

Color Lossless Image Compression Technique Using DWT-DCT Transformation

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ABSTRACT: Wireless Image Compression is embedding scheme for reducing size of image so that image can be store in less disk space and faster attachment possible in communication. Research issues in Image Compression are to increase efficiency in term of the image quality of decompressed image on higher compression ratio and robustness against visual attacks. Discrete Wavelet transform domain based Image Compression is lossy compression technique. The disadvantage of DWT based compression is fraction loss in embedding which increases mean square error and results decreasing PSNR. Quality of decompressed image is proportional to PSNR. The Proposed compression approach use integer wavelet transforms to overcome above fraction loss. The paper presents Hybrid discrete wavelet transform (DWT) and discrete cosine transform (DCT) based compression technique to obtain increased quality of decompressed image compared to DWT+ DCT based compression technique. The proposed combined DWT + DCT based compression technique reduces the fractional loss compared to DWT based compression so the proposed technique provides better image quality of decompressed image on high compression ratio compared to DWT based and hybrid DWT DCT based image compression techniques.

KEYWORDS: Image Compression, DWT, IWT, DCT, PSNR

I. INTRODUCTION

In The vital purpose of compression technique is reducing information redundancy for minimizing transmission bandwidth and archiving costs [1,2]. Compression approach is classified into data compression and multimedia compression [3]. Multimedia has high size in disk which takes much time uploading and downloading over network. Multimedia can be an image or video file. Spatial domain and frequency domain are the two approach of image compression [4]. For image compression, transform based compression shows better robustness than spatial domain based compression. Compression technique can be either lossless or loosy [5]. Inlossy compression, data loss is incurred but compression ratio is very high. In lossless compression approach, decompressed Image is identical to the original one but with compression ratio [6]. We focus on lossy compression approach for image where transform techniques is used. Use of transform technique for compression is dependent on computational complexity and error threshold [7].

The goal of research is to find out a transformation based compression approach which have low computational complexity and able to concentrate the signal energy in the smallest number of parameters [8]. There are discrete Fourier transform (DFT), discrete wavelet transform (DWT) and discrete cosine transform (DCT) based compression technique which have property of reversible, unitary, symmetric and constant energy [9]. Discrete wavelet transform decomposes image into 4 different frequency bands which is called LL, LH, HL and HH where LL sub band represents characteristics of image while HH sub band represents Noise in image [10]. DCT cosine transform image from space domain to frequency domain where low frequency components are top left corner of DCT coefficient matrix and frequency reduce diagonally from top left corner to bottom right corner [11]. Salam Benchikh and Michael Corinthios [12] suggested a scheme of hybrid Compression based on discrete wavelet transformation and discrete cosine transformation but discrete wavelet transform have problem of fraction loss which increases the error between

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original and recovered image.

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II. TYPES OF COMPRESSION

Lossless versus Lossy compression: In lossless compression schemes, the reconstructed image, after compression, is numerically identical to the original image. However lossless compression can only a achieve a modest amount of compression. Lossless compression is preferred for archival purposes and often medical imaging, technical drawings, clip art or comics. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. An image reconstructed following lossy compression contains degradation relative to the original. Often this is because the compression scheme completely discards redundant information. However, lossy schemes are capable of achieving much higher compression. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences can be called visually lossless [8]. **Predictive versus Transform coding:** In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Since this is done in the image or spatial domain, it is relatively simple to implement and is readily adapted to local image characteristics. Differential Pulse Code Modulation (DPCM) is one particular example of predictive coding. Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well-known transform and then codes the transformed values (coefficients). This method provides greater data compression compared to predictive methods, although at the expense of greater computational requirements.

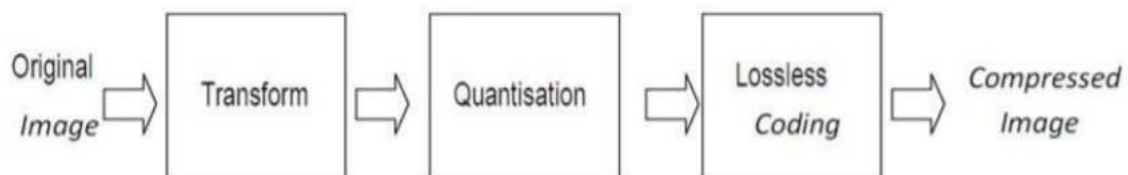


Figure 1: Image Compression Model

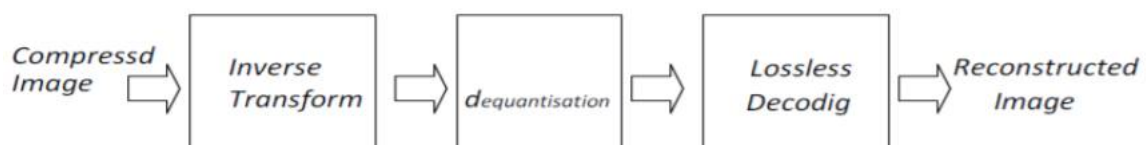


Figure 2: Image Decompression Model

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Image compression model shown here consists of a Transformer, quantizer and encoder.

Transformer: It transforms the input data into a format to reduce interpixel redundancies in the input image. Transform coding techniques use a reversible, linear mathematical transform to map the pixel values onto a set of coefficients, which are then quantized and encoded. The key factor behind the success of transform-based coding schemes is that many of the resulting coefficients for most natural images have small magnitudes and can be quantized without causing significant distortion in the decoded image. For compression purpose, the higher the capability of compressing information in fewer coefficients, the better the transform; for that reason, the Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) have become the most widely used transform coding techniques. Transform coding algorithms usually start by partitioning the original image into subimages (blocks) of small size (usually 8×8). For each block the transform coefficients are calculated, effectively converting the original 8×8 array of pixel values into an array of coefficients within which the coefficients closer to the top-left corner usually contain most of the information needed to quantize and encode (and eventually perform the reverse process at the decoder's side) the image with little perceptual distortion. The resulting coefficients are then quantized and the output of the quantize is used by symbol encoding techniques to produce the output bitstream representing the encoded image. In image decompression model at the decoder's side, the reverse process takes place, with the obvious difference that the dequantization stage will only generate an approximated version of the original coefficient values e.g., whatever loss was introduced by the quantize in the encoder stage is not reversible.

Quantizer: It reduces the accuracy of the transformer's output in accordance with some preestablished fidelity criterion. Reduces the psych visual redundancies of the input image. This operation is not reversible and must be omitted if lossless compression is desired. The quantization stage is at the core of any lossy image encoding algorithm. Quantization at the encoder side, means partitioning of the input data range into a smaller set of values. There are two main types of quantizers: scalar quantizers and vector quantizers. A scalar quantizer partitions the domain of input values into a smaller number of intervals. If the output intervals are equally spaced, which is the simplest way to do it, the process is called uniform scalar quantization; otherwise, for reasons usually related to minimization of total distortion, it is called non uniform scalar quantization. One of the most popular non uniform quantizers is the Lloyd-Max quantizer. Vector quantization (VQ) techniques extend the basic principles of scalar quantization to multiple dimensions. Symbol (entropy) encoder: It creates a fixed or variable-length code to represent the quantizer's output and maps the output in accordance with the code. In most cases, a variable-length code is used. An entropy encoder compresses the compressed values obtained by the quantizer to provide more efficient compression. Most important types of entropy encoders used in lossy image compression techniques are arithmetic encoder, Huffman encoder and run-length encoder.

III. RELATEDWORK

The DWT and DCT transformation technique is describe in following section which is used in proposed work.

A. Discrete Wavelet Transform(DWT)

When an integer data set is mapped into another integer data set, this type of transformation is known as integer wavelet transformation and it is also called s-transformation. The output of smooth(s) and detail (d) are given by the equations 1(a) and 1(b) [13].

$$S(n) = [X(2n) + X(2n+1)]/2 \dots\dots(1a)$$

$$D(n) = X(2n) - X(2n+1) \dots\dots(1b)$$

The inverse of transformation is given by equations 2(a) and 2(b).

$$X(2n) = s(n) + [(d(n) + 1)/2] \dots\dots(2a)$$

$$X(2n + 1) = s(n) - d(n)/2 \dots\dots(2b)$$

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B. Discrete Cosine Transform(DCT)

In the proposed technique, DCT transformation is used as JPEG standard [14]. 8x8 block matrix are created and on each matrix is converted into frequency domain using DCT. For compression process, Quantization is used on DCT matrix and using specific procedure, data are reduced in disk. For reconstruction of image from compressed data, Inverse DCT transform is applied. Discrete Cosine Transform is given as following equation (3).

IV. PROPOSED WORK

Our goal is to propose a compression process to store image and a high quality of reconstruction image after decompression compared to discrete wavelet transform technique. For the achieving of better quality recovered image our goal is to propose a compression process to store image and a high quality of reconstruction image after decompression compared to discrete wavelet transform technique. For the achieving of better quality recovered image with low distortion, hybrid approach of DWT and DCT is used which used advantage of both technique and avoid the drawback of each transform. The proposed techniques avoid the fraction loss of DWT technique also. Proposed encoding model is shown in figure 3. The LL sub bands (Approximation Coefficients) signify the characteristics of image while HH sub bands (Detail Coefficients) signify the detail information in image. For, LL frequency sub bands are selected for DCT transformation and quantization subsequently. The detailed embedding procedure of proposed technique is explained as following.

LL (Approximation Coefficients)	LH (Detail Coefficients)
HL (Detail Coefficients)	HH (Detail Coefficients)

Figure 3: Frequency Sub band after One Level DWT Transformation

Step 1: Image is read and transformed using Integer Wavelet Transformation which decomposes image into 4 different frequency bands as shown in figure 1.

Step 2: Step 1 is applied on upto 3 Level decomposition on LL block. We get one approximation image of size $N/8 \times N/8$ and nine details images of different size (3 images of size $N/8 \times N/8$, 3 images of size $N/4 \times N/4$ and 3 images of size $N/2 \times N/2$).

Step 3: The two-dimensional DCT is applied only on approximation image resulting from iteration 3. For the nine detail sub bands, we apply two thresholds for compression as described in improved-IWT method. The results from the two ways are supposed to be coded and transmitted.

Step 4: Transform the image from DCT domain to DWT domain using inverse DCT.

Step 5: Construct compressed image using inverse Integer Wavelet Transform iteratively so that image is achieved in space domain and save the compressed image.

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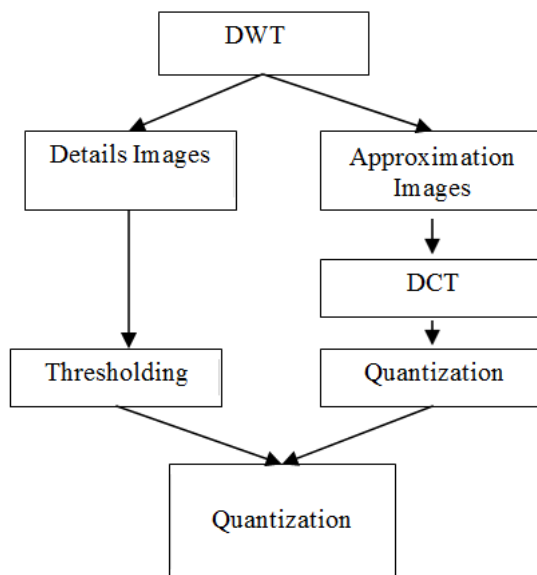


Figure 4: Encoder block for hybrid DWT-DCT.

V. EXPERIMENT RESULTS & ANALYSIS

VI.

The Proposed Technique is implemented on MATLAB.

The Experiments of Proposed DWT-DCT image Compression technique is performed on host images of wbarb and bust images of size of 256x256 pixels each. In image compression, we generally use two metrics to evaluate the quality of image compression: objective and subjective evaluations. It is measured in term of PSNR (Peak Signal to Noise Ratio) and quality of recovered image shows higher PSNR value.



Figure 5: wbarbImagesss size 256x256

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Figure 6: Bust size 256x256

Table1:Comparative PSNR bust cover image using proposed 2-D DWT+DCT method and DWT+DCT

Quality Factor	DWT+DCT Technique [12] PSNR(dB): wbarb	Proposed Technique PSNR(dB):wbarb
50	28.30	29.7
40	27.79	29.1
30	27.39	28.7
20	27.07	28.4
10	26.80	28.1

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Table 2: Comparative PSNR bust cover image using proposed 2-D DWT+DCT method and DWT+DCT

Quality Factor	DWT+DCT Technique [12] PSNR (dB): bust image	Proposed Technique PSNR (dB): bust image
50	29.25	30.7
40	28.54	29.9
30	27.95	29.3
20	27.43	28.8
10	27.00	28.3

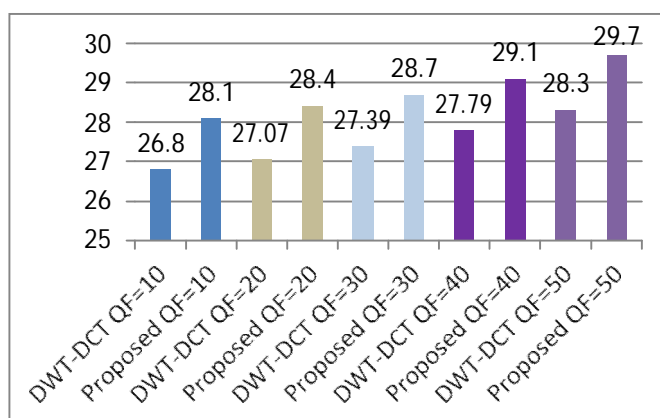


Figure 7: Comparative analysis between proposed 2-D DWT-DCT and DWT-DCT [12] technique for PSNR on Wbarb Image.

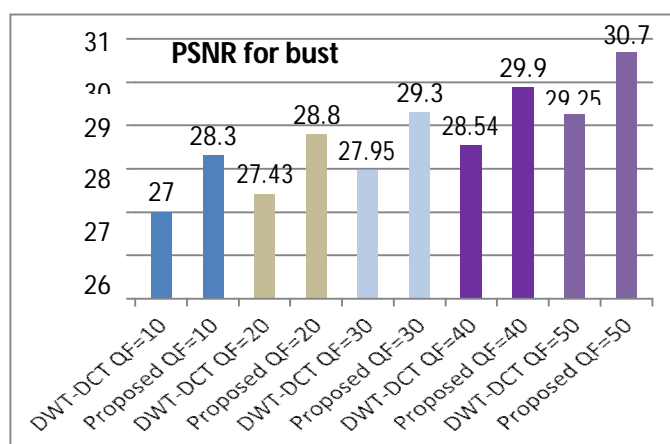


Figure 8: Comparative analysis between proposed 2-D DWT-DCT and DWT-DCT [12] technique for PSNR on bust Image.

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VII. CONCLUSION

From the results it is derived that proposed technique achieved higher PSNR value compared to DWT+DCT method for all quality factors. The results show that PSNR decreases whenever quality factor decreases So PSNR is proportional to quality factor. PSNR signify visual quality against loss due to embedding for compression. So proposed technique have better visual decompressed image or less loss of compressing embedding compared to DWT+DCT based compression. The reason behind better decompressed image quality of proposed technique is that Integer wavelet transformation avoids fraction loss which is occurred during in dwf based technique.

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