Hybrid Image Compression Based On Fuzzy Logic Technology

Neha Pandey, Himani Agrawal

Abstract—**This is a survey paper .In this paper, Image compressions methods such as DCT, DWT, and Hybrid are discussed. Hybrid Image Compression using DWT and DCT is used which performs discrete cosine transformation on the discrete wavelet transformed coefficients. Compression techniques are useful to compressed one image for high value of PSNR (peak signal to noise ratio) and CR (compression ratio) this method is called hybrid compression technique. The new scheme minimizes blocking artifacts, ringing effects and false contouring appreciably. The information in the images is compressed by extracting only the visible elements. The image compression technique can reduce the storage and transmission expenses. During image compression, the size of a graphics file is compact in bytes without distressing the quality of the image beyond a suitable level.**

Index Terms—CR, DCT, DWT, PSNR

I. INTRODUCTION

The main purpose is to design a compression system suitable for processing, storage and transmission, as well as providing acceptable computational complication suitable for practical implementation. The basic rule of compression is to decrease the numbers of bits needed 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. Number of bits required to represent the information in an image can be minimized by removing the redundancy present in it. The need for image compression are The large storage requirements for multimedia data but low power devices such as handheld phones have small storage capacity and Network bandwidths currently available for transmission is limited.

Image compression is mainly two type's lossless compression and lossy image compression. In a lossless compression method compressed data can be used to reconstruct an exact replica of the original; no information is lost to the compression procedure. This type of compression is also known as entropy coding. This name comes from the fact that a compressed signal is generally more random than the original; patterns are removed when a signal is compressed. While lossless compression is useful for exact reconstruction, it generally does not provide satisfactorily high compression ratios to be truly useful in image compression. Lossless image compression is particularly useful in image archiving as in the storage of authorized or medical records. Methods for lossless image compression includes: Entropy coding, Huffman coding, Bit-plane coding, Run-length coding and LZW (Lempel Ziv Welch) coding. [1]

In lossy compression, the original signal cannot be exactly reconstructed from the compressed data bits. The reason is that, much of the detail in an image can be discarded without very much changing the appearance of the image. In lossy image compression, though very small information of the images is lost, but image size is drastically reduced. Lossy image compressions are useful in applications such as broadcast television, videoconferencing, and facsimile transmission, in which a certain amount of error is an acceptable trade-off for increased compression performance. Methods for lossy compression include: Fractal compression, Transform coding, Fourier-related transform, DCT (Discrete Cosine Transform) and Wavelet transform. [1]

Both Dct and wavelet belong to the general class of "transformed based lossy compression techniques. These techniques involved three steps:

- Transformation
- Quantization
- Encoding

Transformation is a lossless step in which image is transformed from the grayscale values in the special domain to coefficients in some other domain. No loss of information occurs in the transformation step. Quantization is the step in which loss of information occurs. It attempts to preserve the more important coefficients, while less important coefficients are roughly approximated, often as zero. Finally, these quantized coefficients are encoded. This is also a lossless step in which the quantized coefficients are compactly represented for efficient storage or transmission of the image. [2]

1) Discrete Cosine Transformation (DCT)

DCT is an orthogonal transform, the Discrete Cosine Transform (DCT) attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency.

DCT separates images into parts of different frequencies where less important frequencies are discarded through quantization and important frequencies are used to retrieve the image during decompression. Compared to other input dependent transforms, DCT has many advantages: (1) It has

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been implemented in single integrated circuit; (2) It has the ability to pack most in-formation in fewest coefficients; [3]It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible.(2) The discrete cosine transform (DCT) helps divide the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The DCT is similar to the discrete Fourier transform: it transforms an image from the spatial domain to the frequency domain.

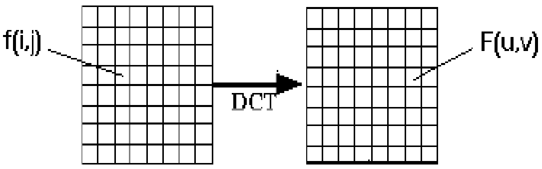

Figure No-1

Dct process-

- Original image is divided into 8 x 8 blocks.
- Pixel values of a black and white image range from 0-255 where 0 corresponds to a pure black and 255 correspond to a pure white. But DCT is designed to work on pixel values ranging from -128 to 127. Therefore each block is modified to work in the range. Then working from left to right, top to bottom the DCT is applied to each block.
- The two-dimensional DCT is given by follows

$$C(u,v) = D(u)D(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{(2x+1)u\pi}{2N}\right]\cos(2y+1)v\pi/2N$$ --------------------Eq1

Where, u, v=0, 1, 2, 3… N-1

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

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

--------------Eq2

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

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

- Than Each block's elements are compressed through Quantization means dividing by some specific 8X8 matrix called QMatrix and rounding to the nearest integer value.
- After Quantization, all of the quantized coefficients are ordered into the zigzag sequence.

Compressed image is reconstructed through re-verse process. Inverse DCT is used for decompression.

2) Discrete Wavelet Transform (DWT)

Wavelets are a mathematical tool for changing the coordinate system in which we represent the signal to another domain that is best suited for compression. Wavelet based coding is more robust under transmission and decoding errors.

It provides a medium for image processing applications, because it has capacity of to take into an account Human Visual System (HVS) characteristics, good energy compaction capabilities, and under transmission & decoding, and also it is more robust under transmission & decoding error, which results in a high compression ratio. In addition to these wavelets transform compression provides a better image quality at low bit rates since there is no require of blocking the image. The Practical implementation of wavelet compression schemes is very similar to that of sub-band coding schemes. As in case sub-band coding, we decompose the signal using filter banks.

The output of the filter banks are down sampled, quantized, and encoded. The decoder decodes the coded representation, up samples, and recomposes the signal. [3]

Wavelet transform (WT) of an image represents image as a sum of wavelets on multi-resolution levels. Multi resolution analysis is implemented via high-pass filters (wavelets) and low-pass filters (scaling functions). In wavelet transform any one-dimensional function is transformed into a two-dimensional space, where it is approximated by coefficients that depend on time (determined by the translation parameter) and on scale, (determined by the dilation parameter). The zoom phenomena of the WT offer high temporal localization for high frequencies while offering good frequency resolution for low frequencies. Hence, the wavelet transform is well suited to image compression. [4]

Dwt Process –

- The image is digitized first. The digitized image can be characterized by its intensity levels.
- Decompose the signal into a sequence of wavelet coefficients.
- A threshold is selected. Any wavelet whose fixed value falls below the tolerance is set to zero with the aim to introduce many zeros without losing a large amount of detail.
- Than Quantization converts a sequence of floating numbers to a sequence of integers. Quantization is called lossy because it introduces error into the process
- Finally Entropy encoding is applied.

3) Hybrid Image Compression

The properties of both the DWT and the DCT are exploited in hybrid DWT-DCT technique. 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. This technique consists of two steps. In first step lossy compression technique is applied to compress image and in second step lossless compression technique is applied so that PSNR (peak signal to noise ratio) value and CR (compression ratio) could be maintained. [5]

The input image taken and whole image is split into blocks of size 32 x 32. The blocks of the image are first decomposed using 2-D Forward DWT. From this Low-frequency coefficients (LL) are passed to the next stage and the high frequency coefficients (LH, HL, and HH) are just

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discarded for getting high compression ratio. The passed LL components are further decomposed using 2nd level 2-D DWT. 8-point DCT is then applied to these DWT coefficients. The next stage is quantization, where the lossy compression occurs in which the higher frequency components are rounded off to zero. Finally entropy coding (lossless compression) is performed using arithmetic coding technique. In the decoding side, the reverse procedure is followed which uses an image enhancement technique as its last process for rebuilding its fine details. [6]

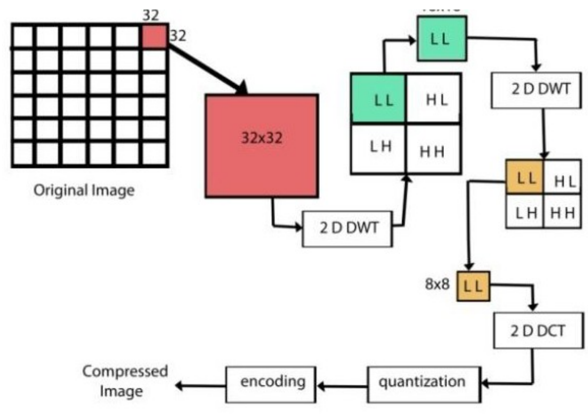

Figure No-2a Hybrid Encoder

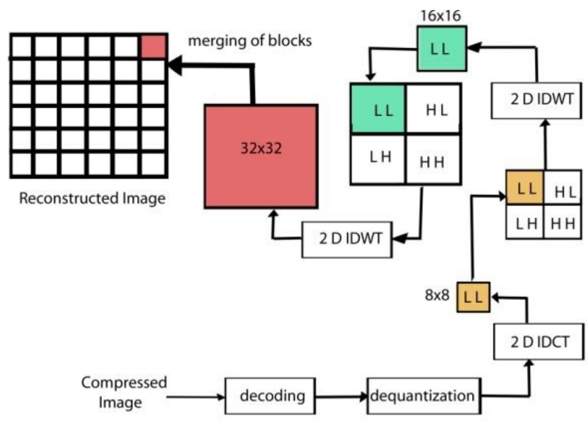

Figure No-2b Hybrid Decoder

II. COMPARISON

s.no	Parameter	DCT	DWT	HYBRID(DCT+DWT)
1	CR (compression ratio)	26.546	30.237	52.539
2	PSNR (in dB)	48.248	40.232	27.592

III. PROPOSED METHODOLOGY

Hybrid image compression based on fuzzy logic technology. The idea of fuzzy sets is simple and natural. For example, if we want to define a set of gray levels that share the property dark, darkness can be set as a the matter of degree. So, Fuzzy Logic can model this property more accurately. To define this set, we also need two thresholds, for example, 60 and 140. In turn, all gray levels that are less than 60 are the full member of the set. On the other hand, all gray levels that are greater than 140 are not the member of the set. The gray levels between 60 and 140, however, have a partial membership in the set.

Procedure:-

- Read the Digital Image.
- Apply fuzzy logic. Fuzzy image processing has three main stages: image Fuzzyfication, modification of membership values, and, if necessary, third stage is image Defuzzyfication.
- Apply hybrid image compression.

IV. EXPECTED OUTCOME

Fuzzy based image compression technique provides higher compression ratio as compare to normal hybrid image compression. Also the fuzzy logic technique used for the calculation of the coefficients could be modified to improve its accuracy.

V. CONCLUSION

An extensive literature survey on various lossy image compression techniques is performed in this paper.

- Hybrid DWT DCT coding scheme that gives high compression ratio without reducing much superiority of the image and encoded using

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arithmetic coding. Hybrid method reduces blocking artifacts, ringing effects and false contouring appreciably. [6]

- DCT performs efficiently at medium bit rates. Disadvantage with DCT is that. Blocks cannot be decorrelated at their boundaries using DCT.

- DWT provides high quality compression at low bit rates. The use of larger DWT basis functions or wavelet filters produces blurring near edges in images.

- DWT performs better than DCT in the context that it avoids blocking artifacts which degrade reconstructed images. However DWT provides lower quality than JPEG at low compression rates. DWT requires longer compression time.

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