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Hybrid Image Compression Based On Fuzzy Logic Technology

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Abstract— In this paper, the comparison between Hybrid Image Compressions methods and Image Compression based on fuzzy logic is discussed. The Hybrid Comparison Method is a combination of both the DWT and DCT Image Compression method. When more than one compression technique are applied to compressed one image for high value of PSNR (peak signal to noise ratio) and CR (compression ratio) this process is called hybrid compression technique. For reducing MSE (mean square error) and for contrast enhancement Fuzzy Logic is applied to same image. The proposed work is designed using MATLAB.

Keywords— DCT, DWT, CR, PSNR, MSE.

INTRODUCTION

The basic rule of compression is to reduce the numbers of bits required to represent an image. In a computer an image is represented as an array of numbers, integers to be more specific, that is called a digital image. Two major components of compression are redundancy and irrelevancy reduction. Redundancy reduction aims at eliminating duplication from the image. Irrelevancy reduction are neglects the parts of the signal that will not be noticed by the signal receiver, namely the Human Visual System (HVS).

In this paper firstly we have discussed two important Image compression method DWT (Discrete wavelet transform) and DCT (Discrete cosine transform).

The term ‘wavelet’ comes from the fact that they integrate to zero; when wave up and down across the axis. Many wavelets also display a property ideal for compressed signal representation: orthogonality. This property confirms that data is not over represented. A signal can be decomposed into many shifted and scaled representations of the original mother wavelet. A wavelet transform can be used to decompose a signal into component wavelets. Once this is done the coefficients of the wavelets can be decimated to remove some of the details. Wavelets have the great advantage of being able to separate the fine details in a signal. Very small wavelets can be used to isolate very fine details in a signal, while very large wavelets can identify coarse details. [1]

The Discrete Cosine Transform (DCT) has been shown to be near optimal for a large class of images in energy concentration and decorrelating. It has been implemented in the JPEG and MPEG coding standards. The JPEG process is a widely used form of lossy image compression that centers on the DCT. The DCT works separating images into parts of differing frequencies. During a step called quantization where part of compression actually occurs, the less important frequencies are discarded, hence the use of the term “lossy’’. Then, only the important frequencies that remain are used retrieve the image in the decompression process. As a result, reconstructed images contain some distortion. The jpeg method is used for both color and black and white images. Importance of image compression increases with advancing communication technology. [2]

Fuzzy logic is a useful technique in image contrast enhancement. It is provided by the application of fuzzy sets theory and fuzzy inference systems. The fuzzy sets theory’s groundwork was set by Prof. Zadeh in 1965, followed later on by the fuzzy logic basis, established in 1973 since then the applications of fuzzy sets theory and fuzzy logic to scientific computing are very vast and still continue to develop along with other modern algorithms in the area of soft computing.

1) HYBRID IMAGE COMPRESSION

Hybrid Image compression method is 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, conserving most of the image information and construct good quality of reconstructed image. Hybrid (DCT+DWT) Transform reduces blocking artefacts, false contouring and ringing effects which normally seen in DWT or DCT techniques.[3]

- **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.as shown in fig 1

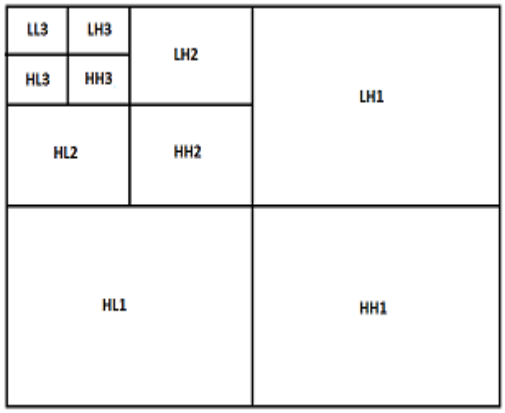

Fig No.1 Wavelet Filter Decomposition

- Than after getting four blocks of size 8x8, we use the approximated details for computation of discrete cosine transform coefficients.

The forward 2D_DCT transformation coefficient is calculated by the following equation:

$$C(u,v)=D(u)D(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{(2x+1)u\pi}{2N}\right]\cos[(2y+1)v\pi/2N$$

Where,u,v=0,1,2,3,……,N-1

The inverse 2D-DCT transformation is given by the following equation

$$F(x,y)=\sum_{v=0}^{N-1} D(u)\,D(v)\,d(u,v)\cos\left[\frac{(2x+1)u\pi}{2N}\right] x\cos(2y+1)v\pi/2N$$

Where D (u) = (1/N) ^1/2 for u=0

D (u) =2(/N) ^1/2 for u=1, 2, 3……., (N-1)

- These coefficients are then quantize and send for coding.

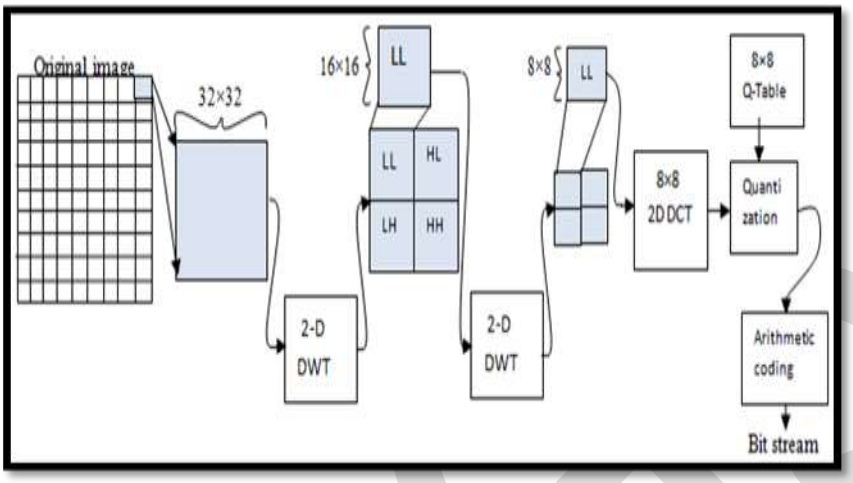

Fig No.2 Block Diagram of Hybrid image compression encoder

- In decoder section just opposite work is done. , 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.

2) FUZZY LOGIC TECHNOGOY BASED HYBRID IMAGE COMPRESSION

Many difficulties in image processing arise because the data/tasks/results are uncertain. This uncertainty, however, is not always due to the randomness but to the ambiguity and vagueness. Beside randomness which can be managed by probability theory, there are three other kinds of uncertainty in the image processing, they are:

1. Grayness ambiguity
2. Geometrical fuzziness
3. Uncertain knowledge

So the fuzzy logic used for

1. Fuzzy techniques are powerful tools for knowledge representation and processing
2. Fuzzy techniques can manage the vagueness and ambiguity efficient.

Fuzzy image enhancement is based on gray level mapping into a fuzzy plane, using a membership transformation function. The aim is to generate an image of higher contrast than the original image by giving a larger weight to the gray levels that are closer to the mean gray level of the image than to those that are farther from the mean. An image *I* of size *M* x *N* and L

gray levels can be considered as an array of fuzzy singletons, each having a value of membership denoting its degree of brightness relative to some brightness levels. For an image *I*, we can write in the notation of fuzzy sets:

$$I = \mathrm{U}_{mn} \ \propto_{mn} / g_{mn} \qquad \text{m} = 1, 2... \text{M} \ \text{and} \ \text{n} = 1, 2... \text{N}$$

Where g_{mn} is the intensity of (m, n) th pixel and $\propto_{mn}$ its membership value

The membership function characterizes a suitable property of image (e.g. edginess, darkness, textural property) and can be defined globally for the whole image or locally for its segments. In recent years, some researchers have applied the concept of fuzziness to develop new algorithms for image enhancement. [4]

The principle of fuzzy enhancement scheme is illustrated in Figure (3).

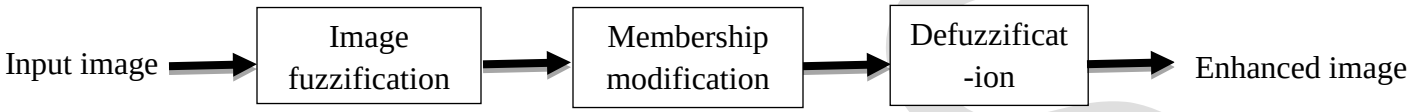

Figure No.3 The Main Principles of Fuzzy Image Enhancement

- **Compression Procedure**

- First read the input image. Convert color image to gray image and applied DWT process on it.
- 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.
- In higher frequencies sub bands (LH, HH, and HL) fuzzy logic is applied to enhance PSNR value. And reduce the Mean Square Error.
- In lower frequency (LL) 2D-DWT is again perform which divides LL to LL1, LH1, HL1, and HH1.
- Than DCT transform is applied to both lower (LL1) and. This process will further increases the compression ratio.

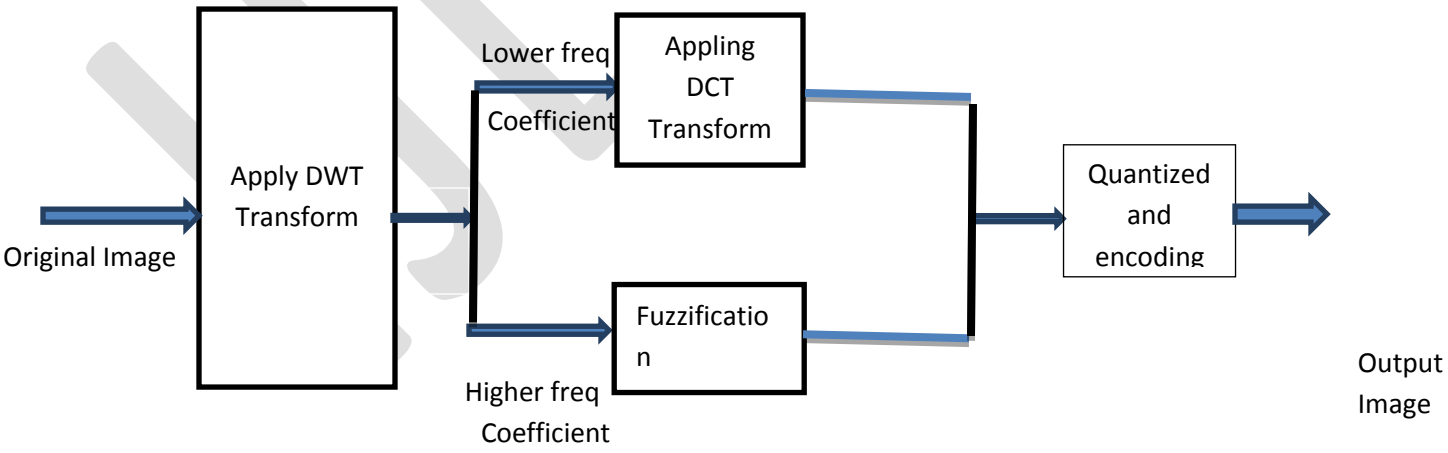

Fig No.4 image compression based on Fuzzy logic technology

3) COMPARATIVE ANALYSIS AND RESULTS

For comparative analysis codes for Hybrid (DWT-DCT) and Hybrid image compression based on fuzzy logic techniques were written in MATLAB and results are tabulated in table 1 the compression ratio CR is high for Hybrid transform as compare to standalone transforms. DWT comprises between compression ratio and superiority of reconstructed image, it adds noise to the image for improvement in the reconstructed image. Hence DWT technique is useful in medical applications. DCT gives less compression ratio but it is computationally efficient compared to other techniques.

Original Image

Fuzzy logic based Hybrid image compression

Hybrid image compression

Compressed Image

Comparison Table No.1

S no.	Method applied	PSNR (in dB)	MSE Value
1	Hybrid Image compression	30.4799	54.1857
2	Image compression based on fuzzy logic	32.8746	31.2164

4) CONCLUSION

In this paper comparative analysis of various Image compression techniques for different images is done based on three parameters mean square error (MSE), peak signal to noise ratio (PSNR). Our results shows that we can attain higher compression ratio by Hybrid technique but damage of information is more. DWT gives better compression ratio without losing more information of image. Drawback of DWT is, it needs more processing power. DCT overcomes this disadvantage since it needs less processing power, but it gives less compression ratio. DCT uses blocks of image, but there is still correlation exits across blocks. Hybrid transform provides higher compression ratio but for getting that clearness of the image is partially tradeoff. By applying fuzzy logic the image quality has been enhanced so it will increases PSNR value of compressed image. And also reduce Errors. Fuzzy based Hybrid image compression used in medical images.

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