Improved N Level Decomposition-Hybrid DCT-DWT Image Compression

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***Abstract*— With the advent of internet, large number of images is transmitted. Memory space and channel capacity are the major challenges during image transmission. Hence image compression plays a major role during image transmission. Image compression is process to remove the redundant information from the image so that only essential information can be stored to reduce the storage size, transmission bandwidth and transmission time. The essential information is extracted by various transforms techniques such that it can be reconstructed without losing quality and information of the image. In this paper comparative analysis of image compression is done by three transform methods, which are Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) & Hybrid (DCT+DWT) Transform.**

***Index Terms*— Image compression, DCT, DWT, HYBRID (DCT+DWT).**

I. INTRODUCTION

Image compression addresses the problem of reducing the amount of data required to represent a digital image. It is a process intended to yield a compact representation of an image, thereby reducing the image storage/transmission requirements. Compression is achieved by the removal of data redundancies. The main purpose of image compression is to reduce the redundancy and irrelevancy present in the image, so that it can be stored and transferred efficiently. The compressed image is represented by less number of bits compared to original. Hence, the required storage size will be reduced, consequently maximum images can be stored and it can transferred in faster way to save the time, transmission bandwidth. For this purpose many compression techniques i.e. scalar/vector quantization, differential encoding, predictive image coding, transform coding have been introduced. Among all these, transform coding is most efficient especially at low bit rate [1].

Transform coding relies on the principle that pixels in an image show a certain level of correlation with their neighboring pixels. Consequently, these correlations can be exploited to predict the value of a pixel from its respective neighbors. A transformation is, therefore, defined to map this spatial (correlated) data into transformed (uncorrelated) coefficients. Depending on the compression techniques the image can be reconstructed with and without perceptual loss. In lossless compression techniques, the original image can be perfectly recovered from the compressed (encoded) image. These are also called noiseless since they do not add noise to the signal (image).It is also known as entropy coding since it use statistics/decomposition techniques to eliminate/minimize redundancy. Lossless compression is used only for a few applications with stringent requirements such as medical imaging.[2]. Lossy schemes provide much higher compression ratios than lossless schemes. Lossy schemes are widely used since the quality of the reconstructed images is adequate for most applications .By this scheme, the decompressed image is not identical to the original image, but reasonably close to it.[3]. Transform coding, which applies a Fourier-related transform such as DCT and Wavelet Transform such as DWT are the most commonly used approach [4]. In this paper we made a comparative analysis of three transform coding techniques, viz. DCT, DWT and hybrid i.e. combination of both DCT and DWT based on different performance measure such as Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE), Compression Ratio (CR), computational complexity. This paper is divided as follows: Section 2 explains Discrete Cosine Transform (DCT) algorithm; Section 3 describes the Discrete Wavelet Transform (DWT) algorithm; combination of both DCT and DWT algorithm explained in Section 4; Section 5 included experimental results and in last Section gives the conclusions.

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II. DISCRETE COSINE TRANSFORM (DCT)

DCT is applied separately on R,G and B components of the image .Discrete cosine transform is applied on the compressed image to further compress the image by selecting the DCT threshold value to 200. We have fixed this value otherwise we can also vary this value to change the results. Then IDCT is applied on every component of the image.

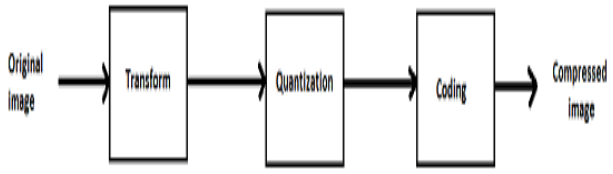

Fig.1 Image compression model

Image is concentrated in just few coefficients of DCT. After the computation of DCT coefficients, they are normalized according to a quantization table. The value of quantization is inversely proportional to quality of reconstructed image, better mean square error and better compression ratio. In a lossy compression technique, during a step called Quantization, the less important frequencies are discarded, then the most important frequencies that remain are used to retrieve the image in decomposition process. [5]. After quantization, quantized coefficients are rearranged in a

zigzag order for further compressed by an efficient lossy coding algorithm.

III. DISCRETE WAVELET TRANSFORM

For the compression of image, firstly the DWT is applied on the image using Threshold value. Threshold values neglects the certain wavelet coefficients. For doing this one has to decide the value of threshold. Value of threshold affects the quality of compressed image. Thresolding can be of two types:

A. ***Hard threshold:***

If x is the set of wavelet coeficients, then threshold value t is given by,

T(t; x) = 0 if x < t
x otherwise,
i.e. all the values of x which are less than threshold t are equated to zero.

B. *Soft threshold:*

In this case, all the coefficients x lesser than threshold t are mapped to zero. Then t is subtracted from all x ¸ t. This condition is depicted by the following equation:

T (t; x) = 0 if x < t
Sign(x) (x - t) otherwise.

This condition is shown in Figure 1(c). Usually, soft threshold gives a better peak signal to noise ratio (PSNR) as compared to hard threshold [6].

IV. HYBRID (DCT + DWT) TRANSFORM

The aim of image compression is to reduce the storage size with high compression and less loss of information. In section II and III we presented two different ways of achieving the goals of image compression, which have some advantages and disadvantages, in this section we are proposing a transform technique that will exploit advantages of DCT and DWT, to get compressed image. Hybrid DCT-DWT transformation gives more compression ratio compared to JPEG and JPEG2000, preserving most of the image information and create good quality of reconstructed image. Hybrid (DCT+DWT) Transform reduces blocking artifacts, false contouring and ringing effect [7].

A. *Coding scheme*

a) *Compression procedure*

The input image is first converted to gray image from colour image, after this whole image is divided into size of 32x32 pixels blocks. Then 2D-DWT applied on each block of 32x32 block, by applying 2 D-DWT, four details are produced. Out of four sub band details, approximation detail/sub band is further transformed again by 2 D-DWT which gives another four sub-band of 16x16 blocks. Above step is followed to decompose the 16x16 block of approximated detail to get new set of four sub band/ details of size 8x8. The level of decomposition is depend on size processing block obtained initially, i.e. here we are dividing image initially into size of 32x32, hence the level of decomposition is 2. After getting four blocks of size 8x8, we use the approximated details for computation of discrete cosine transform coefficients. These coefficients are then quantize and send for coding.

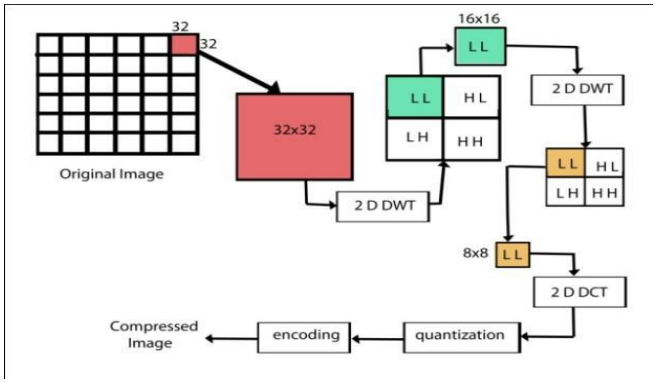

Fig.2 Compression technique using Hybrid transform

b) *Decompression procedure*

At receiver side, we decode the quantized DCT coefficients and compute the inverse two dimensional DCT (IDCT) of each block. Then block is dequantized. Further we take inverse wavelet transform of the dequantized block. Since the level of decomposition while compressing was two, we take inverse wavelet transform two times to get the same block size i.e. 32x32. This procedure followed for each block received. When all received blocks are converted to 32x32 by following decompression procedure, explained above. We arrange all blocks to get reconstructed image [8].

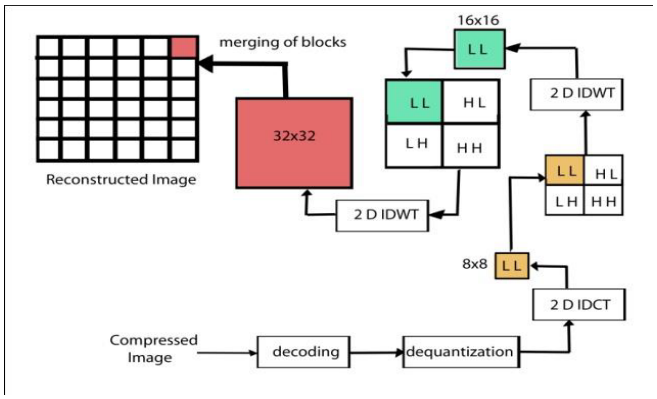

Fig.3 Decompression technique using Hybrid transform

V. EXPERIMENTAL RESULTS

Here, we present the experimental results for II compression using the proposed hybrid technique. For demonstration

purposes, we compressed the image by the proposed hybrid algorithm and by conventional JPEG at different compression depths. We evaluate the efficiency of compression by evaluating the peak-to-peak signal to noise ratio (PSNR)

Calculation of CR and PSNR: After the image is compressed, last step is to calculate the CR and PSNR on different medical images.

To calculate CR: CR = ((original size-compressed size)/original size) * 100;

To calculate PSNR Peak Signal –to-noise ratio is the ratio between the maximum possible power of a signal to the power of corrupting noise that affects the fidelity of its representation.

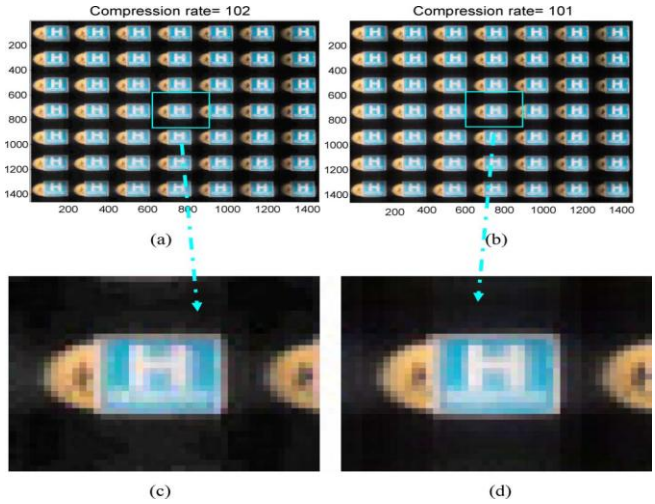

Figure 4. Decompressed integral images of (a) JPEG compressed image and
(b) Using Hybrid compression technique. (c), (d) Respective enlargements of
the upper row images.

VI. CONCLUSION

In this paper comparative analysis of various Image compression techniques for different images is done based on three parameters compression ratio(CR), mean square error (MSE), peak signal to noise ratio (PSNR). Our result shows that we can achieve higher compression ratio using Hybrid technique but loss of information is more. DWT gives better compression ratio without losing more information of image. Pitfall of DWT is, it requires more processing power. DCT overcomes this disadvantage since it needs less processing power, but it gives less compression ratio. DCT based standard JPEG uses blocks of image, but there is a still correlation exit across blocks.

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