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Comparision of Dct and Dwt of Image Compression Techniques

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Abstract**—** Multimedia data requires considerable storage capacity and transmission bandwidth. The data are in the form of graphics, audio, video and image. These types of data have to be compressed during the transmission process. Large amount of data cannot be stored if there is low storage capacity. Compression is minimizing the size in bytes of a graphics file without degrading the quality of image to an unacceptable level. In this paper we are comparing DCT and DWT on the basis of performance parameters Peak signal to noise ratio, Bit error rate, Compression ratio, Mean square error and Time of the compressed images of DCT and DWT.

Keywords-Discrete cosine transform, Discrete wavelet transform, Image compression.

I. INTRODUCTION

Image compression is very important for efficient transmission and storage of images. Demand of communication of multimedia data through telecommunication network and data accessing through internet is explosively growing. Image compression is minimizing the size in bytes of a graphics file without degrading the quality of image to an unacceptable level. Large amount of data can't be stored if there is low storage capacity present. A gray scale image that is 256 x 256 pixels have 65, 536 elements to store and a typical 640 x 480 color image have nearly a million. Downloading of these files from internet can be very time consuming task. The compression offers a means to reduce the cost of storage and increase the speed of transmission. There are two types of image compression is present. These are lossy and lossless [1]. In lossless compression technique the reconstructed image after compression is identical to original image. These images are also called noise less, since they do not add noise to signal image. This is also known as entropy coding. Loss less compression technique is used only for a few applications with stringent requirement such as medical imaging. **:** Lossy compression technique is widely used because the quality of reconstructed images is adequate for most applications. In this technique the decompressed image is not identical to original image but reasonably closed to it. In general, lossy techniques provide for greater compression ratios than lossless techniques that are lossless compression gives good quality of compressed images but yields only less compression whereas the lossy compression techniques lead to loss of data with higher compression ratio [2].

II. IMAGE COMPRESSION

Image compression means minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk more memory space. However, in this modern internet age, the demand for data transmission and the data storage are increasing. The main objective of image compression is to find an image representation in which pixels are less correlated [3]. The two fundamental principles used in image compression are redundancy and irrelevancy. Compression is achieved by removal of one or more of the three basic data redundancies:

- Coding redundancy
- Interpixel redundancy
- Psychovisual redundancy

2.1Coding redundancy: Coding redundancy is present when less than optimal code words are used. A code is a system of symbols used to represent a body of information or set of events. Each piece of information or events is assigned a sequence of code symbols, called a code word. The number of symbols in each code word is its length.

2.2 Interpixel redundancy: Interpixel redundancy results from correlation between pixels of an image. Because the value of any given pixel can be reasonable predicted from the value of its neighbors, the information carried by individual pixels is relatively small.

2.3 Psychovisual redundancy: Psychovisual redundancy is due to data that is ignored by human visual system. To reduce psycho visual redundancy we use quantizer. Since the elimination of psycho visually redundant data results in a loss of quantitative information. [4]

The compression technique reduces the size of data, which in turn requires less bandwidth and less transmission time and related cost .There are algorithms developed for the data compression such as Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) etc.

III. DISCRETE COSINE TRANSFORM(DCT)

The Discrete Cosine Transform (DCT) algorithm is well known and commonly used for image compression. DCT converts the pixels in an image, into sets of spatial frequencies. It has been chosen because it is the best approximation of the Karhunen_loeve transform that provides the best compression ratio [5]. The DCT work by separating images into the parts of different frequencies. During a step called Quantization, where parts of compression actually occur, the less important frequencies are discarded, hence the use of the lossy. Then the most important frequencies that remain are used retrieve the image in decomposition process. As a result, reconstructed image is distorted. Compared to other input dependent transforms, DCT has many advantages [6]:

(1) It has been implemented in single integrated circuit.
(2) It has the ability to pack most information in fewest coefficients.
(3) It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible.

There are mainly two types of DCT: one dimensional (1-D) DCT and two dimensional (2-D) DCT. Since an image is represented as a two dimensional matrix, for this 2-D DCT is considered [7].

The forward 2D_DCT transformation is given by the following equation:

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

Where, u, v=0, 1, 2, 3… N-1

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

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

Where

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

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

In the DCT compression algorithm

- The input image is divided into 8-by-8 or 16-by-16 blocks
- The two-dimensional DCT is computed for each block.
- The DCT coefficients are then quantized, coded, and transmitted.
- The receiver (or file reader) decodes the quantized DCT coefficients, computes the inverse two-dimensional DCT (IDCT) of each block.
- Puts the blocks back together into a single image.

3.1 DCT Results

Fig.1. Original image

Fig.2. Compressed image by DCT

IV. DISCRETE COSINE TRANSFORM (DWT)

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 [8]. Wavelets are functions which allow data analysis of signals or images, according to scales or resolutions. The DWT represents an image as a sum of wavelet functions, known as *wavelets*, with different location and scale. It represents the data into a set of high pass (detail) and low pass (approximate) coefficients. The input data is passed through set of low pass and high pass filters. The output of high pass and low pass filters are down sampled by 2.The output from low pass filter is an approximate coefficient and the output from the high pass filter is a detail coefficient [9]. This procedure is one dimensional (1-D) DWT.but in this research work we are using two dimensional (2-D) DWT. In case of in two directions, both rows and columns. The outputs are then down sampled by 2 in each direction as in case of 1-D DWT [8]. Output is obtained in set of four coefficients LL, HL, LH 2-D DWT, the input data is passed through set of both low pass and high pass filter and HH. The first alphabet represents the transform in row where as the second alphabet represents transform in column. The alphabet L means low pass signal and H means high pass signal. LH signal is a low pass signal in row and a high pass in column. Hence, LH signal contain horizontal elements. Similarly, HL and HH contains vertical and diagonal elements, respectively [10].

In this research work each block of the image is then passed through the two filters: high pass filter and low pass filter. The first level decomposition is performed to decompose the input data into an approximation and the detail coefficients. After obtaining the transformed matrix, the detail and approximate coefficients are separated as LL, HL, LH, and HH coefficients. All the coefficients are discarded, except the LL coefficients. The LL coefficients are further transformed into the second level [11].The process continues for one more level. We are taking four levels of decomposition. The coefficients are then divided by a constant scaling factor (SF) to achieve the desired compression ratio. Finally, for data reconstruction, the data is rescaled and padded with zeros, and passed through the wavelet filter [12].

The Forward DWT Eq.:-

$W\varphi(J_O, K) = \frac{1}{\sqrt{M}} \sum_n f(n) \varphi j_{o,k}(n)$

$W_\Psi(j, k) = \frac{1}{\sqrt{M}} \sum_n f(n) \Psi_{J,K}(n) \quad \text{for } j \geq j_0$

The complementary inverse DWT eq. is:-

$F(n) = \frac{1}{\sqrt{M}} \Sigma\, W\varphi(J_O, K)\, \varphi j_{o,k}(n) + \frac{1}{\sqrt{M}} \Sigma\, \Sigma\, W_\Psi(j, k)\, \Psi_{J,K}(n)$

4.1 DWT Results

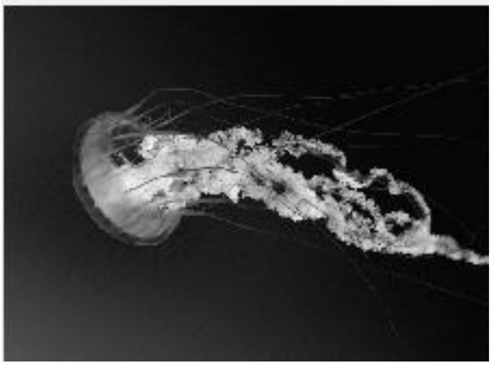

Fig.3. Original image

Fig.4. Compressed image of DWT

IV. EXPERIMENTAL RESULTS

We are comparing the images which are compressed by applying DCT and DWT using MATLAB.Figure5 and Figure7 shows peak signal to noise ratio graph of DCT and DWT, Figure6 and figure8 shows bit error rate graph of DCT and DWT, TABLE 1 shows peak signal to noise ratio, bit error rate, compression ratio, Mean square error and time of the compressed images of DCT and DWT.

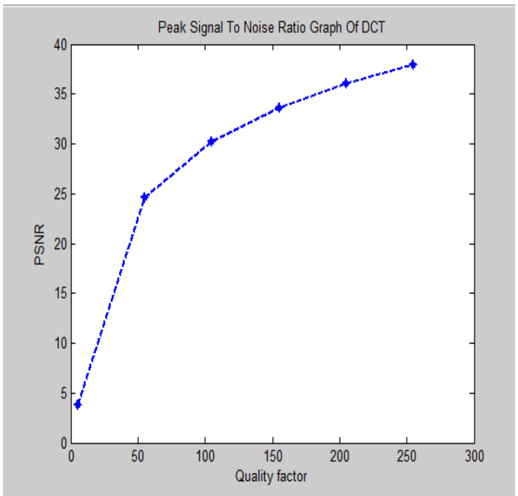

Fig.5. PSNR graph of DCT

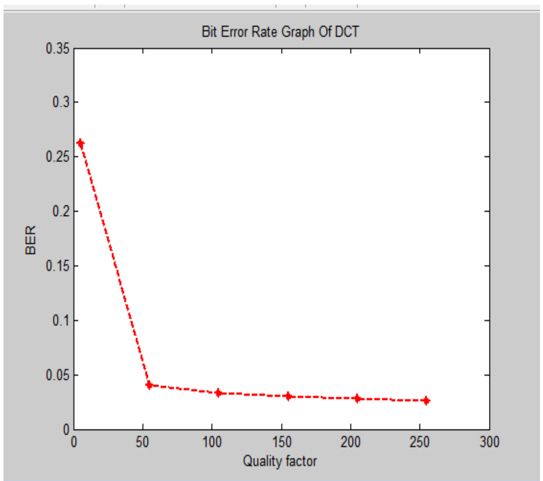

Fig.6. BER graph of DCT

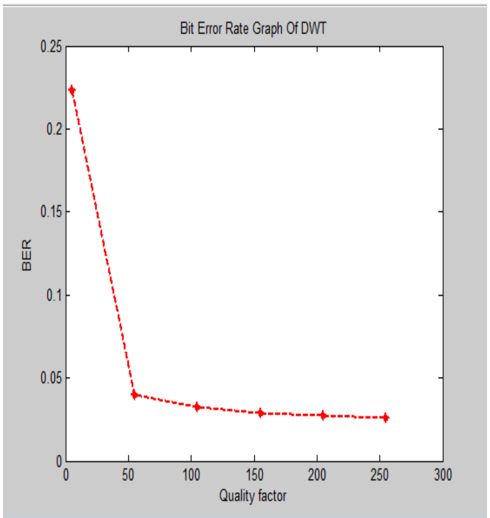

Fig.7. PSNR graph of DWT

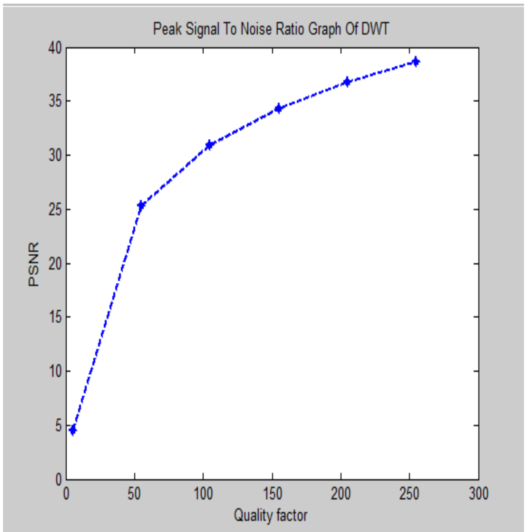

Fig.8. BER graph of DWT

Table 1

	DCT	DWT
Compression ratio	20.1763	20.3955
PSNR	0.0263	38.6309
MSE	10.3820	8.9123
BER	37.9680	0.0259
TIME	7.4121	3.5139

VI. CONCLUSION

In this paper, we are comparing the results of different transform coding techniques i.e. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) we see that DWT provides higher compression ratios & avoids blocking artifacts. Allows good localization both in spatial & frequency domain. Transformation of the whole image introduces inherent scaling. Better identification of which data is relevant to human perception higher compression ratio and we also see that DCT takes more time than DWT.

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