COMPARATIVE PERFORMANCE ANALYSIS OF DISCRETE COSINE TRANSFORM AND WAVELET BASED IMAGE COMPRESSION

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I. ABSTRACT

Compression indicates the decreasing insize of image without decreasing the quality of the input image. The widely addressed researched area in the application of compression on images is Image compression. The importance of compression of image is to decrease the redundancy and irrelevancy in the image given as input, such that the image can be collected and can be transmitted substantially. There are several compression standards present in this compression of imagebut even there is a scope for high compression in quality of reconstructed image.The image compression contains two techniques depending on the compressed image, to be exactly same as the original such as lossy techniques and lossless techniques.The DCT(Discrete cosine transform) can be used by JPEG in the compression of images.Different aspects in image compression gives wavelet image compression introduction. Theresults thus obtained from the output proves the analysis of compression using DCT and DWTdepending on the PSNR, MSE values as well as the compression ratiowithout the image quality degradation.

Keywords: Image Compression, Discrete wavelet transform, Discretecosine transform

II. INTRODUCTION

Image compression determines the compressing of images without reducing its quality. Main advantage of this is to minimize the overabundance and diversion in the images, so that accurately they can be collected and transferred. There are two types in Image compression lossy and lossless.Lossless compression is more preferable than lossy compressionfor archival purposes as well as medical imaging, technical drawings, clip art, comics etc. In order to introduce compression artifacts especially when used at low bit rates, Lossy compression methods are used.These lossy techniquesare suitable for natural images such as photographs where loss of fidelity which is minimum is acceptedin bit rate in order to achieve the reduction substantially.

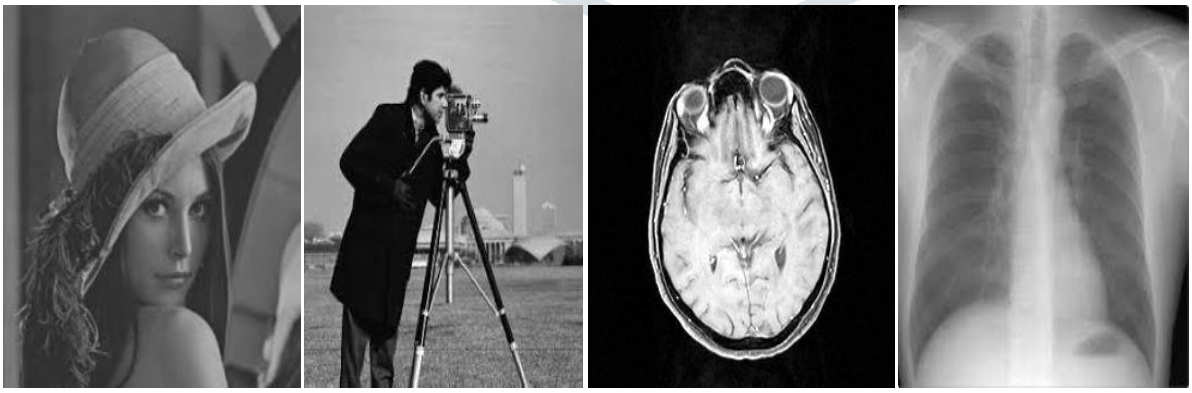
ISO (International Standards Organization) and IEC (International Electro-Technical Commission) are entrenched by the JPEG or 'Joint Photographic Experts Group'for compression of still images. At low bit-rates the performance of these codedecreasesbecause of the underlying block-based DCT scheme.The wavelet based transform has emerged recentlyin the field of image compression as a cutting edge technology. At higher compression ratios Wavelet-based coding provides considerable improvements in image quality . A variety of substantial and knowledgable wavelet-based schemes for image compression have been developed and implemented from the past few years

Using DCT the traditional techniques of image compressions to enhance have already been reported and plenty of literatures are also available on this. The different researchers are actively committed to developing the latest digital signal processing techniques for image compression. To achieve a reasonable ratio of compression as well as better quality of replication of image by including the PSNR and MSE values is the main objective.

III. LITERATURE SURVEY

The analysis of DCT and DWT was proposed by Prabhakar.Telagarapu et al. Extensive experimentation has been made to come to the conclusion. In considering of many input images, the value of MSE is low and PSNR value is highis observed in DWT than DCT based image compression. It is decided that overall performance of DWT is better when compared to DCT based on compression from the result obtained[1]. The paper on studying the performance analysis of Wavelet transform based image compression techniques is explained byRajesh K. Yadav et al. DWT is the compression technique in image compression. In this paper the image transformation using DWT techniques is described. The original image is taken and applied to DWT (haar) such that by applying different techniques the results are obtained and then the result is compared[2].

A paper on various image compression techniques was described byGaurav Vijayvargiya , Dr. Sanjay Silakari, Dr.Rajeev Pandey of UIT- RGPV Bhopal in which survey has been done and also Analysis of different types of existing method of image compression has performed. There are mainly two types of image compression techniques: Lossy and lossless compression techniques. It is found that lossless image compression techniques are most effectual over the lossy compression techniques after studying of other techniques in compression. Lossless has lesser compression ratio compared to that of lossy. [5].The peper on analysis of Image compression Algorithm using DCT and DWT Transforms byNavpreet Saroya et alin which proper method is selected ,such that better result for PSNR value have been obtained. In this paper comparative analysis based on MSE and PSNR for various Image compression techniques for different images is done. DWT gives better results without losing the quality of image. This disadvantage is overcome by DCTbecause of its less processing power, but gives less compression ratio.[Navpreet Saroya* , Prabhpreet Kaur,2014[8].



(a) **(b)** **(c)** **(d)**

Figure1: Sample input images (a) Lena image (b) Camera man image (c) MRI image (d) X-RAY image

IV. DISCRETE COSINE TRANSFORM

A signal from spatial domain into frequency domain is transformed by using DCT with cosine functions. An image with a sinusoidal fluctuating magnitudes as well as frequencies is represented by DCT.For a typical image most of the important information about an image is concentrated inDCT. These are normalized to a quantization table with different scales furnished by the JPEG standard of after the computation of DCT coefficients. The selection of Quantization table affects the entropy and compression ratio. The quality of reconstructed image with better mean square error and compression ratio is inversely related to the value of quantization. During Quantization, the less dominant frequencies are discarded, and the remaining frequencies are used in the image retrieval in the process of decomposition of lossy compression. After the quantization process, the arrangement of quantized coefficients is done in a zigzag manner by a lossy algorithm for further compression.

Theadvantages of DCT includes:

1. The DCT has the capability to pack more information in coefficients of small number.
2. It reduces the block aspect ratiothat inhibits the discovery of boundaries between sub-images.

The image with 8x8 pixel blocks is divided and for each of them 2D- DCT is applied.With coarse quantization high spatial frequency components are applied. Thus compressing the data losslessly and stored. High frequencies will become mostly zero when spatial frequencies are scanned in zigzag pattern. 2-D DCT is used in the DCT Coefficients computation of an image in which an image is represented as 2-dimensional matrix. The representation of 2-D DCT for an NXN input sequence is as follows:

$$D(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{n-1} \sum_{y=0}^{n-1} P(x,y) * \cos\frac{(2x+1)i\pi}{2N} \cos\frac{(2y+1)j\pi}{2N} \quad (1)$$

Where,P(x,y) is the input matrix image N*N,

(x,y) are the coordinate of matrix element and

(i, j) are the coordinate of coefficients,

$$C(u) = \begin{cases} \frac{1}{\sqrt{2}}, & if\ u = 0 \\ 1, & if\ u > 0 \end{cases} \quad (2)$$

The reconstructed image is computed by using the inverse DCT (IDCT) is,

$$P(x,y) = \frac{1}{\sqrt{2N}} \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} C(i)C(j)D(i,j) * \cos\frac{(2x+1)i\pi}{2N} \cos\frac{(2y+1)j\pi}{2N} \quad (3)$$

V. DISCRETE WAVELET TRANSFORM

Wavelets are useful for compressing of images without its quality degradation. These are used to process and improve the medical images wheredeteriorationof images is not tolerated. In order to remove noise from an image wavelets are used. The mathematical functions of DWT are used to transform representation of one function into another function representation. Wavelet transforms the analysis of multi resolution. The simultaneous representation of image on distinct resolution levels determines Multi resolution. It represents an image as the sum of wavelet functions, with various location and scales. The wavelet uses the “mother wavelets”in 2D analysis but an extra step is needed at each stageof its decomposition.

VI. RESULTS AND DISCUSSION

Here, DCT and DWT in compression techniques are analysed for following image quality parameters and compression ratios.

A. COMPRESSION RATIO (CR)

Compression ratio is the ratio of number of bits required to represent original input image to the number of bits required to show the compressed image. Lossy compression techniques have greater compression ratio than lossless compression techniques. It is represented as:

$$\text{CR} = \frac{Discardeddata}{Originaldata} \qquad (4)$$

B. MEAN SQUARE ERROR (MSE)

Mean square error is a criterion for an estimator that minimizes the sum of errors due tobias and variance. The average of the square of the difference between the desired response and the actual system output is as follows:

$$\frac{1}{MN}\sum_{y=1}^{M}\sum_{x=0}^{N}[I(x,y) - I'(x,y)]^2 \qquad (5)$$

Where;

I(x,y) represents the original input image

I'(x,y) is the approximated version of image and

M,N are with the M-dimensions of the N-images.

C. PEAK SIGNAL-TO-NOISE RATIO (PSNR)

It is defined as the ratio between the power of a signal with maximum possibilityto the power of noise signal. The PSNR is usually used to measure of reconstruction quality in compression of images. It is represented as:

$$PSNR = 20 * log10\frac{255}{\sqrt{MSE}} \qquad (6)$$

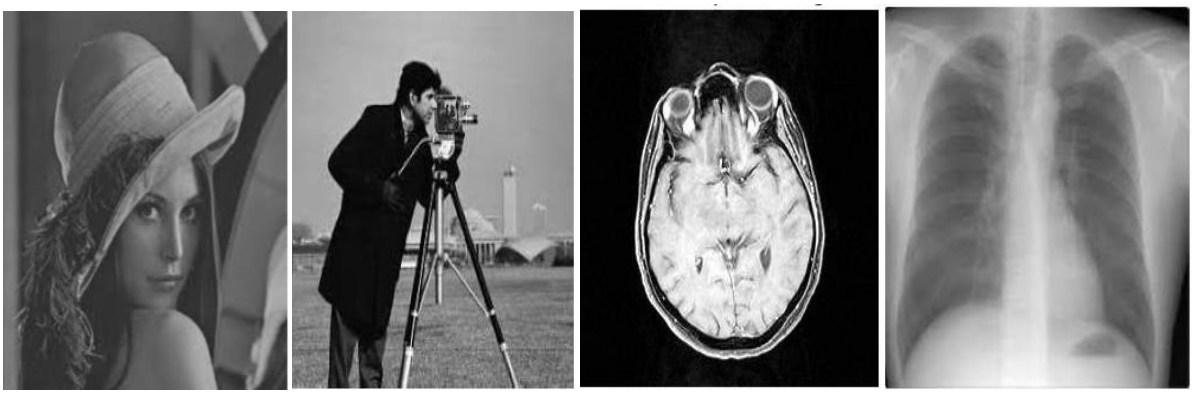


Figure 2: Compression of lena, camera man, MRI, X-RAY images using DCT and DWT (DWT images (1st row), DCT images(2nd row).

Table 1: Comparative analysis of DCT and DWT

Images to be compressed	Size of the image		PSNR Values		MSE values		Compression ratios	
	Original image	Compressed image	DCT	DWT	DCT	DWT	DCT	DWT
Lena image	22.2 KB	19KB	35.266	40.162	19.338	6.2168	1.91%	1.91%
Camera man image	10.4 KB	8.9 KB	35.259	40.0305	19.370	6.4569	7.24%	7.24%
MRI image	10.6 KB	9.3 KB	35.788	38.524	17.150	9.1335	9.56%	9.56%
X-RAY image	6.7 KB	5.3 KB	36.860	41.63	13.398	4.4660	1.04%	1.04%

VII. CONCLUSION

In this paper, Comparative analysis of DCT and DWTfor image compression have studied. By considering the images such as Lena image, Camera man image, MRI image, X-RAY image as input images, and from this the value of MSE is observed as moderateand PSNR value is excessive in DWT based image compression compared to that of DCT based compression. From the results obtained, the overall performance of DWT is better compared to DCT is observed based on their compression rates. In discrete cosine transform,correlation across the block boundaries willnot eliminated because of the blocking of images. This results in observable and troublesome in “blocking artifacts” particularly at low bit rates. To represent the point singularities, Wavelets are the best and line singularities cannot be represented. Thus, from the results obtained conclude that DWT provides good PSNR compared to that of DWT.

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