ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 5, May 2017

Comparative Study of Image Compression using Discrete Wavelet Transform and Discrete Cosine Transform

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ABSTRACT: Image Processing refers to processing an image into digital image. Image Compression is reducing the amount of data necessary to denote the digital image. Image Compression techniques to reduce redundancy in raw Image. This paper addresses the different visual quality metrics, in digital image processing such as PSNR, MSE. The encoder is used to exchange the source data into compressed bytes. The decoder decodes the compression form into its original Image sequence. Data compression is achieved by removing redundancy of Image. Lossy compression is based on the principle of removing subjective redundancy. Lossless compression is depended on effective SR (Subjective redundancy). This paper presents a new lossy and lossless image compression technique using DCT and DWT. In this technique, the compression ratio is compared. In the proposed system image compression ratio are compared with sever results. In future image compression will done in DWT and DCT.

KEYWORDS: DCT, DWT, Lossy, Lossless

I. INTRODUCTION

Image compression is used to reduce the image size and redundancy of the image data. The amount of data used to represent these image, therefore needs to be reduced. Image compression deals with redundancy, the number of bits needed to represent on image by removing redundant data. Decreasing the redundancy is the main aim of the image compression algorithms. Picture pressure system, for the most part utilized two dimensional (2D) picture pressure norms, such us JPEG, JPRG-LS or JPRG2000 by and large consider just intra mark Correlation. Picture pressure is extensively characterized into two classifications in particular Lossy and Lossless relying upon whether the first picture can be recuperated with fill mathematic exactness from the packed picture [1]. Pressure is the best of Digital picture Processing. Lossless or Lossy pressure methodologies can be connected to hyper unearthly picture. Lossy pressure depends on the standard of expelling subjective excess. Lossless pressure depends on successful SR. Unique picture can be completely recuperated in Lossless picture pressure. It is valuable to assemble the huge changes for the Lossless picture pressure territory including dwt and different shading space changes [3]. Presently a day the high pressure was built up in Lossy pressure strategy is JPEG2000. This is a high performance in compression technique developed by the joint graphic Experts Group committee. The High compression was established in lossy finds the highest peak signal ratio (PSNR) and compression ratio. Compression ratio of PSNR values between the same set of images at very low bit rates. It can be observed that Lena image, Barbara image, Peppers Gold hill. This image performance may be calculated using DCT and DWT algorithms. The input image is divided in to nxn blocks. Then each block is transformed using DCT and DWT. The DCT Coefficients of each block is arranged in hierarchical Manner. DWT have different types of Wavelets and thresholding techniques. The first step of the compression algorithm is image decomposition in nxn sub-images. The DWT Coefficients of each block is arranged in Hilbert Fractal Curve. The Wavelet transforms is applied to

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each vector and some of the high frequency are suppressed based on the some threshold criteria. Wavelet transforms involve representing a general purpose in terms of simple, fixed building blocks are generated from a particular fixed function called mother wavelet function. DCT only compress the image of lower decorative performance, DCT is low level image compression. DCT only offers Lossy transform. DWT offers both Lossy and Lossless transform. The main focus of this work is dwt filter based on achieved compression ratio. The Proposed image compression technique has been tested on well-known image like compared with the JPEG2000 and DWT Techniques [1]. At finally lossless compression DWT is followed.

II. LITERATURE REVIEW

Gourav Kumar et al. [1], image compression is used to reduce the amount of data required to represent a digital image. The aim of this paper is to analyze the various image compression methods, factors on which image compression techniques are based and examine the performance of image compression using a detailed empirical evaluation of wavelet function, discrete cosine transform and neural network in term of retained energy, peak signal to noise ratio, output image size etc.

Pradeep Kumar Bhatia et al. [2], feature extraction techniques are applied to get features that will be useful in classifying and recognition of images. Feature extraction techniques are helpful in various image processing applications e.g. character recognition. As features define the behavior of an image, they show its place in terms of storage taken, efficiency in classification and obviously in time consumption also. Here in this paper, we are going to discuss various types of features, feature extraction techniques and explaining in what scenario, which features extraction technique, will be better. Hereby in this paper, we are going to refer features and feature extraction methods in case of character recognition application.

V Srinivasa Rao et al. [3], the paper presents Comparative Analysis of Image Compression Using Haar Wavelets on MATLAB and DSP has shown the speed of image compression is more on Digital Signal Processors when compared to General Purpose Processors. The increase in speed and the reduction of size of an image due to compression is useful to achieve rapid data transfer over the internet or any channel. DWT produces an image having a high quality when compared with Discrete Cosine Transform. Because DWT processed digital images at multiple resolutions.

Ahmed A. Nasha et al. [4], Discrete Wavelet Transform, (DWT), is known to be one of the best compression techniques. It provides a mathematical way of encoding information in such a way that it is layered according to level of detail. In this paper, we used Haar wavelets as the basis of transformation functions. Haar wavelet transformation is composed of a sequence of low pass and high pass filters, known as filter bank. The redundancies of the DWT detail coefficients are reduced through thresholding and further through Huffman encoding. The proposed threshold algorithm is based upon the statistics of the DWT coefficients.

After going throw the review of various existing work taken in the DCT and DWT the following problem formulation:

- According to the DCT properties, a DC is transformed to discrete delta-function at zero frequency. Hence, the transform image contains only the DC component. The work to be done is to perform the inverse transform of the transformed image and also to generate the error image in order to give the results in terms of MSE (Mean Square Error), as MSE increases, the image quality degrades and as the MSE would decrease, image quality would be enhanced with the help of changing the coefficients for DCT Blocks.
- Though in DWT, we get very high compression ratio, we lose minimum amount of information. But if we do more than one level then we get more compression ratio but the reconstructed image is not identical to original image. MSE is greater if DWT apply more than one level.

III. IMAGE COMPRESSION

The term data image compression refers to the process of reducing the amount of data required to represent a given amount of information. A clear distinction must be made between data and information. Data redundancy is a central issue in digital image compression. There are two types if image compression technique Lossy technique and Lossless technique. DCT is used in signal, image processing especially for Lossy compression because it has a strong energy compaction to create predictions according to its local uniqueness. The Lossy image compression did not give Proper

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Vol. 5, Issue 5, May 2017

vision of the image, but it gives good compression ratio of the image. DWT is used to separate the image into a pixel. DWT is used in signal and image processing especially for lossless image compression. DWT is also used for Lossy compression. The Lossless image compression is mostly used in DWT Lossless image compression give the good quality of the image and also the compression ratio of the image also good. The PSNR ratio of the image is also good in the Lossless compression.

A. LOSSY TECHNIQUE

Lossy is the one type of technique in image compression, it is based on the principle of removing subjective redundancy. Lossy technique splits the image into nxn matrix. Lossy compression image did not give the good vision of the compressed image. (i) SVD based compression is lossy due to the nature level of the process. However, the qualitative loss is not visible up to some point. The SVD compression technique offers very good PSNR values but low compression ratios (ii) WDR based compression is lossy due to the nature of the method. However the qualitative loss is noticeable in some point. The WDR compression offers very good PSNR value and good compression ratios. (iii) The DCT lossy image compression technique gives the best result for the lossy image compression. The value of the DCT Lossy image compression PSNR value is good in high compression ratio. In the lossy compression technique the quality of the image is low and the compression ratio was good. (iv) DWT lossy image compression technique did not give the best result because of lossy image compression. The value of the DWT image compression PSNR value is low in high compression ratio. In the Lossy compression ratio was good but average quality of the image.

B. LOSSLESS TECHNIQUE

Lossless is also a one type of image compression technique; it is based on SR effect. In the lossless technique the compressed image give the good quality of the image. In the lossless image compression the output result of PSNR value is good. (i) SVD based compression is lossless due to the nature of the process. That the qualitative lossless is not noticeable up to some point. The SVD compression technique offers very good PSNR values but high compression ratio. (ii) WDR based compression is lossless due to the nature of the process. However the qualitative lossless is visible in some point. The compression measure of the lossless image is also high value. The WDR compression offers very good PSNR value and good compression ratios. (iii) The DCT lossless image compression technique gives the average result for the lossless image compression. The value of the in the lossless compression technique DCT did not give the best result for the image compression. The PSNR value of lossless compression is good. (iv) DWT image compression is the technique mostly used in the lossless image compression. In this technique lossless gives the best compression result. The PSNR value of Lossless Image is good quality. The lossless image compression ratio was good, and also the quality of the lossless image compression also good.

VI. VARIOUS COMPRESSION ALGORITHMS

A. Image Compression by DCT

1. What is a Discrete Cosine Transform?

A discrete cosine transform (DCT) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral methods for the numerical solution of partial differential equations. The use of cosine rather than sine functions is critical for compression, since it turns out (as described below) that fewer cosine functions are needed to approximate a typical signal, whereas for differential equations the cosines express a particular choice of boundary conditions.

2. Why Discrete Cosine Transform based Compression?

With the advent of high resolution images and high definition videos, they are very popular and can be easily found in daily use by several people. Relying on quality data for processing led to the development of the multimedia products such as Mobile phone video capture, Wireless camera, Sensor Networks etc. Figure 1 shows Ideal coding architecture for upcoming video applications.

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 5, Issue 5, May 2017

The increase in crime and elevated Terrorist threats has also been a reason for the increase in video surveillance system. More often than not, these applications and/or devices require storing and/or transmitting of the recorded media. Compression becomes important in such cases, where the video is need to be of minimal space possible but not degrading the visual quality too much. Due to the scarcity of storage space and computational capabilities in the handheld and monitoring devices, we need an algorithm with good compression rate. For some applications/devices it is imperative that they consume low power at both the ends of the codec, as in mobile phone camera. Modern digital video coding schemes are ruled by the ITU-T (International Telecommunication. This results in high complexity encoders because of the motion estimation (ME) process run at the encoder side. On the other hand, the resulting decoders are simple and around 5 to 10 times less complex than the corresponding encoders (26). However, these types of architecture are more suited for the applications where the media is once encoded and might be decoded multiple times. Few such areas include on-demand-video, broadcasting etc. It presents a challenge for the traditional video coding paradigms to fulfill the requirements posed by these applications. So, there is a need for the low cost and power encoding device possibly at the expense of slightly complex decoder. Additional challenge arises while trying to achieve the efficiency as of those achieved by the traditional coding techniques, like those of MPEG-x or H.26x when the complexity shifts from encoder to decoder.

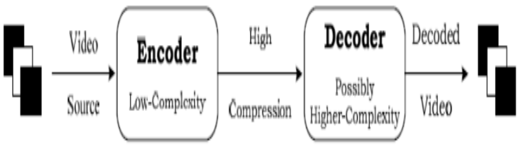

Figure 1: Ideal coding architecture for upcoming video applications

Distributed source coding (DSC) mainly depends on the principle of independent encoding and joint decoding. ‘Distributed’ in DSC points to the distributed nature of encoding operation, not the location as in distributed computing. DSC regards the compression of correlated information resources that do not communicate with each other (1). DSC models the correlation between multiple sources together with channel code and hence able to shift complexity from encoder to decoder. Hence DSC, DVC in current context, can be used to develop the devices having complexity-constrained encoder.

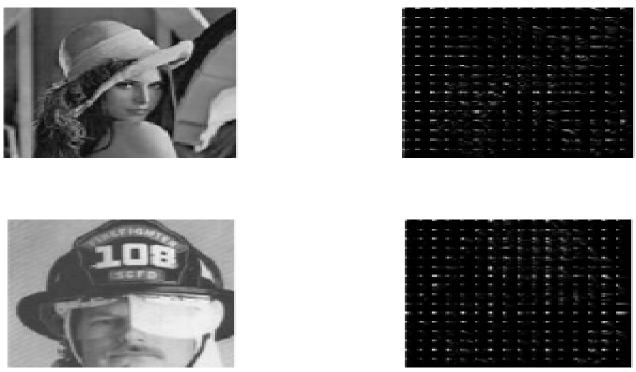

Figure 2: Original Image and Compressed Image with 8×8 DCT

 DOI: 10.15680/IJIRCCE.2017. 0505049

ISSN(Online): 2320-9801
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Vol. 5, Issue 5, May 2017

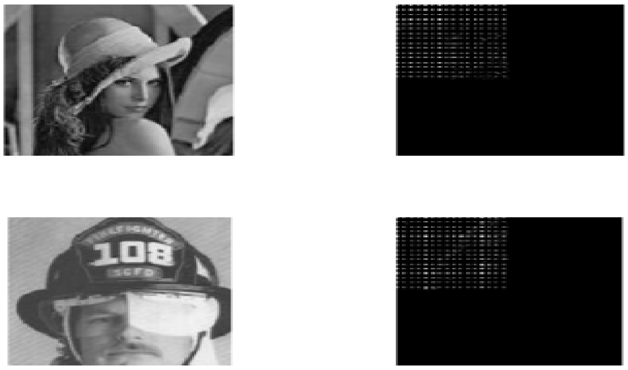

Figure 3: Original Image and Compressed Image with 4×4 DCT

B. Image Compression by DWT

1. What is Discrete Wavelet Transform

Wavelet Transform has become an important method for image compression. Wavelet based coding provides substantial improvement in picture quality at high compression ratios mainly due to better energy compaction property of wavelet transforms. Wavelet transform partitions a signal into a set of functions called wavelets. Wavelets are obtained from a single prototype wavelet called mother wavelet by dilations and shifting. The wavelet transform is computed separately for different segments of the time-domain signal at different frequencies.

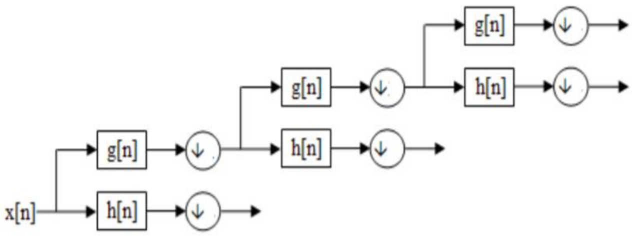

Figure 4: Discrete Wavelet Transform using Filter Bank

2. Why Discrete Wavelet Transform based compression?

Multiresolution analysis (MRA) is a characteristic feature of SB and it is used for better spectral representation of the signal. In MRA, the signal is decomposed for more than one DWT level known as multilevel DWT. It means the low-pass output of first DWT level is further decomposed in a similar manner in order to get the second level of DWT decomposition and the process is repeated for higher DWT levels. Few algorithms have been suggested for computation of multilevel DWT. One of the most important algorithm are pyramid algorithm (PA), this algorithm are proposed Mallet (1989a) for parallel computation of multilevel DWT. PA for 1-D DWT is given by

$$Y_l^j(n) = \sum_{i=0}^{k-1} h(i) Y_l^{j-1}(2n-i) \qquad (1)$$

$$Y_h^j(n) = \sum_{i=0}^{k-1} g(i) Y_h^{j-1}(2n-i) \qquad (2)$$

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International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 5, Issue 5, May 2017

Where $Y_l^j(n)$ is the n-th low-pass sub band component of the j-th DWT level and $Y_h^j(n)$ is the n-th high-pass sub band component of the j-th DWT level. Two-dimensional signal, such as images, are analyzed using the 2-D DWT. Currently 2-D DWT is applied in many image processing applications such as image compression and reconstruction [Lewis and Knowles (1992)], pattern recognition [Kronland *et al*. (1987)], biomedicine [Senhadji *et al*. (1994)] and computer graphics [Meyer (1993)]. The 2-D DWT is a mathematical technique that decomposes an input image in the multiresolution frequency space. The 2-D DWT decomposes an input image into four sub bands known as low-low (LL), low-high (LH), high-low (HL) and high-high (HH) sub band.

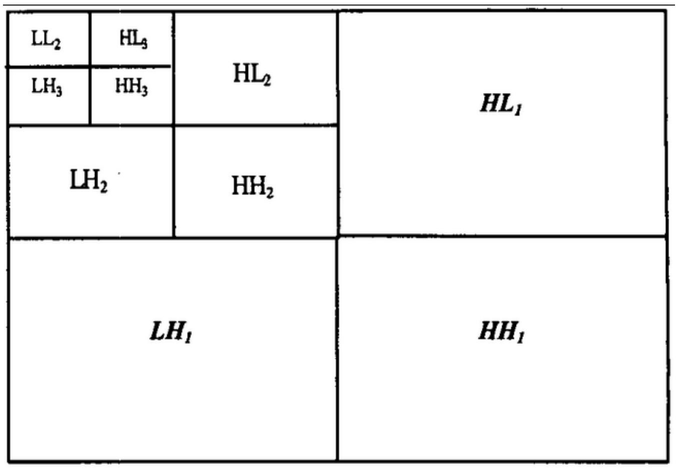

Figure 5: Three Level Diagram of 2-D Sub-band Wavelet Transform

3. Compression Steps:

- Digitize the source image into a signal s, which is a string of numbers.
- Decompose the signal into a sequence of wavelet coefficients w.
- Use threshold to modify the wavelet coefficients from w to w'. Use quantization to convert w' to a sequence q.
- Entropy encoding is applied to convert q into a sequence e.

Digitation:- The image is digitized first. The digitized image can be characterized by its intensity levels, or scales of gray which range from 0(black) to 255(white), and its resolution, or how many pixels per square inch [9].

Thresholding: **-** In certain signals, many of the wavelet coefficients are close or equal to zero. Through threshold these coefficients are modified so that the sequence of wavelet coefficients contains long strings of zeros. In hard threshold, a threshold is selected. Any wavelet whose absolute value falls below the tolerance is set to zero with the goal to introduce many zeros without losing a great amount of detail.

Quantization: **-** Quantization converts a sequence of floating numbers w' to a sequence of integers q. The simplest form is to round to the nearest integer. Another method is to multiply each number in w' by a constant k, and then round to the nearest integer. Quantization is called lossy because it introduces error into the process, since the conversion of w' to q is not one to one function [9]. Entropy encoding with this method, a integer sequence q is changed into a shorter sequence e, with the numbers in e being 8 bit integers The conversion is made by an entropy encoding table. Strings of zeros are coded by numbers 1 through 100,105 and 106, while the non-zero integers in q are coded by 101 through 104 and 107 through 254.

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Vol. 5, Issue 5, May 2017

Figure 6: Original image and compressed image for threshold value 1

Figure 7: Compressed image for threshold value 2 and threshold value 5

IV. CONCLUSION

In this research work, a hybrid scheme combining the DWT and the DCT algorithms has been presented. The algorithm was tested on the image. The result show consistent improved performance for the hybrid scheme compared to DCT.
DCT is used for transformation in JPEG standard. DCT performs efficiently at medium bit rates. Disadvantage with DCT is that only spatial correlation of the pixels inside the single 2-D block is considered and the correlation from the pixels of the neighboring blocks is neglected. Blocks cannot be de-correlated at their boundaries using DCT. DWT is used as basis for transformation in JPEG 2000 standard. 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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ISSN(Online): 2320-9801
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