International Journal of Electrical, Electronics and Computer Engineering **7**(1): 49-54(2018)

ISSN No. (Online): 2277-2626

A Survey on Different Techniques of Discrete Cosine Transform and Discrete Wavelet Transform in Image Compression

Ankit Barskar

Assistant Professor, Department of Electrical & Electronics Engineering,
Truba Institute of Engineering & Information Technology, Bhopal, (Madhya Pradesh), India.

(Corresponding author: Ankit Barskar)

(Received 02 March, 2018 Accepted 24 April, 2018)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Digital image in their raw form require an enormous amount of storage capacity. Considering the important role played by digital imaging, it is necessary to develop a system that produces high degree of compression while preserving critical image information. There are various transformation techniques used for data compression. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) are the most commonly used transformation. DCT has high energy compaction property and requires less computational resources. On the other hand, DWT is multiresolution transformation. In this paper we have survey different papers related to the the Discrete Cosine Transform (DCT) on the Discrete Wavelet Transform (DWT) coefficients. These algorithms are very helpful for the image analyzing. We study about this papers with different parameter which was related to the image processing. The survey show different hybrid algorithm performance and compare them with reconstruction quality.

I. INTRODUCTION

Study has shown that the 90% of total volume of data in internet access consists of image data [1]. Image in its raw (uncompressed) form requires huge storage space. Such raw data needs large transmission bandwidth for the transmission over the network. Hence, lots of researches have been conducted in the field of data compression system. However, in this modern internet age, the demand for data transmission and the data storage are increasing. In this concern, data compression and reconstruction is the only option to relieve the network congestion. Image compression is a process of reducing the size of an image, while maintain the quality of the image. The reduced image allows to store more images in a given amount of memory. When a reduced image with smaller image size is transmitted over network it will take less transmission. The compression technique [5] reduces the size of data, which in turn requires less bandwidth and less transmission time and related cost. Images contain large amounts of information that requires much storage space, large transmission bandwidths and long transmission times. Therefore it is advantageous to compress the image by storing only the essential information needed to reconstruct the image. An image can be thought of as a matrix of pixel (or intensity) values. In order to compress the image, redundancies must be exploited, for example, areas where there is little or no change between pixel values. Therefore images having large areas of uniform colour will have large redundancies, and conversely images that have frequent and large changes in colour will be less redundant and harder to compress [12]. There are algorithms developed for the data compression such as: Discrete Cosine Transform (DCT) [2], Discrete Wavelet Transform (DWT) [4], etc.

Image:- An image is the two dimensional (2-D) picture that gives appearance to a subject usually a physical object or a person. It is digitally represented by a rectangular matrix of dots arranged in rows and columns. The size of the row (M) and column (N) gives the size (or resolution) of image. A small block (8 X 8) of the image is indicated at the lower right corner in the form of matrix. Each element in the matrix represents the dots of the image. Each dot represents the pixel value at that position.

Redundancy:- In data compression, main objective is to reduce the redundancy. Data compression is basically a redundancy reduction technique [14]. For the transmission of same quantity of information, different quantity of data might be used. If the similar information can be represented using different amounts of data, and, the representations that require more data than real information, is referred as data redundancy [2]. There are two kinds of redundancies that may present in the image.

I. Spatial redundancy and II. Spectral redundancy

I. Spatial Redundancy: Nearly all of the image contains correlated pixels. If then neighboring pixels are spatially correlated to each other, then it is known as spatial redundancy [8]. In this thesis work, the spatial redundancy has been taken into consideration and data compression algorithm is analyzed by reducing the spatial redundancy.

II. Spectral redundancy: A correlation between different color planes i.e. spectral bands in an image and video is called spectral redundancy [15].

Data Compression: Due to redundancy image requires large storage space. The compression can be achieved by reducing these redundant data is referred as data compression. Mathematically, by image compression [1, 9] means process of transforming pixel array of an image into statistically uncorrelated data set.

Necessity of data compression:- The need for image compression becomes perceptible when number images on a given system is more. And when number of bits per image is computed resulting from typical sampling rates and quantization methods [19]. Thus storage of even a few images could cause a problem.

Principle of data compression:-The main theory behind the image compression technique [10] is to reduce the redundancy. In image compression methodology, generally spectral and spatial redundancy should be reduced as much as possible. As the redundancy reduce, the amount of data required to represent the data reduces, hence the image get compressed.

Classification of data compression: The data compression techniques are mainly classified into two groups as follows: I. Lossless compression technique and II. Lossy compression technique.

I. Lossless compression technique: In the lossless data compression techniques, the original data can be exactly reconstructed as the original data. This type of compression techniques are generally used where the reconstruction quality is of the utmost importance, such as, executable programs, text documents, and source codes. Some example of lossless compression techniques are: a. Zip file format, and b. Tiff image format

II. Lossy compression technique: The lossy compression techniques achieve data compression by losing some information while maintaining the reconstruction quality [5]. Hence, the data cannot be reconstructed exactly as the original one. This is used for applications where low storage space and fast data transmission speed are needed while maintaining the acceptable reconstructed data quality [25]. The examples of such applications are still image compression, video conferencing, internet telephony and so on. Some example of lossy compression techniques are as follows:- a. JPEG and b. JPEG 2000111

II. LITRATURE SURVEY

Cabeen *et. al.* [1] has proposed in their research paper that we need an efficient way to store digital images on computer. Some image compression techniques to save some storing space is needed. There are several methods of image compression techniques available today, which categorized into two: lossy image compression and lossless image compression. JPEG is a lossy image compression technique which works on Discrete Cosine Transform. Discrete Cosine Transform has following steps- transformation, quantization and encoding. In order to retrieve the image inverse DCT is applied. Proposed by Prabhakar Telagarapu, *et. al* [2] in their image compression is a widely addressed researched area. Many compression standards are in place. In this paper, they have considered that DCT and DWT for image compression and decompression. By considering several images as inputs, it is observed that MSE is low and PSNR is high in DWT than DCT based compression. From the results it is concluded that overall performance of DWT is better than DCT on the basis of compression rates. Gupta, *et. al,* [3] proposed that, the discrete cosine transform (DCT) is a technique for converting a signal into elementary frequency components. It is widely used in image compression. They develop some simple functions to compute the DCT and to compress images. The results presented in their document show that the DCT exploits inter pixel redundancies to render excellent decorrelation for most natural images. In addition, the DCT packs energy in the low frequency regions. Therefore, some of the high frequency content can be discarded without significant quality degradation. Chowdhury and Khatun [4] in their research suggests a new image compression scheme with pruning proposal based on discrete wavelet transformation (DWT). The efficiency of the algorithm has been justified over some real images, and the performance of the algorithm has been compared with other common methods of image compression and the result obtained proofs that their proposed technique provide high compression ratio than other methods In his research paper Harjeetpal Singh, *et. al.* [5], present hybrid model which is the combination of several compression techniques. They presented DWT and DCT implementation because these are the lossy techniques and also introduce Huffman encoding technique which is lossless. The results shows that in terms of PSNR the proposed hybrid algorithm performs much better as compared to standalone DCT and DWT algorithms. In medical image, image compression plays a key role as hospitals also move towards completely digital. Quality of image is an important factor in medical field. Lossy compression schemes are not used in medical image compression due to possible loss of useful clinical information and as operations like enhancement may lead to further degradations in the lossy compression. In this paper Sridevi [6], proposed various medical image compression techniques such as JPEG2000 image compression, JPEG2000 scaling based ROI coding. Discrete cosine transform, Discrete wavelet transform, Mesh based coding scheme, Sub-band block hierarchical partitioning are reviewed. Therefore the research is available on to conquer these drawbacks and also to increase the reconstructed quality of compressed image with high compression rate for medical image. In this research paper Sharma *et. al,* [7], presented a method for the compression of medical images using hybrid compression technique (DWT, DCT and Huffman coding). The purpose of this hybrid scheme is to achieve higher compression rates by first applying DWT and DCT on individual. After applying this technique, image is quantized to calculate probability index for each unique quantity.

Finally the Huffman compression is applied. Results show that the coding performance can be significantly improved by the hybrid DWT, DCT and Huffman coding algorithm. This technique is tested for different medical images using different values of Huffman quantization factor. Image compression plays a critical role in digital image processing. One of the transforms used for lossy image compression is DCT. In this paper Anitha [8] studied for the mathematical equations of the DCT and its uses DCT for image compression. DCT performs well at medium bit rates. Disadvantage of DCT is that only spatial correlation which leads to blocking artifacts. Using DCT blocks cannot be decorrelated at their boundaries. DWT is used as basis for transformation in JPEG 2000 standard. DWT provides high class compression at low bit rates. DWT performs better than DCT in the perspective that it avoids blocking artifacts which degrade reconstructed images. As per the current scenario, the rising growth of technology and the entrance into the digital age, it is hard to handle a vast amount of information every time. Singh *et. al.* [9], presented a novel scheme that combines the Discrete Wavelet Transform (DWT) and Discrete Cosine Transform (DCT). In this paper, a hybrid scheme combing the DWT and the DCT algorithms under high compression ratio constraint for image has been offered. It was observed that the proposed algorithm has superior performance as compared to the other stand alone algorithms. Moreover, the proposed algorithm was also compared with some standards and already developed hybrid algorithms. In uncompressed form digital images require an huge amount of storage capacity. Such uncompressed data requires large transmission bandwidth for the transmission over the network. In this study Bindu, *et. al* [10], observed the performance of three most generally used techniques namely DCT, DWT and Hybrid DCT-DWT are discussed for image compression. And their performance is evaluated in terms of Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE) and Compression Ratio (CR) [10]. The experimental results obtained shows that the Hybrid DCT- DWT technique for image compression has better performance than individual DCT or DWT. In their research paper Sriram, *et. al.* [11], proposed that data compression for images using hybrid DWT-DCT is used which performs discrete cosine transformation on the discrete wavelet transformed coefficients. This method gives high compression ratio, preserving most of the image information and the image is reproduced with good quality. Generally for getting high compression ratio, algorithm have to trade off the clarity of the image. In this paper, they presented a new hybrid DWT-DCT coding scheme that gives high compression ratio without reducing much quality of the image and encoded using arithmetic coding. The new method reduces blocking artifacts, ringing effects and false contouring appreciably. This survey performed by Vrindavanam, *et. al.* [12], summarizes the major image compression methods spanning across lossy and lossless image compression techniques and explains how the JPEG and JPEG2000 image compression techniques are distinct from each other. Further, the paper concludes that still research possibilities exist in this field to explore efficient image compression.

III. PROBLEM IDENTIFICATION

A. Problem Definition

The main idea behind the compression technique is to use orthonormal transformation making the pixel value smaller than the original. The transformation of the data also makes the coefficients of the transformed matrix uncorrelated to each other [27]. There are various methods of transformations being used for data compression as follows: i. Karhunen-Loeve Transform (KLT), ii. Discrete Fourier Transform (DFT) iii. Discrete Sine Transform (DST)v. Discrete Cosine Transform (DCT)vi. Discrete Wavelet Transform (DWT)

Discrete Fourier Transform: DFT is linear, separable and symmetric. It also exhibits good decorrelation and energy compaction characteristics but less compared to DCT.

Discrete Sine Transform: The DST is another option for data compression but it produces the reduced quality reconstruction as compared to DCT [29]. This is due to the fact that the DST does not yields DC coefficient and have only the AC coefficient i.e. there is less degree of energy compaction.

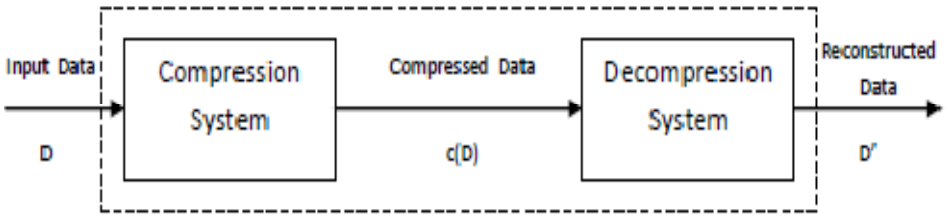

Fig. 1. Block diagram of CODEC.

B. Methodology

Discrete Cosine Transform (DCT). JPEG provides a compression method that is competent of compressing continuous-tone image data [22]. JPEG may be in tune to produce very small, compressed images of relatively poor quality in visibility, but it is suitable for many applications. On the other hand, it is capable of producing an compressed image of very high-quality that are far smaller than the original uncompressed image. JPEG is mainly a lossy image compression method [19]. JPEG, specifically discard information that the human eye cannot easily observe. Minor changes in color are not apparent well by the human eye, while small changes in intensity (light and dark) are noticeable. Therefore JPEG's lossy encoding tends to be more careful with the gray-scale part of an image and to be merrier with the color [21]. Images are separated into parts of different frequencies in DCT, where less significant frequencies are discarded through quantization and while important frequencies are retained to retrieve the image during decompression. 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 [11].

Discrete Wavelet Transform (DWT). In DWT an image is represented as the sum of wavelet functions known as wavelets. Wavelet based coding provides significant improvement in picture quality at high compression ratios mainly due to better energy compaction property of wavelet transforms [6]. Wavelet transform partitions a signal into a set of functions called wavelets. A signal is passed through a series of filters to calculate DWT [8]. The procedure of DWT starts by passing this signal sequence through a half band digital low pass filter. A half band low pass filter removes all frequencies that are above half of the highest frequency in the tile signal. Then the signal is passed through high pass filter. The two filters are related to each other as $h[L-1-n]=(-1)^n g(n)$

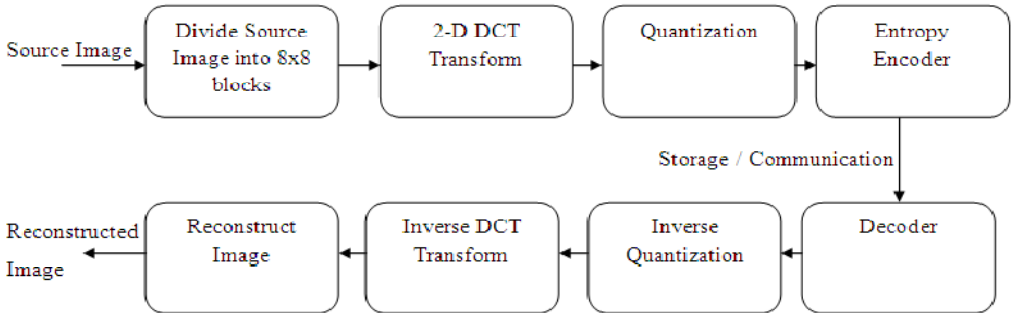

Fig. 2. Block diagram of DCT.

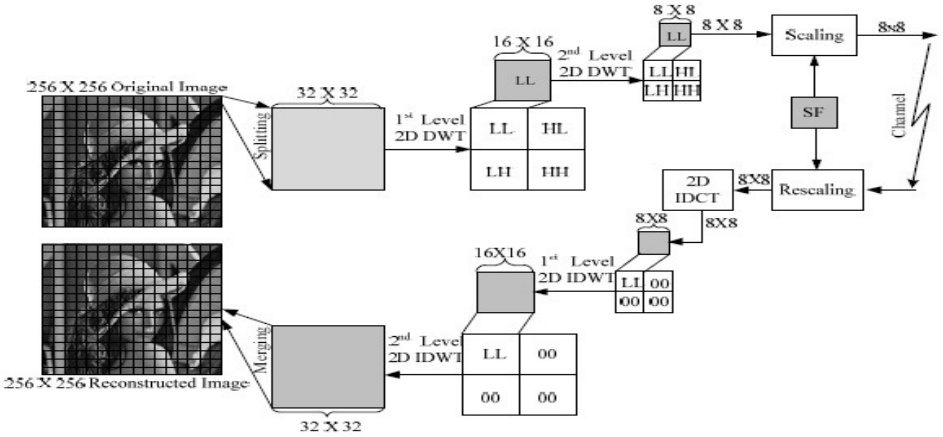

Fig. 3. Block diagram of DWT.

IV. CONCLUSION AND FUTURE WORK

In this research work, a hybrid scheme combing the DWT and the DCT algorithms under high compression ratio constraint for image compression has been presented. The algorithm was tested on several types of images, such as, human, animal, natural, and sea images. The results of the exhaustive simulations show consistent improved performance for the hybrid scheme compared to the JPEG-based DCT. In this paper we have survey different papers related to the Discrete Cosine Transform (DCT) on the Discrete Wavelet Transform (DWT) coefficients. These algorithms are very helpful for the image analyzing. We study about this paper with different parameter which was related to the image processing. The survey show different hybrid algorithm performance and compare them with reconstruction quality.

REFERENCES

[1]. Ken Cabeen and peter Gent "Image compression and discrete cosine transform" college of redwood.

[2]. Prabhakar, Telagarapu, V. Jagan Naveen, A. Lakshmi. Prasanthi, G. Vijaya Santhi (2011). "Image Compression Using DCT and Wavelet Transformations". *International Journal of Signal Processing, Image Processing and Pattern Recognition,* Vol. **4**, No. 3, pp 61-74.

[3]. Maneesha Gupta, Dr. Amit Kumar Garg (2012). "Analysis Of Image Compression Algorithm Using DCT" International *Journal of Engineering Research and Applications* (IJERA) Vol. **2**, Issue 1, pp.515-521.

[4]. M. Mozammel Hoque Chowdhury and Amina Khatun (2012). "Image Compression Using Discrete Wavelet Transform". *IJCSI International Journal of Computer Science Issues*, Vol. **9**, Issue 4, No 1, pp327-330

[5]. Harjeetpal singh, Sakhi Sharma (2012). "Hybrid Image Compression Using DWT, DCT & Huffman Encoding Techniques" *International Journal of Emerging Technology and Advanced Engineering*, Volume **2**, Issue 10, pp 300-306.

[6]. Mrs. S. Sridevi Dr. V. R. Vijayakuymar (2012). "A Survey on Various Compression Methods for Medical Images" I.J. Intelligent Systems and Applications, Published Online April 2012 in MECS DOI: 10.5815/ijisa.2012.03.02 pp 13-19.

[7]. Sandhya Sharma and Sarabjeet Kaur (2013). "Image Compression using hybrid of DWT,DCT and Huffman Coding" *International Journal for Science and Emerging Technologies with Latest Trends*, pp-19-23.

[8]. Anitha (2011). "Image Compression Using Discrete Cosine Transform & Discrete Wavelet Transform" *International Journal of Scientific & Engineering Research.* Volume **2**, Issue 8, pp-1-6.

[9]. Manisha Singh and Agam Das Goswami (2012). "Image Compression Technique Using Hybrid Discreet Cosine Transform (DCT) and Discreet Wavelet Transform (DWT) Method ". *International Journal of Advanced Research in Computer Science and Software Engineering.* Volume **2**, Issue 10, pp 217-223.

[10]. Kiran Bindu, Anita Ganpati, Aman Kumar Sharma (2012). "A Comparative Study of Image Compression Algorithms" *International Journal of Research in Computer Science*, Volume **2** Issue 5 (2012) pp. 37-42.

[11]. Sriram B, Thiyaga Rajan. S. (2012). "Hybrid Transformation Technique for Image Compression" *Journal of Theoretical and Applied Information Technology,* Vol. **41** No.2 ISSN: 1992-8645 pp 175-180.

[12]. Jayavrinda Vrindavanam, Saravanan Chandran, Gautam K. Mahanti (2012). "A Survey of Image Compression Methods" *International Journal of Computer Applications*, pp 12-17.

[13]. Manisha Singh and Devanand Bhonsle (2013). "Image Compression With Hybrid Method: An Overview". *International journal of electrical engineering & telecommunication*. Vol. **2**, No. 3, pp6 - 12.

[14]. I.H. Witten, R.M. Neal, and J.G. Cleary, "Arithmetic coding for data compression", *Commun. ACM*, vol. **30**, pp. 520-540.

[15]. M. I. Khalil, (2010). "Image Compression Using New Entropy Coder" *International Journal of Computer Theory and Engineering,* Vol. **2**, No. 1, pp 1793-8201.

[16]. Madhuri A. Joshi, (2006). "Digital Image Processing, An Algorithmic Approach", PHI, New Delhi, pp. 175-217.

[17]. Othman Khalifa, (2009). "Wavelet Coding Design for ImageData Compression", *The International Arab Journal of Information Technology,* 2009 Vol. **6**, No. 2, pp. 118-127.

[18]. Singh, S., Kumar, V. and Verma, H. K. (2007). "DWT-DCT Hybrid Scheme for Medical Image Compression", J. Med. Eng. Technol. 2007, Vol. **31**, No. 2, pp. 109-122.

[19]. Talukder K H and Harada K (2006). "A Scheme of Wavelet Based Compression of 2D Image", Proc. IMECS, June, pp. 531-536.

[20]. Matthew J. Zukoski, Terrance Boult, Tunç Iyriboz, (2006). "A novel approach to medical image compression", Int. J. Bioinformatics Research and Applications, Vol. **2**, No. 1, 2006.

[21] K. Krishnan, M. Marcellin, A. Bilgin, and M. Nadar, (2006). "Efficient transmission of compressed data for remote volume visualization", IEEE Trans. Med. Imag. 2006, vol. **25**, no.9.

[22]. M. I. Khalil, (2010). "Image Compression Using New Entropy Coder", *International Journal of Computer Theory and Engineering*, Vol. **2**, No. 1 February, 2010 pp 1793-8201.

[23]. Saad Bouguezel, M. Omair Ahmad, and M.N.S. Swamy, (2009). "A fast 8×8 transform for image compression", IEEE International Conference on Microelectronics (ICM'2009), Marrakech, Morocco, Dec. 2009, pp.74-77.

[24]. Rehna V.J, Jeya Kumar M.K, "Hybrid Approach to Image Coding: A Review". *International Journal of Advanced Computer Science and Applications,* Vol. **2**, No. 7, 2011.

[25]. Anil Kumar Katharotiya, Swati Patel, Mahesh Goyani, (2011). "Comparative Analysis between DCT compression applications" *IEEE International Conference on Information Sciences, Signal Processing and Applications*, 2010, pp. 280–283.

[29]. Aree Ali Mohammed, (2011). "Hybrid Transform coding scheme for medical image application" IEEE 2011. [30]. XiHong ZHOU, (2011). Research on DCT-base Image Compression Quality" Cross Strait Quad-Regional Radio Science and Wireless Technology Conference, IEEE 2011.

[31]. Suchitra Shreshtha et al, (2010). "Hybrid DWT-DCT Algorithm for Biomedical image and video compression applications." 10th International Conference on Information Science, Signal Processing and their Applications (ISSPA 2010) IEEE, 2010.

& DWT Techniques of Image Compression". *Journal of Information Engineering and Applications*, Vol. **1**, No. 2, 2011.

[26]. K. A. Wahid, M. A. Islam, S. S. Shimu, M. H. Lee, S. Ko, "Hybrid architecture and VLSI implementation of the Cosine-Fourier-Haar transforms". *Circuits, Systems and Signal Processing,* Vol. **29**, No. 6, 2010, pp: 1193– 1205.

[27]. Swastik Das and Rasmi Ranjan Sethy, (2009). "Digital Image Compression using Discrete Cosine Transform and Discrete Wavelet Transform", B. Tech. Dissertation, NIT, Rourkela, 2009.

[28]. S. Shrestha and K. Wahid, (2010). "Hybrid DWTDCT algorithm for biomedical image and video

[32]. S. Bhavani, K. Thanushkodi, (2010). "A Survey on Coding Algorithms in Medical Image Compression", *International Journal on Computer Science and Engineering*, Vol. **02**, No. 05, pp. 1429-1434.

[33]. A. Alice Blessie1, J. Nalini and S.C. Ramesh, (2011). "Image Compression Using Wavelet Transform Based on the Lifting Scheme and its Implementation", *IJCSI International Journal of Computer Science*, Vol. **8**, Issue 3, No. 1, May 2011.

[34]. Othman Khalifa, (2009). "Wavelet Coding Design for Image Data Compression", *The International Arab Journal of Information Technology*, Vol. **6**, No. 2, April 2009, pp. 118-127.