An Approach for Color Image Compression of JPEG and PNG Images using DCT And DWT

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***Abstract*—Now a days image compression has become is an indispensible part of digitized image storage and transmission. Compression of an image is necessary before storing and transmitting it due to its limitation of storage and bandwidth capacity. Wavelet transform decomposes complexion of images into its elementary forms. In this paper, a comparative study has been carried out on image compression using DCT (Discrete Cosine Transform) and DWT (Discrete Wavelet Transform). A comparison is outlined to emphasize the results of this compression system between DCT and DWT using JPEG (Joint Photographic Experts Group) and PNG (Portable Network Graphics) color images. We have done conversion of color images into gray scale and also compression of gray scale image is shown after conversion using DWT method. DWT algorithm performs much better than DCT algorithms in terms of Compression, Mean Square Error (MSE) and Peak Signal to Noise Ratio (PNSR).**

Keywords:- DCT; DWT ; PSNR; MSE; Wavelet Transform; Image Compression; Huffman Coding; JPEG;PNG; Compression ratio.

I. INTRODUCTION

An image can be defined as a matrix of pixel or intensity values. Image compression is used to reduce the redundancy and randomness present in the image because to increase the storing capacity and efficiency level of the images. Therefore it is essential to compress the images by storing only the required information needed to reconstruct the image. To compress any image, redundancy must be removed. Sometimes images having large areas of same color will have large redundancies and similarly images that have frequent and large changes in color will be less redundant and harder to compress[1-3].

The main objective of this paper is to reduce irrelevance and redundancy of the JPEG and PNG image data in order to be able to store or transmit data in an efficient form using DCT and DWT. We have tried to study the different image compression algorithm and evaluate their performance on different image formats and also developed a system for image compression using Discrete Wavelet Transform and compare the results with the existing techniques or systems. Image compression can be done in two ways:

- Lossy Compression
- Lossless Compression

If any pixel value is changed from a digital image and then energy will be lost and this technique is called 'lossy' compression. The amount of information retained by an image after compression and decompression is known as 'lossless' compression [7].

In this research paper, a modified and efficient image compression scheme is proposed based on DWT and which results a good compression ratio without degrading the quality of the image. The proposed algorithm has been analyzed and compared with some other existing methods. Several quality measurement techniques like PSNR and MSE have been considered to determine the image compression with respect to the reference image. For that purpose some traditional images are taken and have done experiment on it [1-3].

This paper structure contains the following sections: section 2 describes the previous work done by different authors, section 3 describes the basic principles of image compression techniques, section 4 illustrates the fundamentals of wavelet transform, section 5 presents the proposed method using DWT, section 6 demonstrates the experimental results and discussions and finally section 7 winds up the paper.

II. RELATED WORKS

Image compression has many practical applications because of huge data storage, transmission and retrieval for medical imaging, documents and videoconferencing. Chowdhury and Khatun [1] described the performance of the image compression algorithm and provide sufficient high compression ratios compared to other techniques. Sukanya and Preethi [2] have described about compression methods such as JPEG 2000, EZW, SPHIT (Set Partition in Hierarchical Trees) and HS-SPHIT

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(Highly Scalable-SPHIT) on the basis of hierarchical time, error comparison, MSE, PSNR and compression ratio. Qureshi [8] in his Computational Project 'Image Compression using Wavelet Transform' explained how wavelets can be used in image compression. Anandanarayan and Srivastava [9] proposed a technique for image compression where Huffman coding is used to compress an image then chooses edge detection to identify and locating sharp discontinuities in image. Averbuch et al. [3] have tested several compression techniques and 512X512 images are trained together and common table codes were created to achieve a compression ratio 60-65 and a PSNR of 30-33 and compression ratio 35-36 and a PSNR of 35-37.Talukdar and Harada [4] in their paper described the 2D Discrete Wavelet Transform (DWT) and the detail matrices from the information matrix of the image have been estimated. Wavelet Transform is used in the reconstructed image and amalgamated by the estimated detail matrices and information matrix. The compression quality of the images has been calculated using Compression Ratio (CR), Peak Signal to Noise Ratio (PSNR), Mean Opinion Score (MOS), and Picture Quality Scale (PQS).

III. Image Compression Techniques

The basic encoding method for transform based compression works as follows:

1) *Image transform:* Divide the source image into blocks and apply the transformations to the blocks.

2) *Parameter quantization:* The data generated by the transformation are quantized to reduce the amount of information. This step represents the information within the new domain by reducing the amount of data. Quantization is in most cases not a reversible operation because of its lossy property.

3) *Encoding:* Encode the results of the quantization. This last step can be error free by using Run Length encoding or Huffman coding. It can also be lossy if it optimizes the representation of the information to further reduce the bit rate.

Transform based compression is one of the most useful applications. Combined with other compression techniques, this technique allows the efficient transmission, storage, and display of images that otherwise would be impractical [4].

4) *DCT-Based Transform Coding*

The DCT was first applied to image compression in the work by Ahmed et al [5]. It is a popular transform used by the JPEG image compression standard for lossy compression of images. Since it is used so frequently, DCT is often referred to in the literature as JPEG-DCT, DCT used in JPEG. JPEG-DCT is a transform coding method comprising four steps. The source image is first partitioned into sub-blocks of size 8x8 pixels in dimension. Then each block is transformed from spatial domain to frequency domain using a 2-D DCT basis function. The resulting frequency coefficients are quantized and finally output to a lossless entropy coder. DCT is an efficient image compression method since it can decorrelate pixels in the image and compact most image energy to a few transformed coefficients. JPEG and PNG may be replaced by wavelet-based image compression algorithms, which have better compression performance [5].

IV. The Wavelet Transform

A wavelet is a mathematical function used to divide a given function or continuous-time signal into different wave signals. It can assign a frequency range for each wave signals. All wave signals that match its scale can be analyzed with a resolution. It is the delegation of a function by wavelets.

$$\psi_{a,b}(t) = \frac{1}{\sqrt{|a|}}\psi\left(\frac{t-b}{a}\right),\ a, b \in R, a \neq 0,$$

Where ψ is a function called wavelet, a, is another function which measure the degree of compression or scale, and b, is a translation function which measures the time location of the wavelet.

A. *Quantization:* Quantization is the process where actual reduction of image is done. It is a lossy compression technique which basically used in DCT data quantization and DWT data quantization for JPEG and PNG images.

B. *Entropy Encoding:* Entropy encoding is a lossless data compression method. Two commonly used entropy encoding techniques are Huffman coding and Arithmetic coding.

C. *Discrete Wavelet Transform (DWT)**:*** Suppose a function f(x) is a continuous function and expanded in a sequence of numbers, then the resulting coefficients are called the Discrete Wavelet Transform (DWT) of f(x) [2].

The discrete wavelet transform in two dimensions of functions f(x,y) of size M×N is

$$W_{\varphi}(j_0, m, n) = \frac{1}{\sqrt{MN}} \sum_{X=0}^{M-1} \sum_{Y=0}^{N-1} f(x, y)\varphi_{j0,m,n}(x, y)$$

Here, f(x), $\varphi_{j_0,k}(x)$,and $\psi_{j,k}(x)$ are functions of the discrete variable x=0,1,2……M-1 [6].

The DWT can be decomposed into three level of decomposition. For example, decomposition level 1, decomposition level 2 and decomposition level 3. The Fig. 1 shows each level of decomposition.

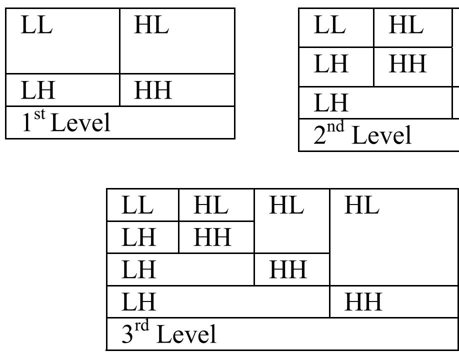


Figure 1. Wavelet Decomposition

V. Proposed Compression Method using DWT

This portion describes the compression method based on DWT. The basic method of the wavelet transform is selecting a color input image of any format from the computer and to find out the size of the image, compressed size of the image, percentage of compression using DCT and percentage of compression using DWT and then convert the compressed image into gray scale and finally find the compression ratio of gray scale image and also find out the PSNR and MSE of the image using DWT and IDWT of three level of decomposition. The method is given below:

Read an input image of any format from the user. We are using 2D wavelet decomposition with respect to a haar or doubencies wavelet computes the approximation coefficients matrix and detail coefficient matrixes horizontal, vertical & diagonal respectively which is obtained by wavelet decomposition of the input matrix. Again using 2D wavelet decomposition with respect to a haar or doubencies wavelet computes the approximation and detail coefficients which are obtained by wavelet decomposition of the approximation coefficient matrix. This is considered as level 2.

Again if we apply the haar wavelet transform from approximation coefficient matrix which is considered as approximation coefficient 1 for level 3. Again we will take inverse transform for level 1, level 2 & level 3 that is, image input and approximation coefficients respectively for each level of decomposition. We can reconstruct the images for level 1, level 2 & level 3. After this whole process it will display the results of reconstruction 1, reconstruction 2 and reconstruction 3 that is, level 1, 2 and 3 with respect to the original image.

The Fig. 2 shows the basic compression method of our work.

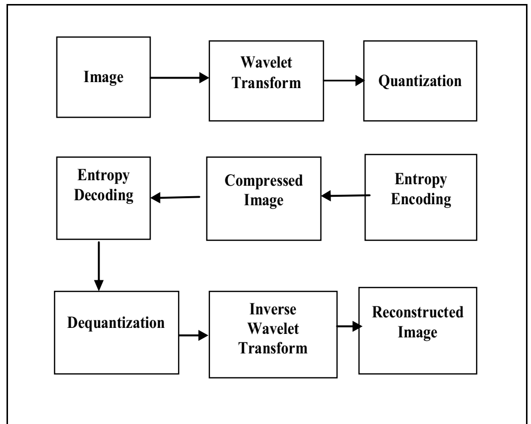


Figure 2. The structure of image compression using wavelet transforms

The compression ratio (CR) of an image can be calculated using the following formula:

Compression Ratio (%) =

Original image size - compressed image size/original image*100.

VI. Results and Discussions

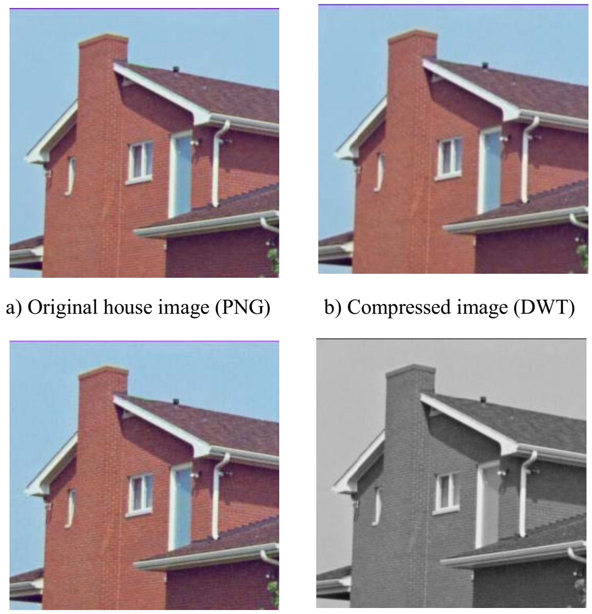
In this research, an efficient compression method based on DWT is proposed. The algorithm has been implemented in MATLAB 7.12.0. A pair of test images like JPEG and PNG is taken to justify the efficiency of the algorithm. Figure 3 and 4 shows the test images and their corresponding resulting compressed images using JPEG, PNG and the proposed compression methods.

The experimental results with the proposed compression method have been arranged in the Table 1 and Table 2 for the different traditional image processing images. It also shows the comparison between DCT and the proposed compression method. From these tables, we find out the compression ratio of different JPEG and PNG color and gray scale images with different resolutions and then finally to find the PSNR and MSE value of images using DWT. So, the proposed compression technique gives the better results compared to other compression methods.

a) Original lenna image (JPEG) b) Compressed image(DWT)

c) Compressed image (DCT) d) Compressed gray scale image

(Resolution: 128 X 128)
Figure 3: A Lenna image and corresponding compressed images in JPEG format using DCT and DWT



a) Original house image (PNG) b) Compressed image (DWT)

c) Compressed image (DCT) d) Compressed gray scale image

(Resolution: 256 X 256)
Figure 4: A House image and corresponding compressed images in PNG format using DCT and DWT

TABLE II: EXPERIMENTAL RESULTS OF PNG IMAGES AT DECOMPOSITION LEVEL 1

Original Image	Image Resolution	Decomposition Level	Original Image Size (bytes)	Compressed Color Image size		Compression Ratio of Color image (%)	Compressed Grayscale image Size	Compression Ratio of Grayscale image(%)	MSE (%)	PSNR (dB)
				DCT	Proposed Method (DWT)					
Zelda256.jpg	256X256	1	24522	26941	10136	58.67	8637	64.79	20.05	35.11
Zebra256.jpg	256X256	1	79582	35594	15950	79.96	14344	81.98	26.99	33.88
House.jpg	256X256	1	23763	26070	10354	56.433	8736	63.24	20.97	34.91
Baboon256.jpg	256X256	1	16671	21966	1788	89.28	1280	92.32	4.93	26.52
Barbara.jpg	512X512	1	111257	45206	36983	68.37	40485	74.71	16.29	36.01
tulips.jpg	1024X768	1	620888	216976	85968	86.15	65619	89.43	20.88	34.93
flower1.jpg	256X256	1	83462	11215	14057	83.14	11095	86.71	5.81	28.32
sunflower.jpg	512X512	1	68485	42491	20142	64.88	15991	71.56	9.64	28.15
lenna.jpg	128X128	1	41122	25111	4480	90.11	3493	92.12	6.25	29.92
rose1.jpg	1024X768	1	278934	343776	121311	66.50	79319	74.39	7.37	39.46

TABLE II: EXPERIMENTAL RESULTS OF PNG IMAGES AT DECOMPOSITION LEVEL 1										
Original Image	**Image Resolution**	**Decomposition Level**	**Original Image Size (in bytes)**	**Compressed Color Image size (bytes)**		**Compression Ratio of Color image (%)**	**Compressed Grayscale image Size(bytes)**	**Compression Ratio of Grayscale image (%)**	**MSE (%)**	**PSNR (dB)**
				DCT	**Proposed Method (DWT)**					
Zelda256.png	256X256	1	161753	26937	10134	93.73	8633	94.66	20.07	35.11
Zebra256.png	256X256	1	177792	35608	15928	91.04	14342	91.93	27.02	33.81
House.png	256X256	1	171133	26006	10198	94.05	8464	95.09	20.14	36.91
Baboon256.png	256X256	1	209905	46812	19208	90.86	16809	91.99	19.56	31.97
Barbara512.png	512X512	1	667546	46967	45194	93.23	40494	93.93	16.31	36.01
Peppers.png	512X512	1	651027	41037	33529	94.85	27105	95.84	2.22	44.67
Lenna128.png	128X128	1	48023	25132	4488	90.65	3491	92.73	29.93	66.06
airplane.png	512X512	1	639736	43702	38679	93.95	33793	94.72	22.61	35.67
Boat.png	512X512	1	620616	45486	42106	93.22	37212	94.04	16.41	35.98
sailboat.png	512X512	1	787545	53739	52482	93.34	44936	94.29	7.47	31.37

VII. CONCLUSION

In this research plan, an attempt has been made to study and compare the image compression techniques using DCT and DWT. From the above experimental analysis, it is seen that in comparison to the other experiments our experiment shows better performance with respect of compression size and percentage of image compression. A new algorithm has been proposed on Image Compression using DWT and Inverse DWT. An experimental result has been shown after compressing any color image of different image formats and finally conversion of color image into gray scale is shown. The most distinguishing feature of using DWT and Inverse DWT is that it will not only enable to compress an image but also will help to maintain the quality of the image as it was in its original form, which was hardly possible earlier in other image compression techniques. The future direction of this research is to develop such an algorithm where any random image of any resolution or size could be compressed at a uniform rate without degrading the quality of image.

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