Color Image Compression Using DPCM with DCT, DWT and Quadtree Coding Scheme

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ABSTRACT

This paper is concerned with the design and implementation of a compression method for color image. This method based on Differential Pulse Code Modulation (DPCM), Discrete Cosine Transform (DCT) , Discrete Wavelet Transform (DWT) and Quadtree Coding Scheme. As a first step the DPCM technique is used to isolate blocks of an image into correlated and uncorrelated blocks. The isolated correlated blocks have been compressed using DCT based compression method then each block has been embedded with zeros on the original image. Each uncorrelated block has been compressed using DWT based method and put the compressed block in its location on the original image. Then, the result (i.e., the zeros blocks and compressed blocks with DWT) coded using Quadtree spatial coding. The output from DWT based and DCT based passed through shift coding stage to gain a possible further compression. The performance results of proposed hybrid algorithms produces better quality of image in terms of Peak-Signal-to-Noise Ratio (PSNR) with a higher Compression Ratio (CR) compared to standalone DCT or DWT. The PSNR values of the reconstructed images after applying proposed system are ranged from 30.62 to 40.95dB and CR on average, have been reduced to be around 1:19.6 of the size of the original image.
Keyword: DCT, DWT, DPCM, Quadtree, Shift Coding, Image Compression.

INTRODUCTION

Today's transmission bandwidth and storage capacity considerable required for compressing multimedia (graphics, audio and video) data. In spite of rapid progress in processor speeds, mass-storage density and digital communication system performance; demand for greater digital data storage capacity and transmission bandwidth is overwhelming. Data compression plays a very vital role in the field of multimedia computer services and other telecommunication applications [1].

The most commonly used algorithms are DCT and DWT. The DCT has a property of high energy compaction and requires less computational resources. The property of energy compaction of an algorithm leads to concentrate most important information signal into a small amount of low-frequency component. On the other hand, DWT is easily achieved a multi-resolution transform and variable compression. The main disadvantages of DCT is the introduction of the effects of false contouring and blocking artifacts in the high compression rate while the DWT is requiring of large computational resources. Therefore, the idea of discovering the advantages of both algorithms led us to investigate the combination of DWT and DCT algorithms. In the survey of various image compression techniques discussed through which researchers can get an idea of effective techniques for use. In 2015 [2], Manjot Kaur and Pawandeep Kaur made a comparative analysis of three transform coding techniques DCT, DWT and hybrid (i.e. combination of both DCT and DWT)) on the basis of various performance measurement, PSNR, CR and Mean Square Error (MSE).In 2014 [3], Shiby Angel K. et al., compared and studied an efficient method for compression of medical images with different metrics and algorithms. The results of experiment determine how the PSNR, CR, and Signal to Noise Ratio (SNR) of various compression algorithms respond to the dual conversion algorithm. This dual transform method preserves the high quality images with high compression ratio and bit per pixel. Also it is improved image quality in terms of PSNR. K.N. Bharath et al. in 2013 [4]suggested an approach of combining multiple transformations i.e. DWT-DCT, and Huffman coding has been introduced successfully in this research work. The hybrid algorithm offset the disadvantages of standalone DCT and DWT. Harjeetpal Sing et al. in 2012 [5] introduce a hybrid algorithm: the 2- level 2-D DWT followed by the 4x4 2-D DCT. The DCT is applied to the DWT low-frequency components that generally characterized by zero mean and small variance and results accordingly in a much higher CR with important diagnostic information. Huffman encoding technique has been also introduced which is lossless. Salih H. A. and Aymen D. S. in 2010 [6] investigate a compression based on 2D Dual Tree complex wavelet transform (2D DT-CWT).

Threshold can be modified the coefficients to obtain more zeros that are allowing a higher compression rate. Huffman coding has been used with a signal processed by the wavelet analysis in order to compress data. Ammar A. R el al. in 2011 [7] introduced a method to compress and hide image based on wavelet transform. Firstly a wavelet transform has been applied on stego image to reduce the size of it and also re-sorting to the transactions analysis (Secret Sub-band level) of the image via a secret algorithm and then minimized transaction values of sub bands level of image wanted to hide

In general, lossy techniques work on subdivide the image into fixed or variable sizes of non-overlapping blocks. Usually the fixed partitioning method is adopted because of its simplicity and popularity, but this is the expense of efficiency, and with a storage cost of larger, because the blocks were divided on the basis of the size of the region, regardless of the content, whether that block or region is uniform or non-uniform [8]. To overcome the fixed division method defect using partitioning techniques such as quadtree, Horizontal-Vertical (HV) and triangular, in which the results are promising but still under development, and not recognized to be used by standard techniques because of complexity or difficulty of selecting the unification scale and time required [9].

This paper presents a lossy compression method based on hybrid techniques using DCT and DWT along with variable block partition method to remove redundancy between neighboring pixels in accordance with its own local dependency that efficiently enhance the quality and the compression rate. The rest of the paper organized as follows, section 2 presents the compression efficiency parameters which have been used to evaluate the proposed system, section 3 contains comprehensive illustration of the proposed system, and, the results of the proposed system, is given in section 4.Finally section 5 concludes a research paper.

Efficiency Parameters of Compression

In general, as used a lossy compression system, the performance measure on the basis of the objective fidelity criteria of PSNR, along with the CR. The PSNR based on the Mean Square Error (MSE) can be determined using the following equation:

$$PSNR = 10\log_{10}(\frac{255^2}{MSE_{RGB}})\ (dB) \quad \text{....(1)}$$

where

$$MSE_{RGB} = \frac{1}{3}\,(MSE_{red} + MSE_{green} + MSE_{blue}) \qquad .... (2)$$

CR is defined as the ratio between the size of the original image data and the size of the compressed data file in overall. The CR is determined in the following equation:

$$CR = \frac{\text{Original File Size}}{\text{Compressed File Size}} \qquad ..... (3)$$

The Proposed method

Main concerns are taken in the proposed system these are:

1. The proposed method is based on the fact that the DCT has excellent compaction to the pixels that are correlated highly in each block that takes advantage of spatial redundancy.
2. DWT can be used to reduce the image size without losing a lot of the resolutions calculated and discarding the values that are less than a predetermined threshold.
3. Recently, the wavelet transform emerged as a cutting edge technology, in the field of image compression. Coding based on wavelet provides significant improvements in image quality at higher compression ratios.
4. Because, main difficulties in the development of algorithms for image compression is a necessity to keep the details i.e. ridges endings and bifurcations, which are then used in identifications. To achieve high compression ratios while preserving the fine details, hybrid method between DWT and DCT are used. This paper focuses on the choice of the most suitable transform for blocks of image (i.e., edge blocks or non edge blocks).
5. In a monochrome image, neighboring pixels more interconnected. DCT and DWT are commonly used to reduce the redundancy between the pixels and for energy compaction.
6. Get the benefit of the hierarchical representation of the partition where the production of various blocks of variable sizes, which works to improve the quality and efficiency of the compression rates.

The proposed system consists of two units: the first unit is called "Encoding unit" and the second unit is called "Decoding unit". Each one of these two units made up of many parts.

Encoding Unit

Encoding unit takes an original color image as input and after processing, it gives compressed stream as output using a lossy compression methods based on DCT and DWT techniques. As shown in figure (1), steps of proposed compression are illustrated Algorithm 1.

Algorithm 1: Encoding

Input: RGB color image.

Output: Compressed stream.

Step1: The color components (RGB) of the input color image is transformed into less correlated color space components (like YUV) to reduce the spectral redundancy.

Step2: The DPCMis applied on each color components (i.e., *Y, U* and V) using the following formula:

$$Y'_i = Y_{i+1} - Y_i,\ \text{and}\ Y'_0 = Y_0 \qquad ... (4)$$

Where Y is the color component Y *and* Y_0 is the first element of *Y*c omponent.

Step3: Each components of (*Y'*, *U'*, and *V'*) is divided into blocks of 8 × 8 pixels. Then for each block find Maximum absolute value (MaxDiff).
Step4: According to Maxdiff which is compared with selected threshold *T*, the blocks is isolated as correlated and noncorelated blocks. The selection of *T* has been chosen by experiments according to the features of the images.
Step5: The collected correlated blocks compressed using DCT based method using Algorithm 4and set the blocks on original location to zero.
Step6: Each noncorrelated block is compressed using DWT based method using Algorithm 2 and put it in its original location. Then quadtree coding scheme is used to compress the resulted blocks from DWT based method and blocks which are set to zero in step5.
Step7: The result of quadtree and the DCT based method are compressed in enhance shift coding method as describe in section (3.1.4).

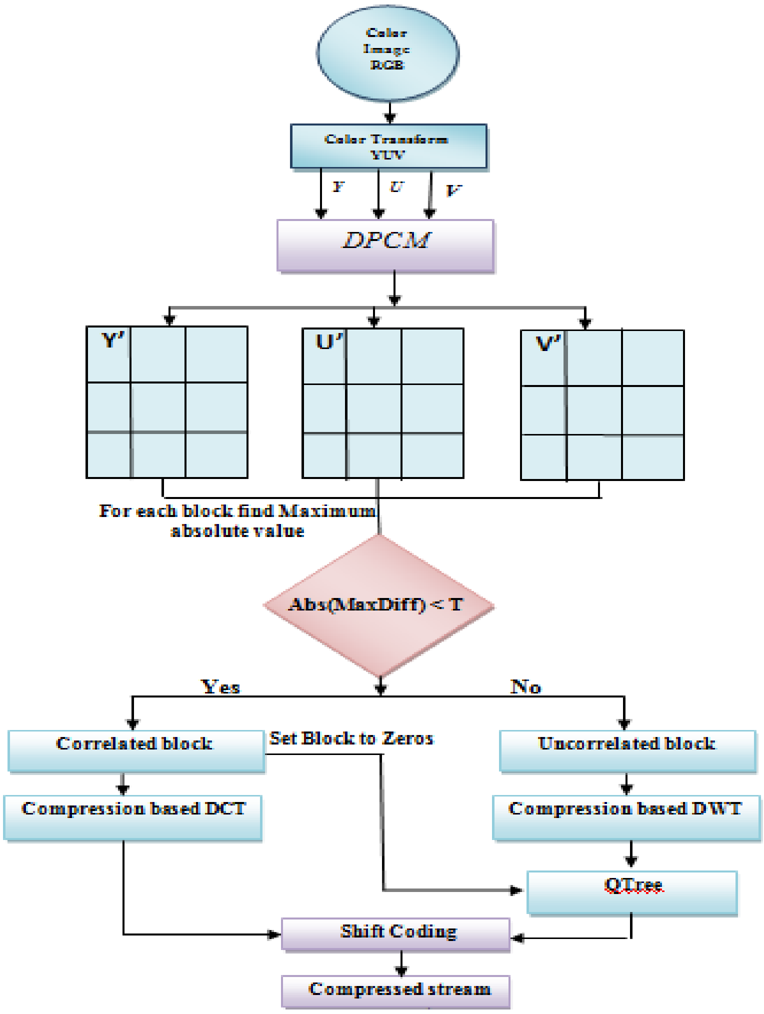

Figure (1): Block diagram of proposed system.

Compression Based on DWT

The next steps of Algorithm 2 are clearly illustrating the implementation of the proposed compression method on the basis of DWT in details:

Algorithm 2: Compression Based on DWT
Input: Uncorrelated blocks.
Output: Compressed stream.
Step1: Tap 9/7 wavelet transform was applied on each block to decompose the image data into four sub-bands (LL, LH, HL, and HH) each carries certain type of image information, such that most of the image information is concentrated in the LL sub-band.
Step2: utilizing a hierarchal uniform quantization to quantize the coefficients of each wavelet sub-band. The quantization steps that are used to quantize the coefficients of each sub-band were determined according to the following equation:

$$Q_{stp}(n)\begin{cases} Q_0 & for\ LL\ in\ n^{th} \\ Q_1\alpha^{n-1} & for\ LH, HL\ in\ n^{th} \\ Q_1\beta\alpha^{n-1} & for\ HH\ in\ n^{th} \end{cases} \quad \ldots (5)$$

Where, n is the wavelet level number, (Q_0, Q_1, α, β) are quantization parameters (such that, $Q_1,Q_0 \geq 1$, $\alpha \leq 1$, $\beta \geq 1$). According to the above equation is the decreasing of the quantization step with the increase in the level of wavelet. So that the quantization step value of the HH-subband has been taken greater than the corresponding value used in the quantize HL and LH subbands.
Step3: Determining the quantization index for each band (details) coefficient using the following equation:

$$Q(x,y)=round\left(\frac{A(x,y)}{Q_{stp}}\right) \quad \ldots (6)$$

Where A () is a set of wavelet transform coefficients, Q () set a quantization index.
Step4: Mapping to positive: All numbers have been converted to positive numbers; this step is useful to simply the next steps of coding. The following mapping equation was used:

$$Q'(x,y)=\begin{cases} 2Q(x,y) & if\ Q(x,y) \geq 0 \\ 2|Q(x,y)|+1 & if\ Q(x,y) < 0 \end{cases} \quad \ldots (7)$$

Where $Q()$ is the quantized signed value.
Step5: Putting the mapping block into its original location.

Quadtree

Quadtree technique was used to compress the data is the simplicity of its approach. The quadtree is strong and simple data structure to represent two dimensional arrays characterized by high occurrence of certain set of symbols (like in case of sparse matrices). Possibly the applications of quadtree are found in many different contexts, such as the compression of wavelet sub-band coefficients in decomposition and coding of the sub-blocks data. The algorithms of quadtree are depending on simple averages and comparisons. A quadtree is the data tree-like structure where each node on either end contains useful information, or branches for quadtrees sub-level [10].

The proposed quadtree algorithm subdivides the image into blocks based on hierarchal scheme and save them in a way that blocks can easily be restored again. After that, the data of (LH, HL, and HH) sub-bands have been compressed using quadtree algorithm based on taking the advantage of high occurrence of zero values. The following flowchart shows carried out steps of quadtree coding.

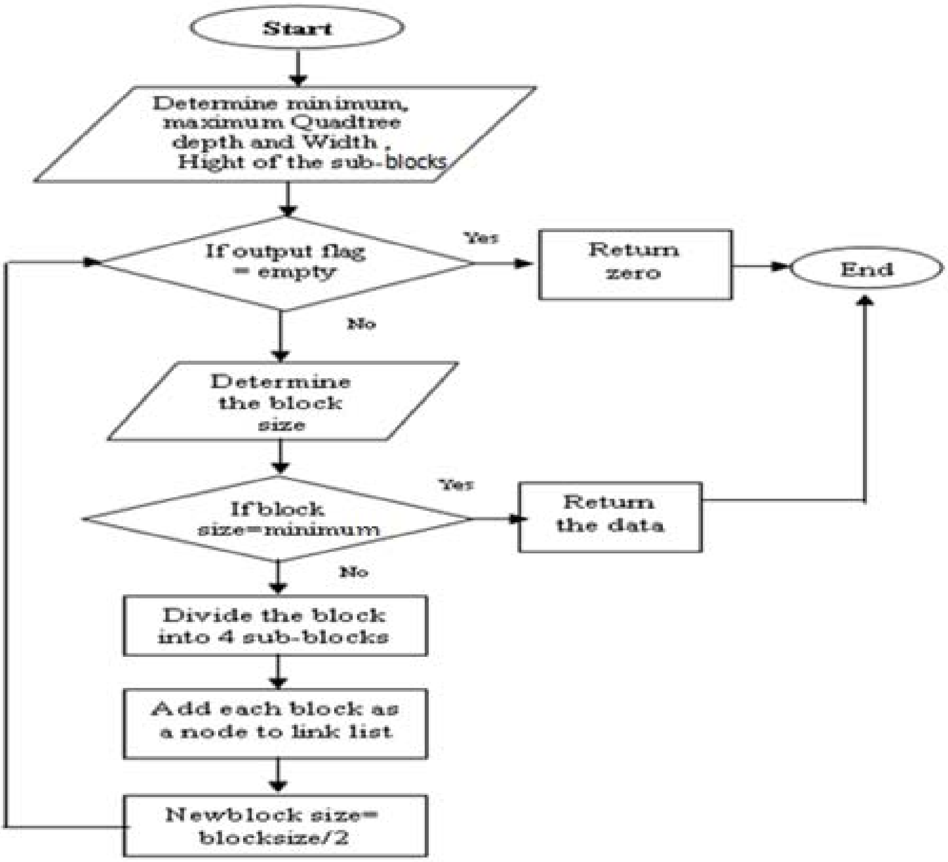

Figure (2): Flowchart of the Quadtree algorithm.

Finally the output of quadtree partitioning, which is a sequence of zeros and ones, is compressed into sequence of bytes using Algorithm 3.

Algorithm3: Compressed Sequence of Zeros and Ones
Input: S // Sequence of zeros and ones.
L // Length of Sequence.
Output: Output // Compressed bytes.
Step1: Set K=0and I=0.
Step2: While *I*is less of the length of sequence *L,* then combined each 8 bits of*S* into a byte
Step3: Increment *K* by one and by 8.
Step4: Putting the byte into Output.
Step5: The Output (i,e., a sequence of bytes) is combined with data as shown in fig. (2).

3.1.3 Compression Based on DCT

The steps of the DCT based compression are illustrated in details in the Algorithm 4:

Algorithm 4: Compression Based on DCT

Input: Correlated blocks.

Output: Compressed stream

Step1: Apply DCT on each CorrBlock blocks to produce the set of transform coefficients.

Step2: Apply scalar quantization to quantize the DCT coefficients of each block. This step will reduce the number of bits required to represent nearly the transform coefficients, and to prepare them for the encoding step. Applied equations for the quantization process are as follows:

Step 2-1: For DC Coefficient:

$$D_q(0) = round\left(\frac{D(0)}{q_1}\right) \qquad \textbf{... (8)}$$

Where, *D(0)* is the DC-coefficient, $D_q(0)$ is the quantized DC coefficient and q_1 is Quantization step.

Step 2-2: For AC Coefficient:

$$D_q(u) = round\left(\frac{D(u)}{q_2(1+q_3(u-1))}\right) \qquad \textbf{..... (9)}$$

Where,q_2 and $q_3$are the quantization steps.

Step3: Mapping to positive: Convert all numbers to positive numbers using equation (4).

Step4: Apply Length Encoding (RLE) on positive numbers to produce the compressed stream.

In proposed system the RLE step was used because of the redundant occurrence of many sequences consisting of long runs of zeros. Shift coding could not deal with these long runs efficiently because it prunes only the short runs by pairing step. RLE will represent the long repeated sequences of symbols as records for each consisting of (Run Value, Length).

Shift Coding

Shift coding is applied after RLE and Qtree, the streams coefficients are shift coded, usually the incoming stream, after the previous steps (i.e., the result of quadtree and DCT), it has highly peaked histogram which makes shift coding a good entropy coding based choice for more compression. The introduced Algorithm of enhanced shift coding consists of the following steps:

Algorithm 5: Enhanced Shift Coding

Step1: Apply shift coding optimizer to find the optimal two code word sizes needed to represent the small and large sequence elements values. The applied optimization criterion is [11]:

$$T(in\ Bits) = b_1 \sum_{i=0}^{Pp} His(i) + b_2 \sum_{i=R}^{Pp} His(i) \qquad \textbf{.......... (10)}$$

Step2: The optimizer should find the best values for $b_1$andb_2 leads to lowest possible value of *T*. The values of $b_1$andb_2 represent the length of short code words and long code words, respectively. The range of $b_1$and b_2 lay within the range $[1, \lceil \log_2(Pp) \rceil - 1]$. The array *His()* represent the histogram array. The symbol *R* is equal to 2^{b1} -2, which represent the highest value of the short codeword.

Step3: Implement the traditional shift coding operation, and then save the output code words into the binary output file.

Decoding Unit

The decoding unit consists of the inverse operations to those applied in the encoding process; also these operations are applied in reverse order. The operations are:

- **i.** Shift decoding,
- **ii.** Long runs expansion,
- **iii.** De-quantization,
- **iv.** Inverse DCT and DWT,
- **v.** Mapping to negative,
- **vi.** Inverse of quadtree.

Testing and Discussion

Various standard images were selected; all the images are square gray scale images of size 256×256 and 512×512 pixels of 24 bit/per pixelas shown in fig. 3.

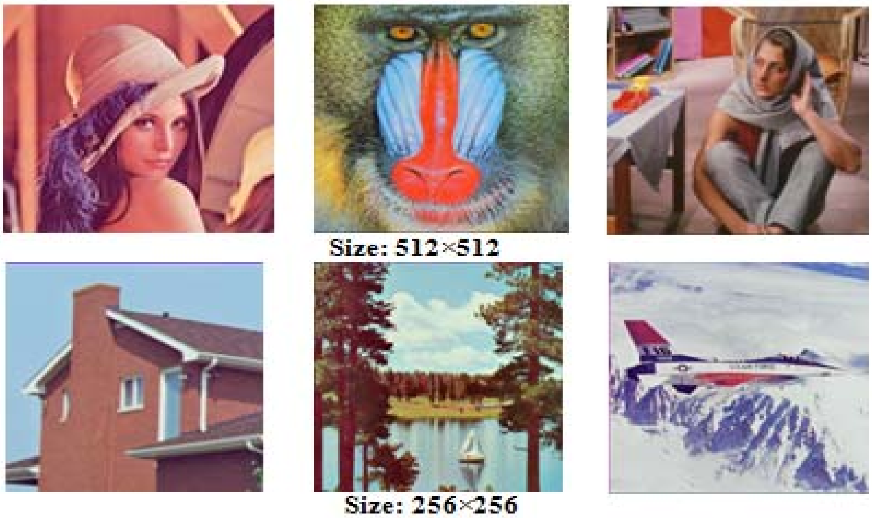

Figure (3): Tested images

The effected of choosing the value of Threshold *T* has been shown in fig. 4.When the threshold value will be increased the number of blocks (uncorrelated blocks) that will be compressed based on DWT method will be decreased, on the other hand the number of blocks (correlated blocks) that will be compressed based on DCT method will be increased. As a result the PSNR and CR have been affected accordingly. Depending on the value of *The* blocks of image have been separated to correlated and uncorrelated blocks. When the value of differences are small for all block values this mean that block doesn't has edge but if the value of differences are large this indicate that block has edge. If *T* is selected large, the blocks with very large differences have been chosen as uncorrelated block (i.e., edge blocks) and the others are correlated blocks (i.e., not edge blocks). But if *T* is selected small, the blocks with large differences will be increased this means the blocks that will be compressed by DWT have been increased and the blocks that will be compressed by DCT have been decreased accordingly.

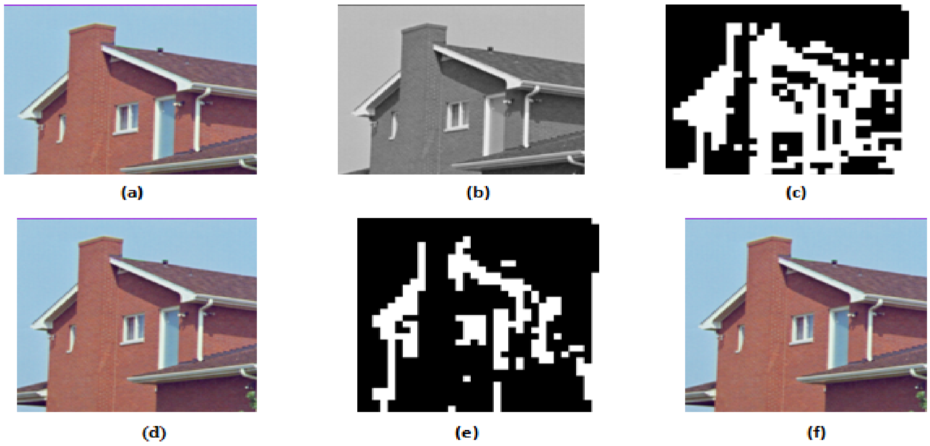

Figure (4): Simulation results using proposed system using different threshold values.(a) Original image, (b) Y Band, (c) Partition Band in correlated block (black) and uncorrelated block (white)(d) Recovered image with PSNR= 41.26 and CR=29.12 at Q_0=0.8,Q_1=2.5 , α=2,β=0.5,q_1=1, q2=1, q3=1and *T*=15,(e)Partition Band in correlated block (black) and uncorrelated block (white) and (f)Recovered image with PSNR= 42.86 and CR=18.01 at Q0=0.8, Q1=2.5, α=2,β=0.5,q1=1, q2=1, q3=1 threshold=30.

Table (1) shows the effects of different cases of quantization steps of Q_0 and Q_1 with α=0.8, β=2 on the compression performance parameters, when using the proposed compression method with T=15, q_1=1,q_2=1,q_3=1.

Table (1): The effect of quantization steps Q_0 and Q_1 when applying proposed scheme with(α=0.8, β=2).

Q_{stp}		Compression Ratio (CR)						
Q_0	Q_1		Lena	Baboon	Barbara	House	Sailboat	Jet_plane
2	5	PSNR	40.24	30.62	40.62	40.95	39.66	40.32
		CR	12.09	6.80	11.71	7.34	16.28	8.77
	10	PSNR	37.41	29.90	36.71	38.67	35.77	36.71
		CR	12.36	7.94	12.01	7.51	17.80	9.30
	15	PSNR	35.45	29.20	34.19	36.79	33.46	34.36
		CR	12.36	8.04	12.01	7.64	17.91	9.85
	20	PSNR	33.96	28.51	32.34	35.43	31.99	32.52
		CR	12.66	9.87	12.34	7.74	19.70	10.01
3	5	PSNR	40.06	30.15	40.39	40.78	31.99	40.10
		CR	12.10	6.69	11.71	7.46	19.70	8.86
	10	PSNR	37.31	28.78	36.62	38.56	35.68	36.62
		CR	12.38	8.05	12.01	7.60	17.85	9.31
	15	PSNR	35.39	27.85	34.14	36.73	33.40	34.31
		CR	12.38	8.14	12.01	7.68	17.96	9.86
	20	PSNR	33.92	26.88	32.31	35.39	31.95	32.48
		CR	12.66	9.96	12.34	7.77	19.72	10.02
4	5	PSNR	39.83	29.87	40.12	40.57	39.13	39.84
		CR	12.14	6.76	11.73	7.49	16.35	8.94
	10	PSNR	37.19	28.00	36.50	38.44	35.55	36.50
		CR	12.38	8.12	12.02	7.63	17.89	9.43
	15	PSNR	35.31	27.68	34.07	36.64	33.32	34.24
		CR	12.38	8.22	12.02	7.72	18.00	9.86
	20	PSNR	33.86	26.84	32.27	35.32	31.89	32.44
		CR	12.67	10.04	12.34	7.79	19.84	10.05

Table (2) shows the effects of the quantization steps q_1,$q_2$withq_3=1on the compression performance parameters, when using the proposed compression method with T=15, Q_0=2 and Q_1=5, α=0.8 and β=2.

Table (2): The effect of quantization steps (q_1, q_2) when applying proposed scheme with (q_3=1).

Q_{stp}		Compression Ratio (CR)						
Q_0	Q_1		Lena	Baboon	Barbara	House	Sailboat	Jet-plane
1	1	PSNR	40.24	38.96	40.62	40.95	39.66	40.32
		CR	12.09	8.60	11.71	7.34	16.28	8.77
	3	PSNR	39.65	38.86	39.95	39.19	39.45	39.85
		CR	20.01	8.89	17.74	11.43	20.12	11.16
	5	PSNR	39.42	38.82	39.50	38.29	39.36	39.57
		CR	22.87	8.94	21.27	13.33	21.01	12.10
	7	PSNR	39.23	38.79	39.17	37.90	39.27	39.41
		CR	25.42	8.97	22.94	14.01	21.75	12.46
2	1	PSNR	39.73	38.88	40.09	39.64	39.48	39.92
		CR	19.32	8.85	16.95	10.72	19.91	10.93
	3	PSNR	39.22	38.80	39.23	37.69	39.26	39.41
		CR	25.90	8.97	23.09	14.14	21.90	12.54
	5	PSNR	38.94	38.77	38.70	36.98	39.11	39.16
		CR	28.21	8.99	26.26	15.43	22.38	13.05
	7	PSNR	38.69	38.75	38.22	36.51	38.94	38.87
		CR	29.51	9.01	28.65	15.76	22.66	13.28
3	1	PSNR	39.46	38.83	39.71	38.94	39.39	39.67
		CR	22.77	8.93	20.59	12.78	21.04	12.02
	3	PSNR	38.93	38.77	38.76	37.03	39.12	39.13
		CR	28.51	9.00	26.27	15.49	22.48	13.12
	5	PSNR	38.57	38.74	38.07	35.72	38.68	38.78
		CR	30.32	9.01	29.32	16.06	23.10	13.42
	7	PSNR	38.28	38.72	37.48	34.90	39.66	38.58
		CR	31.33	9.02	30.59	16.54	16.28	13.58

Table (3) shows the effects of the quantization steps Q_0 and Q_1 with α=0.8 and β=2 on the compression performance parameters, when using the DWT based compression method.

Table (3): The effect of quantization steps (Q_0, Q_1) when applying DWT based scheme with (α=0.8, β=2).

Q_{stp}		Compression Ratio (CR)						
Q_0	Q_1		Lena	Baboon	Barbara	House	Sailboat	Jet-plane
2	5	PSNR	34.42	28.51	37.75	32.06	30.34	32.37
		CR	7.67	3.99	6.39	7.12	4.23	5.03
	10	PSNR	33.66	27.62	36.23	31.58	29.61	31.51
		CR	9.19	5.36	7.51	8.72	5.39	6.24
	15	PSNR	33.27	26.91	35.13	31.06	29.09	30.77
		CR	9.59	6.38	7.98	9.62	5.96	6.86
	20	PSNR	33.00	26.39	34.33	30.75	28.74	30.14
		CR	9.75	7.05	8.29	10.18	6.28	7.25
3	5	PSNR	32.80	28.35	36.65	31.77	30.16	32.08
		CR	9.84	4.17	7.61	8.15	4.98	5.56
	10	PSNR	32.64	27.49	35.43	31.32	29.45	31.27
		CR	9.89	5.69	9.26	10.32	6.65	7.07
	15	PSNR	32.52	26.81	34.49	30.82	28.95	30.57
		CR	9.93	6.85	9.98	11.59	7.54	7.89
	20	PSNR	32.42	26.30	33.79	30.53	28.61	29.97
		CR	9.95	7.64	10.47	12.42	8.06	8.40
4	5	PSNR	32.35	28.18	35.68	31.47	29.94	31.74
		CR	9.96	4.26	8.01	8.65	5.62	5.99
	10	PSNR	34.42	27.35	34.68	31.05	29.27	30.98
		CR	7.67	5.86	9.87	11.14	7.85	7.77
	15	PSNR	33.66	26.68	33.88	30.57	28.79	30.32
		CR	9.19	7.10	10.69	12.64	9.11	8.76
	20	PSNR	33.27	26.19	33.26	30.30	28.46	29.76
		CR	9.59	7.95	11.26	13.64	9.89	9.40

Table (4) shows the effects of the quantization steps q_1 and q_2 with q_3=1 on the compression performance parameters, when applying the DCT based compression method.

Table (4): The effect of quantization steps (q_1, q_2) when applying DCT based scheme with (q_3=1)

Q_{stp}		Compression Ratio (CR)						
Q_0	Q_1		Lena	Baboon	Barbara	House	Sailboat	Jet-plane
1	1	PSNR	32.30	26.15	34.93	24.93	29.01	30.64
		CR	8.19	3.62	6.92	7.92	5.29	5.37
	3	PSNR	31.33	24.82	27.76	24.78	27.72	23.65
		CR	14.90	7.07	12.01	14.39	10.55	9.66
	5	PSNR	30.60	24.15	30.50	24.44	26.02	27.57
		CR	19.80	10.34	16.15	19.38	14.59	13.30
	7	PSNR	29.19	23.60	28.30	22.71	26.27	26.58
		CR	22.82	13.08	19.54	22.34	17.49	16.00
2	1	PSNR	31.28	26.13	32.23	21.01	27.33	21.40
		CR	13.45	5.92	10.71	12.75	9.11	8.36
	3	PSNR	28.85	23.58	29.88	21.98	26.30	27.04
		CR	22.63	12.33	18.89	22.10	16.97	15.32
	5	PSNR	27.41	22.68	28.31	27.91	25.01	25.77
		CR	28.95	18.27	25.65	27.80	22.69	21.04
	7	PSNR	28.65	22.04	26.19	24.13	24.85	25.03
		CR	32.64	22.69	29.86	30.87	26.28	24.77
3	1	PSNR	30.92	23.17	31.75	29.25	25.76	28.41
		CR	17.99	8.27	13.98	17.26	12.52	11.17
	3	PSNR	25.87	22.83	27.35	27.99	25.39	25.99
		CR	29.02	17.69	25.34	27.80	22.40	20.55
	5	PSNR	27.89	21.83	27.12	20.03	24.56	19.63
		CR	34.66	24.48	33.26	34.13	27.90	26.48
	7	PSNR	27.75	20.19	26.39	25.89	24.33	24.05
		CR	40.09	29.83	37.46	37.69	33.30	32.51

The listed results in table (1) show that the size of images, on average, have been reduced to be around 1:11.6 of the size of the original image. The CR is selected under the consideration that the quality of the image should be at acceptable level (i.e., 40 to 30 db). The PSNR values of the reconstructed images are ranged from 30.26 to 40.95 dB. While table (2) shows the PSNR values of the reconstructed images are ranged from 38.72 to 40.95 dB and the CR on average, have been reduced to be around 1:19.6 of the size of the original image. As the result, it is noteworthy to address some characteristics of the proposed hybrid schemes such as the selection the suitable quantization parameters depending on the image features to gain good compression results.

Tables (3) and (4) show the PSNR values of the reconstructed secret images when applying DCT based scheme are ranged from 26.15 to 34.93 dB and from 26.51 to 37.75 dB when applying wavelet based scheme. The CRon average, have been reduced to be around 1:8.6and 1:7.8of the size of the original when applying DCT based scheme and DCT based scheme respectively

As the results obtained by DWT, DCT and hybrid compression technique with respect to PSNR and CR, here it's clear that DWT compression shows higher values of PSNR and gives better performance in term of quality than DCT but on the other hand the DCT base scheme produce better CR compared with the DWT based scheme and gives better performance in term of storage space. The hybrid technique gives butter result compare with DWT and DCT based schemes in both terms of quality and storage space and these features make proposed system is more suitable for certain application environments when low bandwidth and storage requirement with high quality are needed.

CONCLUSIONS

In this paper, an image compression scheme using DCT, DWT, DPCM, Quadtree, and shift coding has been introduced; the performance test results indicated that the proposed scheme has a good reduction in the size of the image data while remaining above the acceptable image quality. The algorithm based on DCT provides a powerful efficient in terms of storage space and quality with minimal distortion. The DWT has advantage to decomposition of images which gives higher signal to noise ratio in all images. The shift encoding reduces the average code word length by assigning shorter code words to highly frequent symbols and longer code words to rarely occurring symbols. Thus it has been desired to use these properties to create a new robust compression technique

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