# Color Image Compression Using DCT & DWT

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***Abstract*—This paper aims to study image compression, Both methods use cosine transform and wavelet transform to deduct a portion of the information in the image that can endure losing it without a significant disturbance in the image itself, as we know digital cameras and other cameras are now a day's being provided with more and more megapixels to improve the quality of captured images. With improvement in image quality, size of the image file also increases. Due to speed limitation of the Internet, it takes more time to upload good-quality images that are of bigger sizes. A user needs to compress the image without degrading its quality. Mobile manufacturers need algorithms in their cameras that enable storing the images in reduced sizes without degrading their quality. In proposed system, 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. DWT algorithm and DCT algorithm are much better algorithms in terms of compression, A user needs to compress the image without degrading its quality.**

***Index Terms*— Discrete cosine transform, Discrete wavelet transform, image compression.**

## I. INTRODUCTION

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.


**Fig 1**.Original image

The main objective of this system 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.

Lossless compression is a class of data compression algorithms that allows the original data to be perfectly reconstructed from the compressed data. By contrast, lossy compression permits reconstruction only of an approximation of the original data, though this usually improves compression rates (and therefore reduces file sizes). Lossless data compression is used in many applications. For example, it is used in the ZIP file format and in the GNU tool gzip. It is also often used as a component within lossy data compression technologies.

Lossless compression is used in cases where it is important that the original and the decompressed data be identical, or where deviations from the original data could be deleterious. Typical examples are executable programs, text documents, and source code. Some image file formats, like PNG or GIF, use only lossless compression, while others like TIFF and MNG may use either lossless or lossy methods. Lossless audio formats are most often used for archiving or production purposes, while smaller lossy audio files are typically used on portable players and in other cases where storage space is limited or exact replication of the audio is unnecessary. Most lossless compression programs do two things in sequence: the first step generates a statistical model for the input data, and the second step uses this model to map input data to bit sequences in such a way that "probable" (e.g. frequently encountered) data will produce shorter output than "improbable" data. There are two primary ways of constructing statistical models: in a static model, the data is analyzed and a model is constructed, then this model is stored with the compressed data. This approach is simple and modular, but has the disadvantage that the model itself can be expensive to store, and also that it forces using a single model for all data being compressed, and so performs poorly on files that contain heterogeneous data. Adaptive models dynamically update the model as the data is compressed. Both the encoder and decoder begin with a trivial model, yielding poor compression of initial data, but as they learn more about the data, performance improves. Most popular types of compression used in practice now use adaptive coders.

Lossless compression methods may be categorized according to the type of data they are designed to compress. While, in principle, any general-purpose lossless compression algorithm (general-purpose meaning that they can accept any bit string) can be used on any type of data, many are unable to achieve significant compression on data that are not of the form for which they were designed to compress.

## II. LITERATURE REVIEW AND RELATED WORK

Image compression has many practical applications because of huge data storage,transmission and retrieval for medical imaging , documents and video conferencing. Chowdhury and Khatun [1] in his Computational Project 'Image Compression using Wavelet Transform' explained how wavelets can be used in image compression. Anandanarayan and Srivastava 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. In Study of JPEG Image Compression Technique Using Discrete Cosine Transformation by Priyanka dixit, Mayanka dixit - This paper covers the analysis process of JPEG (joint picture expert group) standard which is based on the technique called discrete cosine transform (DCT).In this process, DCT, is used for the separating information by different frequencies. Using the processes quantization and encoding the Compression is achieved. There were various algorithms of fast DCT was analyzed. These could be finding efficient for JPEG encoding process. Therefore, it is very hard or difficult to develop algorithm of quantization and coding for enhancing the efficiency of JPEG encoding process.

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.

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 theb literature as JPEG-DCT, DCT used in JPEG.

## III. CONCEPT OF 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 . 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:-

1)Coding redundancy

2)Interpixel redundancy

3)Psychovisual redundancy

1) Coding 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) 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.

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.

## IV. ANALYSIS OF PROBLEM

We can analyze proposed system by two method, Wavelet Transform & Cosine transform which are used in the reconstructed image and associate by the estimated detail matrices and information matrix. The compression quality of the images has been calculated using Compression Ratio (CR), PeakSignal to Noise Ratio (PSNR), Mean Opinion Score(MOS), and Picture Quality Scale (PQS).

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

The basic encoding method for transform based compression works are Image transform, Parameter quantization, Encoding. And two important transformations are.

***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. 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 frequency es 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:-

(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.


**Fig 2**.DCT Compression

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.

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

C(u,v)=D(u)D(v)∑$N-1,x=0$∑$N-1,y=0$ f(x,y)cos[(2x+1)uπ/2N]cos[(2y+1)vπ/2N]

Where, u, v=0, 1, 2, 3… N-1

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

f(x,y)=∑ $N-1,u=0$ ∑$N-1$, $v=0$

D(u)D(v)D(u,v)cos[(2x+1)uπ/2N]xcos(2y+1)vπ/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

1) The input image is divided into 8-by-8 or 16-by-16 blocks

2)The two-dimensional DCT is computed for each block.

3) The DCT coefficients are then quantized, coded, and transmitted.

4) The receiver (or file reader) decodes the quantized DCT coefficients, computes the inverse two-dimensional DCT (IDCT) of each block.

5) Puts the blocks back together into a single image.

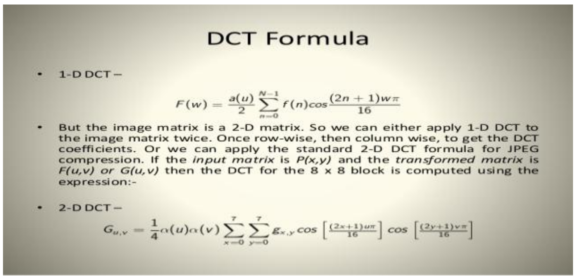


**Fig 3**.1D & 2D-DCT transformation equation:

***Discrete Wavelet 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.

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.

The Forward DWT Eq.:-

$W(J\text{O},K) = 1/\sqrt{M}\sum f(n)\varphi jn$ o, k (n)

$W\Psi$ (j, k) = $1/\sqrt{M}\sum f\ n\ n\Psi$ j, k (n) for $j \geq j0$

The complementary inverse DWT eq. is:-

F (n) = $1/\sqrt{M}\ \Sigma\ W(J\text{O},K)\ \varphi j$ o, k (n) + $1/\ M\ \Sigma\ \Sigma$ $W\Psi$ (j, k) $\Psi$ j, k (n)

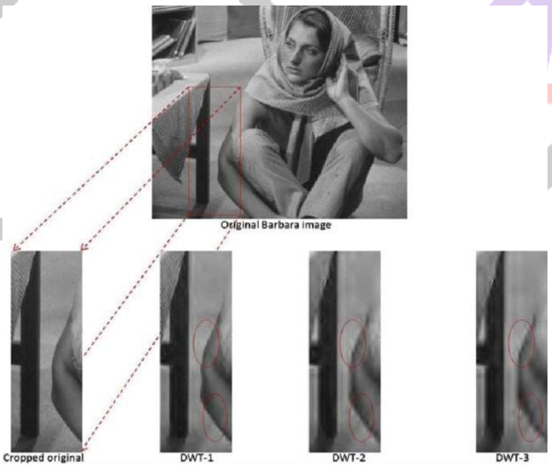


**Fig 4**.DWT Compression

## V. PROPOSED WORK

In this work system it describes the compression method based on DWT & DCT. The basic method of the wavelet transform and cosine 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.

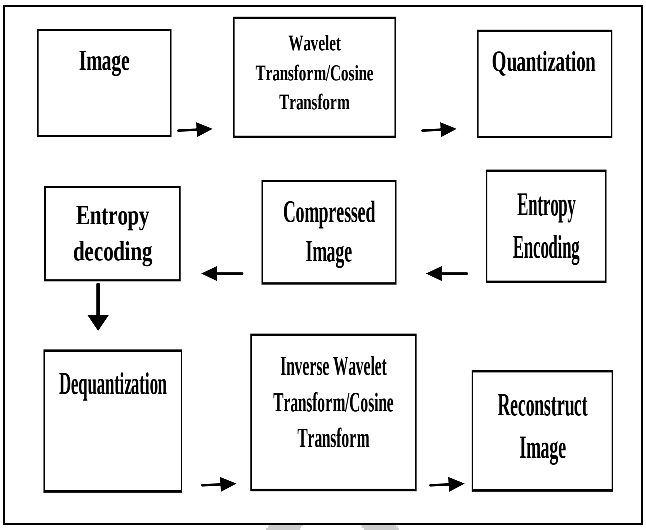


**Figure 6.**The Structure of image compression using DCT & DWT

This section presents jpeg compression steps

− An RGB to YCbCr color space conversion ( color specification )

− Original image is divided into blocks of 8 x 8.

− The pixel values within each block range from [-128 to 127] but pixel values of a black and white image range from [0-255] so, each block is shifted from[0-255] to
[-128 to 127].

− The DCT works from left to right, top to bottom thereby it is applied to each block.

− Each block is compressed through quantization.

− Quantized matrix is entropy encoded.

− Compressed image is reconstructed through reverse process. This process uses the inverse Discrete Cosine Transform (IDCT).

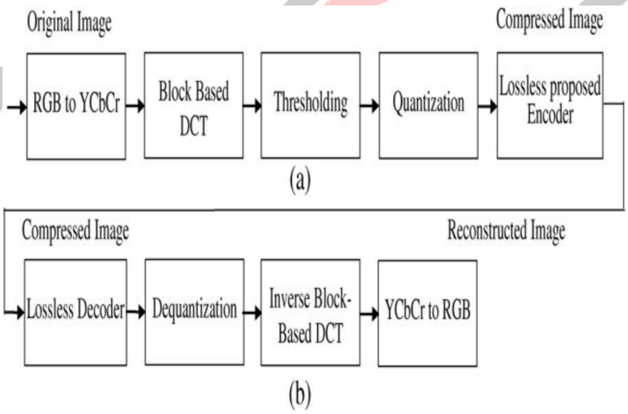


**Figure 5.**Compression algorithm scheme: (a) compression step and (b) decompression step

## VI. OBJECTIVES

The various compression techniques are used today to compress multimedia data for storage and transmission some of them are efficient techniques that proved to be the better one in terms of performance. JPEG compression algorithm which is the lossy compression technique uses the Discrete Cosine Transform (DCT). Many multimedia data are usually
transmitted in the efficient compressed form, for example, JPEG conventionally; manipulating the JPEG image must be decompressing first. Because the traditional method is not efficient and cannot satisfy the requirements of real-time systems. So studying the technology of image processing based on DCT compressed domain.

There are some important objectives of both compression algorithm.

1) It has been implemented by the single integrated circuit.

2) It has the ability to pack most information in fewest coefficients.
3) It minimizes the block like appearances called blocking artifact that results when boundaries between sub-images become visible.
4) The algorithm has been implemented in MATLAB.A pair of test images like JPEG and PNG is taken to justify the efficiency of the algorithm.
5) It provides a believable cost savings involved with sending less data over the switched telephone network where the cost of the call is really usually based upon its duration.
6) It not only reduces storage requirements but also overall execution time. And it also reduces the probability of transmission errors since fewer bits are transferred.
7) It provides a level of security against un lawful monitoring.

## VII .CONCLUSION

In this research paper, 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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