizing one-dimensional DCT. In the meantime high recurrence coefficients at level two are packed in two phases. In first stage an ideal edge is connected to every single point by point coefficient utilizing enhanced neigh recoil utilizing stein's impartial hazard estimator (SURE) to dispense with some excess. In second stage, Eliminate Zero and Store Data (EZSD) calculation is connected to kill zeroes in sub framework of high recurrence coefficients and to store just nonzero information into a cluster. The calculation is more minimal as it utilizes two level quantization and number juggling coding. Consequences of this calculation contrasted and JPEG2000 by utilizing three diverse shading pictures.

Keywords*: Discrete Wavelet Transform (DWT),Discrete Cosine Transform(DCT), T-Matrix coding, Eliminate Zero and Store Data(EZSD),Neigh Shrink threshold.*

INTRODUCTION

Recent developments in digital communication depend on efficient data compression technologies. The compression increases the efficiency of technology by reducing the hardware space and transmission bandwidth. Joint Photographic Experts Group presented a pressure standard as JPEG2000 for still pictures [1]. It gives prevalent pressure execution, area of intrigue and various pressure/decompression choice[2]. However, execution criteria of picture quality and algorithmic intricacy are critical in examining, remote detecting, and restorative imaging applications [3]. Another calculation presented by M. M. Siddeq in his paper gives great picture quality and moderate pressure proportion contrasted with JPEG2000 for grayscale image[4]. Here the pressure is accomplished by disregarding high recurrence sub groups at level one and high recurrence sub groups at level two are encoded straightforwardly by EZSD. The LL sub groups are packed by DCT and encoded By RLE and Arithmetic coding.

Proposed compression algorithm:

In this paper we have utilized mixture wavelet change approach for picture pressure. Initial, a two level DWT is connected to source picture, which parts the picture into seven sub groups (LL2, HL2, LH2, HH2, HL1, LH1, and HH1). Here HL1, LH1, HH1 sub groups are disregarded and ideal limit decided utilizing enhanced neigh shrivel utilizing SURE. The quantization and Eliminate Zero and Store Data (EZSD) calculation is connected to pack HL2, LH2, HH2 sub groups. Likewise one dimensional DCT and quantization is connected to each line and segment of LL2 sub band and all sub groups are encoded by number-crunching coding. The decompression procedure is switch procedure of encoder.

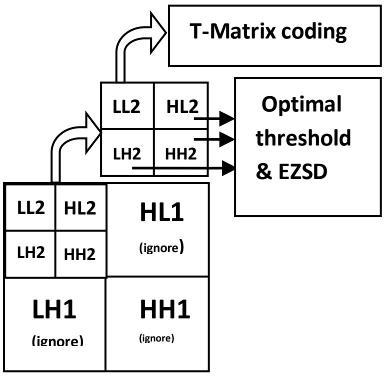

Fig:1. *Block diagram of proposed compression algorithm*

Low frequency sub band coding

Discrete Wavelet transform(DWT):

DWT offers multiresolution analysis and uses two set of functions as scaling and mother wavelet associated with low and high pass filters orderly. It made less number of samples (low frequency)are enough to represents original signal. But ignoring all high frequency sub band odd the quality of image.In level two decomposition first level decomposed coefficients are ignored and remained high frequency coefficients thresholded and encoded[5,6].

Quantization

Quantization applied for each RGB layers of source image. For grayscale image two levels of quantization are required. Level1 quantization to reduce the size of LL2 by ratio of maximum value of LL2 and Quality factor, as shown below

$$Q1 = Quality\ factor \times \max(LL2) \qquad (1)$$

$$LL2 = round\left(\frac{LL2}{Q1}\right) \qquad (2)$$

Quality factor in condition (1) demonstrates the nature of picture. Acquired by greatest qualities in LL2 is separated by every one of the qualities in LL2(factor territory from 0.01 to 0.5 for better execution). It makes LL2 sub band coefficients more assembly. Level2 Quantization performed after DCT to LL2 sub band and afterward separates the framework by Q2. Which takes out the immaterial coefficients by embeddings zeros [7].

$$Q2(m,n) = \begin{cases} 1, & if\ (m=1, n=1) \\ m+n+R & if\ (m \neq 1, n \neq 1) \end{cases} \quad (3)$$

Use of Discrete Cosine Transform(DCT)

High degree of "spectral compaction" at a qualitative level in DCTis helpful for image compression algorithms. It made small set of significant coefficients are enough to represent original image and discard the very small values in image causes DCT coefficients more de-correlation and results good performance in compression and quality.

DWT decomposed LL2 sub band have high energy and more correlated information. Therefore Application of DCT on LL2 compresses the coefficients and increases compression. The one dimensional forward and inverse DCT illustrates as,

$$J_k = S_k \sqrt{\frac{2}{N}} \sum_{i=0}^{N-1} G_i \cos\frac{\pi}{N} K(i + {}^{1}/_{2}) \quad (4)$$

$$G_i = \sqrt{2/N} \sum_{i=0}^{N-1} J_k S_k \cos\frac{\pi}{N} K(i + {}^{1}/_{2}) \quad (5)$$

$$\text{Where, } S_k = \begin{cases} \frac{1}{\sqrt{2}} & , if\ k = 0\ to\ N \\ 1 & , otherwise \end{cases} \quad (6)$$

The Normalization factors √2/√N and 1/√2 makes DCT matrix orthogonal[8].

T-Matrix coding for Low frequency sub band:

The LL2 sub band coefficients are difficult to encode directly by arithmetic coding, because of its integer values and correlation.Therefore it was partitioned into few numbers of parts and each partition is processed by one dimensional DCTand each transformed row is quantized by using formula,

$$Q(n) = Q(n-1) + 2 \qquad (7)$$

Transformed values are stored as a row matrix called as Transformed matrix (T-matrix). This process increases coefficients insignificancy and décor-relation.Each line of T-lattice has DC esteems and AC coefficient stream, now check T-framework segment by-segment for changing over it into one dimensional cluster, at that point pack by RLE and number juggling code. Run Length encode (RLE) decreases the length of rehashed information, and number-crunching code changes over lessened informational collection into bit streams [9].

High frequency Sub band coding

Rather than direct end of zeroes in HL2, LH2, HH2 sub groups, streamlining of these sub groups with ideal edge and after that use of EZSD increment the pressure proportion without adjust picture quality. This paper introduces improved Neigh shrink with optimal threshold and neighbor window size by using SURE.

Adaptive threshold algorithm for compression

Consider $W_{i,j}$ be the wavelet coefficient with corresponding sub band S, it incorporates a square neighboring window $P_{i,j}$ centered at it as shown in Fig.2. The window size can be represented by **LXL**(>1 and odd number**)**.

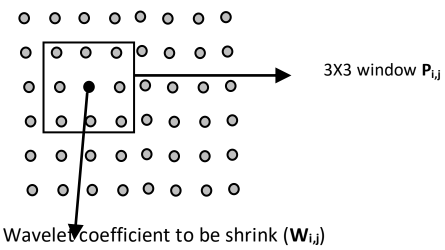

***Fig: 2.** Shows centered wavelet coefficients to be shrinking by neighboring window.*

If $S_{i,j} = \sum_{k,l \in B_{i,j}} W_{k,l}$, Neigh shrink is represented by formula,

$$\tilde{\theta}_{i,j} = w_{i,j}\, P_{i,j} \qquad (8)$$

Where, $\tilde{\theta}_{i,j}$ is unknown estimator, $P_{i,j} = 1 - \lambda^2 / S_{i,j}^2$ and 'λ' is universal threshold.

By Eq. (8) for n^{th} wavelet coefficient W_n:

$$l_n(W_n) = \hat{\theta}_n - W_n = \begin{cases} -(\lambda^2 / S_n^2)W_n & (\lambda < S_n) \\ -W_n & (otherwise) \end{cases} \qquad (9)$$

with,

$$\partial l_n / \partial W_n = \begin{cases} -\lambda^2 (S_n^2 - 2W_n^2 / S_n^4) & (\lambda < S_n) \\ -W_n^2 & (otherwise) \end{cases} \qquad (10)$$

the quality,

$$\mathrm{SURE}(W_s, \lambda, L) = N_s + \sum_n \| l_n W_n \|_2^2 + 2 \sum_n \partial l_n / \partial W_n \qquad (11)$$

We obtain the λ^s, L^s to minimize the SURE by formula[10],

$$(\lambda^s\, L^s) = argmin_{\lambda, L}\, SURE(W_s, \lambda, L) \qquad (12)$$

Eliminate Zero and Store Data(EZSD)

After utilization of edge and quantization high recurrence sub groups contain rich number of zeroes. Superfluous coding of this zeroes make our calculation temperamental. Accordingly EZSD is utilized to kill square of zeroes and stores the square of non-zero information.

EZSD algorithm begins with splitting high frequency sub bands into non overlapped blocks (8X8,16X16) ,then starts searching for non zero blocks. If it found non zero block, it will stored in reduced array and its position stored in position array. If block contain zeroes it is neglected and jump to next block. Reduced array even also contain some zeroes because few blocks contain few data and remaining all are zeroes. Therefore EZSD for reduced array gives more compact array for encoding[11].

a. Arithmetic coding and Decoding

It plays very important role in compressing a stream of data sequence into one dimensional lengthy codeword along with calculating the probability. Run Length encoding helps to avoid coding of repeated coefficients by a value, which reduces the length of codeword. Arithmetic code converts codeword into bit streams[12].

Decompression steps

It fallows two steps,

1) Decode diminished exhibit and its situation from EZSD and apply Return Zero Matrix calculation.
2) Recover LL2 from T-Matrix utilizing one dimensional IDCT, and after that apply IDWT for all sub groups.

Return Zero Matrix(RZM) algorithm

Decoded High frequency sub bands are containing reduced arraywhich is expanded by searching zeros fallowed by number, it counts the repeated zeros in new an array. Replace data in an array into blocks of matrix. This method is applied to all high frequency sub bands.

Recover LL2 and reconstruct the image :

Run length decoder and arithmetic decoder decodes the one dimensional array, it converted into column of T-matrix. After generation of T-matrix apply inverse quantization and one dimensional inverse DCT for each row and repeat the process until all rows are completed. Then apply IDWT for first level reconstruction by using LL2,HL2,LH2,HH2 to get LL1. Second level reconstruction by LL1 with ignored HL1, LH1 and HH1 gives approximated original gray image. Reconstruct color image by using RGB color space.

RESULTS AND DISCUSSION

Our algorithm tested on three color image(512X512) “lena”, ”mandrill” and ”pepper” of .bmp file format. Figure-3 shows original tested image “Lena”, ”mandrill”, ”pepper” respectively.These Images tried by INTEL center to pair center processor, MATLAB R2009a as a programming dialect with working framework windows-7(32-bits). Table 1 demonstrates pressure and PSNR results regarding time and quality. The JPEG2000 is standard picture pressure strategy utilizes DWT for staggered disintegration to segment the picture into vast number of coefficients and encoded by math coding.[13,14]. In this paper JPEG2000 compressor software was downloaded from anything 3D.com copyrighted program used to get compressed image for comparison with our algorithm. Table 2 showscompression results of JPEG2000 and our algorithm. Decompressed image of “Lena”, ”mandrill”, ”pepper” are shows in Figure-4,5 and 6.

Table: 1. *Compression ratio, PSNR of image.*

Image(size)	**Compression Ratio**	**PSNR of *Decoded image***	**Compressed size(KB)**	***Elapsed time for compression(Sec)***
‘Lena’(768KB)	32:1	30.50	24	13.3
‘mandril’(768KB)	20:1	22.32	38	17.8
‘pepper’(768KB)	25.5:1	29.68	30	14.02
Eye(768KB)	54.8:1	32.95	14	9.50

Table: 2. *Comparison between JPEG2000 and our approach.*

Tested Images	**JPEG2000**		**Proposed method**	
	CR	PSNR	CR	PSNR
Lena	32:1	33.26	32:1	30.50
Mandrill	20:1	24.81	20:1	22.32
Pepper	25:1	32.23	25.5:1	29.68
Eye	54:1	36.58	54.8:1	32.95

Fig: 3. *Original image used for test by our approach.(a) Lena image, size 768KB, dimension(512x 512);(b)mandrill image, size 768KB, dimension(512 x512);(c) pepper image, size 768KB, dimension (512 x512);(d) eye image, size 768KB,dimension (512X512).*

Fig: 4. *Decoded Lena image with different quality by our approach and JPEG2000.(a)Decoded image with Quality 0.01; (b)Decoded image with Quality 0.05; (c)Decoded image with Quality 0.2; (d)Decoded image with Quality 44.1 ; (e)Decoded image with Quality 33.1; (f)Decoded image with Quality 23.8;*

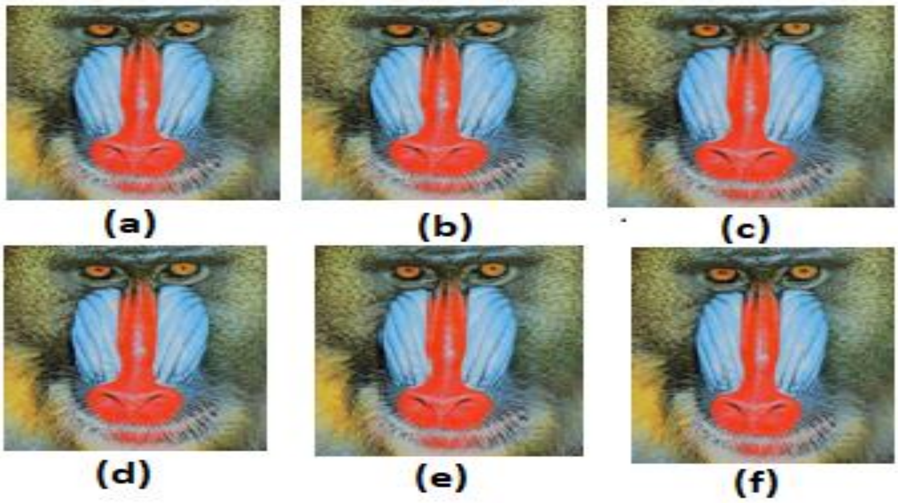

Fig: 5. *Decoded "mandrill" image with different quality by our approach and JPEG2000. (a)Decoded image with Quality 0.01; (b)Decoded image with Quality 0.05; (c)Decoded image with Quality 0.2; (d)Decoded image with Quality 65.8; (e)Decoded image with Quality 51.5;(f)Decoded image with Quality 39.6 ;*

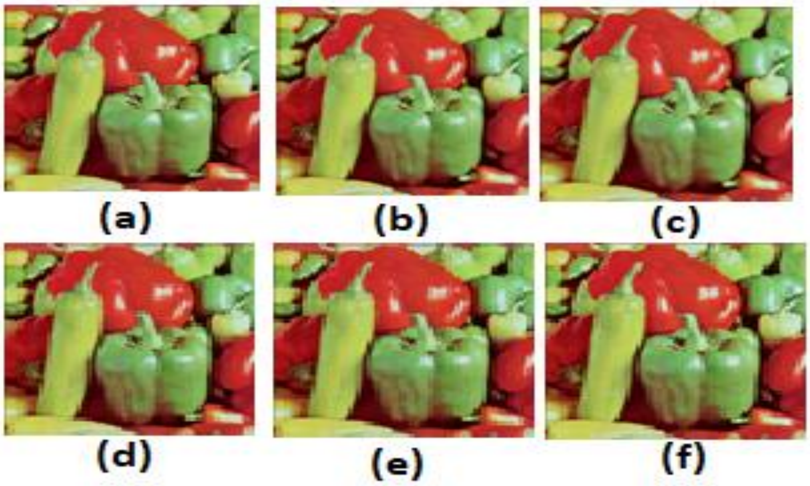

Fig: 6. *Decoded "pepper" image with different quality by our approach and JPEG2000. (a)Decoded image with Quality 0.01; (b)Decoded image with Quality 0.05; (c)Decoded image with Quality 0.2; (d)Decoded image with Quality 43.8; (e)Decoded image with Quality 31.4; (f)Decoded image with Quality 25.1;*

Estimating PSNR doesn't choose the ideal execution of picture in light of computation of MSE gives most astounding an incentive than the existed splendor esteems and variety in brilliance gives high PSNR esteem. Henceforth Human visual framework utilized for estimating the distinctions [13].

CONCLUSION

This paper introduces new compression and decompression algorithm, contain two transforms (DCT and DWT) with T matrix coding and optimal sub band threshold with neighbor window method.This method has some advantages,

a. Use of DWT increases number of high frequency sub bands and Limited low frequency sub bands enough for reconstruction. DCT on LL2 bands gives high compression performance.
b. Quantization of LL2 sub band and second level high frequency sub band increases zero in matrix.
c. Optimal Sub band threshold for second level high frequency sub band increases zeroes in matrix.
d. The properties of Daubechies DWT helps in our approach to ignore unnecessary reconstruction of high frequency sub bands and increases compression.
e. Our compression method gives good compression performance than JPEG2000 at low quality of quantization matrix values(0.01 to 0.1). This method also has some disadvantage:

a. This approach depends onDaubechies family of DWTupto scale 6, if we increase the scale results less compression performance.
b. Quality degraded due to discarding first level high frequency sub band.
c. More number of minimized code array data increases the header file size in compressed output.

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Cite this article as: Naveenkumar.R, B.N.Jagadale, & J.S.Bhat. (2018). Efficient Wavelet Coding Technique in DWT-DCT for Color Image Compression. Journal of Signal Processing, 4(3), 26–32. http://doi.org/10.5281/zenodo.1494882