JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

"DISCRETE WAVELET TRANSFORM BASED LOSSLESS IMAGE COMPRESSION"

ALOK MESHRAM EE DEPT JABALPUR ENGINEERING COLLEGE JABALPUR

DR SHAILJA SHUKLA PROFESSOR EE DEPT JABALPUR ENGINEERING COLLEGE JABALPUR

ABSTRACT- Image compression is an application of data compression on digital images. Digital images contain large amount of digital information that need effective techniques for storing and transmitting large volume of data. Image compression techniques are used for reducing the amount of data required to represent a digital image. Uncompressed multimedia (graphics, audio and video) data requires considerable storage capacity and transmission bandwidth. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technology

Keyword: **-** MATLAB, DWT, Lossless compression

I.INTRODUCTION

Multimedia is an evolving method of presenting many types of information. Multimedia combines text, sound, pictures and animation in a digital format to relate an idea. In future multimedia may be readily available as newspapers and magazines. The multimedia and other types of digital data require large memory for storage, high bandwidth In digital image processing, quality of an image is crucial to obtain high accuracy on features extraction,classification, identifying diseases etc. Diverse images have different storage acquisition.During Transmission, images may be corrupted due to obstruction in transmission channels.Images can be classified in to (1) Binary (ii) Gray Scale (iii) Color. Binary images [1] can be represented with only two values 0 (Black) & 1 (White). Binary image can also be classed as 1-bit image as it need only one byte for representing each pixel. These are repeatedly used where information is required only in the form of shape or general line. Mainly there are 5 formats for storing images. TIFF (Tagged Image File Format) - creates very large files and mostly used in Photoshop, Quark etc. JPEG (Join Photographic Experts group) - generally used for photographs on the web. These are the images that have been compressed to store large amount of data. GIF (Graphic Interchange Format) – compressed but lossless. PNG (Portable Network Graphics) – extensively used for web images. RAW image File- contains data from a digital camera and also contains a huge amount of data that is uncompressed

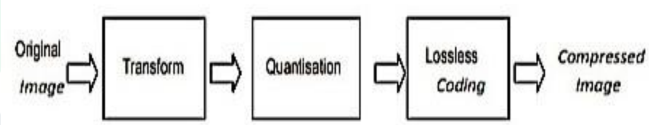

FIG1. DATA COMPRESSION BLOCK DIAGRAM

II.DISCRETE WAVELET TRANSFORM

In Fourier analysis, the Discrete Fourier Transform (DFT) decompose a signal into sinusoidal basis functions of different frequencies. No information is lost in this transformation; in other words, we can completely recover the original signal from its DFT representation. Discrete Wavelet Transformation (DWT) transforms discrete signal from the time domain into time frequency domain. The transformation product is set of coefficient organized in the way that enables not only spectrum analysis of the signal but also spectral behavior of the signal in time. The wavelet transform has emerged as a cutting edge technology, within the field of image compression. Wavelet-based coding provides substantial improvements in picture quality at higher compression ratios . Over the past few years, a variety of powerful and sophisticated wavelet-based schemes for image compression have been developed and implemented. JPEG 2000, the new ISO/ITU-T standard for still image coding, is wavelet- based compression algorithm. This second generation algorithm is being designed to addressthe requirements of very different kinds of applications, e.g.

Internet, color facsimile, printing,scanning, digital photography, remote sensing, mobile applications, medical imagery, digital library and e- commerce.In wavelet analysis, the Discrete Wavelet Transform (DWT) decomposes a signal into a set of mutually orthogonal wavelet basis functions. These functions differ from sinusoidal basis functions in that they are spatially localized – that is, nonzero over only part of the total signal length. Furthermore, wavelet functions are dilated, translated and scaled versions of a common function φ, known as the mother wavelet. As is the case in Fourier analysis, the DWT is invertible, so that the original signal can be completely recovered from its DWT representation. Unlike the DFT, the DWT, in fact, refers not just to a single transform, but rather a set of transforms, each with a different set of wavelet basis functions. Two of the most common are the Haar wavelets and the Daubechies), it is important to note the following important properties of wavelet functions.

1. Wavelet functions are spatially localized;
2. Wavelet functions are dilated, translated and scaled versions of a common mother waveletand
3. Each set of wavelet functions forms an orthogonal set of basis functions.

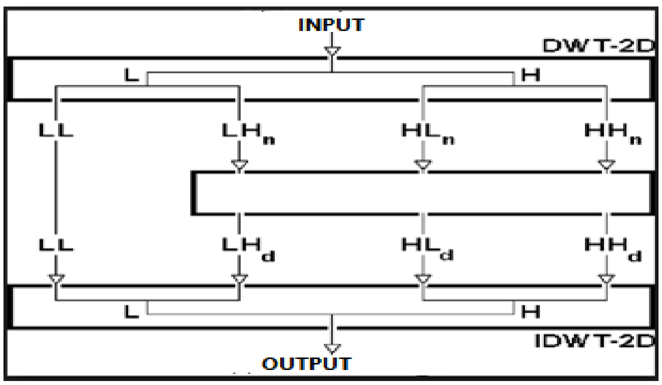

Fig2:Block diagram Compression in Wavelets

DWT in two dimensions In this section, we describe the algorithm for computing the two-dimensional DWT through repeated application of the one-dimensional DWT. The two-dimensional DWT is of particular interest for image processing and computer vision applications, and is a relatively straightforward extension of the one-dimensional DWT discussed above.

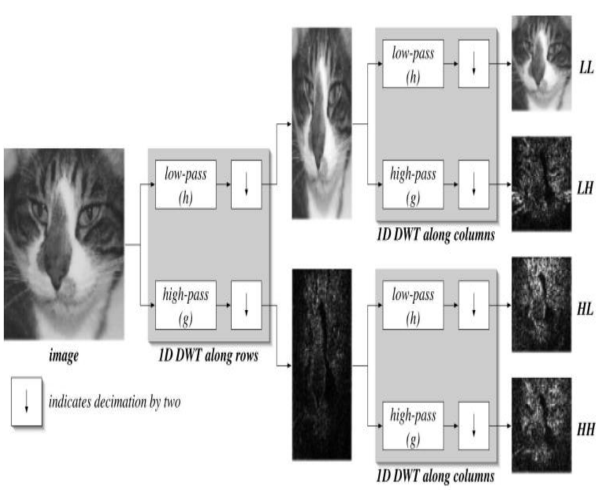

Figure 3: One-level, two-dimensional DWT.

First, the one-dimensional DWT is applied along the rows; second, the one-dimensional DWT is applied along the columns of the first-stage result, generating four sub-band regions in the transformed space: LL, LH, HL and HH

Figure 2 illustrates the basic, one-level, two-dimensional DWT procedure. First, we apply a one-level, onedimensional DWT along the rows of the image. Second, we apply a one-level, one-dimensional DWT along the columns of the transformed image from the first step. As depicted in Figure 2 (left), the result ofthese two sets of operations is a transformed image with four distinct bands:

(1) LL,

(2) LH,

(3) HL and

(4) HH. Here, L stands for low-pass filtering, and H stands for high-pass filtering. The LL band corresponds roughly to a down-sampled (by a factor of two) version of the original image. The LH band tends to preserve localized horizontal features, while the HL band tends to preserve localized vertical features in the original image. Finally, the HH band tends to isolate localized high-frequency point features in the image.

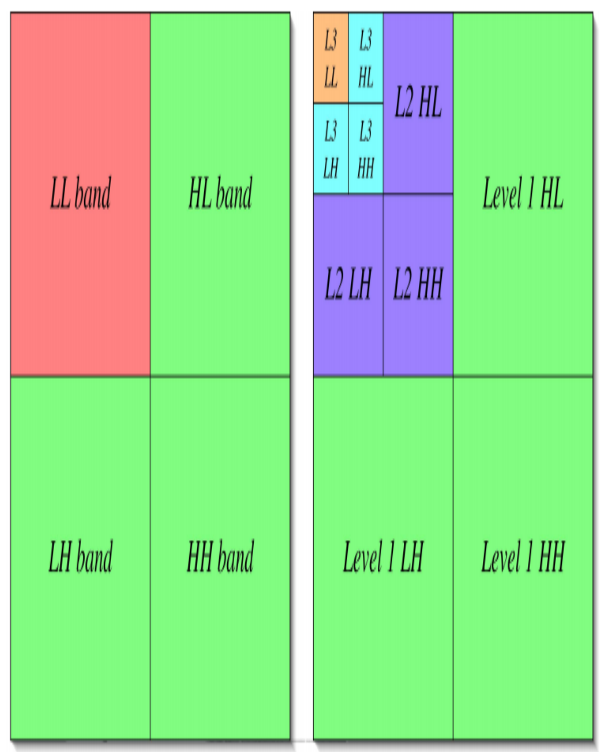

Fig.Dimensional DWT

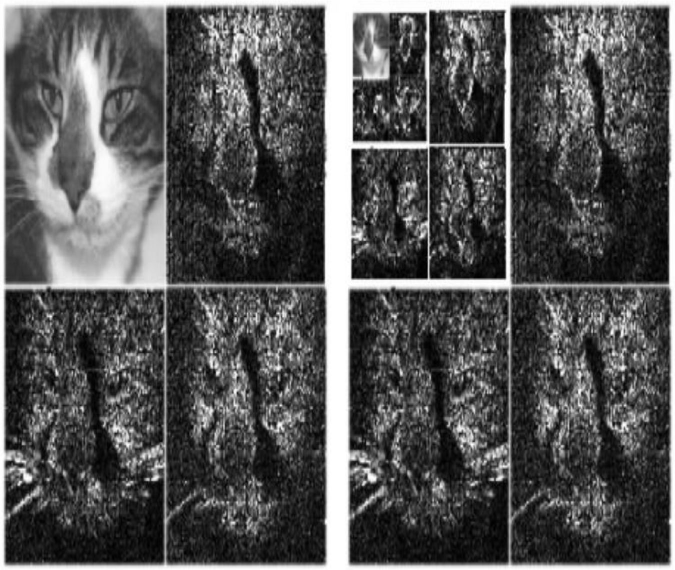

Figure4: Two-dimensional wavelet transform: (left) one-Level 2D DWT of sample image, and (right) threelevel 2D DWT of the same image. Note that the LH bands tend to isolate horizontal features, while the HL band tend to isolate vertical features in the image.

III.INVERSE DWT

To understand the procedure for computing the one-dimensional inverse DWT, consider Figure 2, where we illustrate the inverse DWT for a one-level DWT of length 16 (assuming filters of length four). Note that the two filters are now h^{-1} and g^{-1} where,

$$h_k^{-1} = \begin{cases} h_k & k \in \{1, 3, \dots\} \\ h_{n-k-1} & k \in \{0, 2, \dots\} \end{cases}$$

and g^{-1} is determined from h^{-1} using equation (1). To understand how to compute the one-dimensional inverse DWT for multi-level DWTs, consider Figure 3. First, to compute w2 from w3, the procedure in is applied only to values L3 and H3. Second, to compute w1 from w2, the procedure is applied to values L2 and H2. Finally, to compute x from w1, the procedure in is applied to all of w1 – namely, L1 and H1

IV.PROPOSED DWT FEATURE EXTRACTION ALGORITHM

Initially, it is verified that the digitized flaw data are available in the powers of 2 for making the effective decomposition. The various steps involved in the feature extraction algorithm are as follows:

Step 1: The data are decomposed into four detail subbands using Discrete Wavelet Transform (DWT). The subbands are high frequency detail band coefficients and low frequency approximation band coefficients.

Step 2: The approximation co-efficients are further decomposed using DWT to extract localized information from the subband of detail coefficients. In this work, four levels of decomposition have been done using haar wavelet. Four level approximation.

Step 3: For further analyzing and processing, all the four level detail band coefficients have been taken.

Step 4: The frequency vector (in radians/sample) is extracted for four detail subbands using periodogram function in **MATLAB**.

Step 5: The features are computed either by using syntax or by implementing the formulae. They are mean, variance, mean of energy, maximum amplitude, minimum amplitude, maximum energy, minimum energy, average frequency, mid frequency, maximum frequency, minimum frequency, half point of the function.

Step 6: Finally, the extracted features for the six classes of defects are tabulated and analyzed for classification.

V. HUFFMAN CODING

Huffman Code is an instantaneous uniquely decodable block code. It is a block code because each source symbol is mapped into a fixed sequence of code symbols. It is instantaneous because each codeword in a string of code symbols can be decoded without referencing succeeding symbols. That is, in any given Huffman code, no codeword is a prefix of any other codeword. And it is uniquely decodable because a string of code symbols can be decoded only in one way. Thus any string of Huffman encoded symbols can be decoded by examining the individual symbols of the string in left to right manner. Because we are using an instantaneous uniquely decodable block code, there is no need to insert delimiters between the encoded pixels. For Example consider a 19 bit string1010000111011011111 which can be decoded uniquely as x1 x3 x2 x4 x1 x1 x7. A left to right scan of the resulting string reveals that the first valid code word is 1 which is used is a code symbol for, next valid code is 010 which corresponds to x1, continuing in this manner, we obtain a completely decoded sequence given by x1 x3 x2 x4 x1 x1 x7.

VI. QUANTIZATION

A quantizer simply reduces the number of bits needed to store transformed coefficients by reducing the precision of those values. Since this is a many-to-one mapping, it is the main source of compression in an encoder. Quantization can be performed on each individual coefficient, which is known as Scalar Quantization (SQ). Quantization can also be performed on a group of coefficients together, and this is known as Vector Quantization (VQ).

V. EXTRACTED FEATURES

Some of the extracted feature used in this paper to analyse the parameter of image decompression.

1.Compression ratio:-The compression that is achieved can be quantified by the compression ratio given by the following formula:

CR=n1/n2

where n1 and n2 denote the number of information carrying units (bits) in the original image and the compressed image respectively. A compression ratio like 20 (or 20:1) indicates that the original image has 20 information carrying units (e.g. bits) for every 1 unit in the compressed data set.

2. PSNR:- The measure of peak signal-to-noise ratio (PSNR) is defined as the following formula:

$$PSNR = 10\log_{10}\frac{(2^B - 1)}{MSE}$$

VII. RESULT AND SIMULATION

The generated result is show in Table 1, Table 2& Table 3 respectively where image(cameraman) 256x256 file size 66614 byte or 532912 bits image encoding at different quantization level where the Compression ratio is increased and the PSNR value is in constant manner . the compressed file size also reduced at different quantization level.

DECOMPOSITION	First level	Second level	Third level
Comp.Ratio	1.8685	1.9716	2.0046
PSNR	91.6186	91.686	91.686
Enc. Time (ms)	6.3753	4.3115	4.3699
Comp.file size (bits)	280598	265919	261537

Table 1.Image compression table when quantization =10

DECOMPOSITION	First level	Second level	Third level
Comp.Ratio	3.503	3.5659	3.6481
PSNR	91.6186	91.686	91.686
Enc. time	2.7495	2.5169	2.4154
Comp.file size (bits)	149568	147030	143717

Table 2. Image compression table when quantization =30

DECOMPOSITION	First level	Second level	Third level
Comp.Ratio	5.6807	6.2845	6.304
PSNR	91.6186	91.686	91.686
Enc. Time (ms)	3.9333	3.4415	2.9124
Comp.file size (bits)	92293	83425	83168

Table 3. Image compression table when quantization=60

Fig 5a.GUI Image compression MATLAB(10)

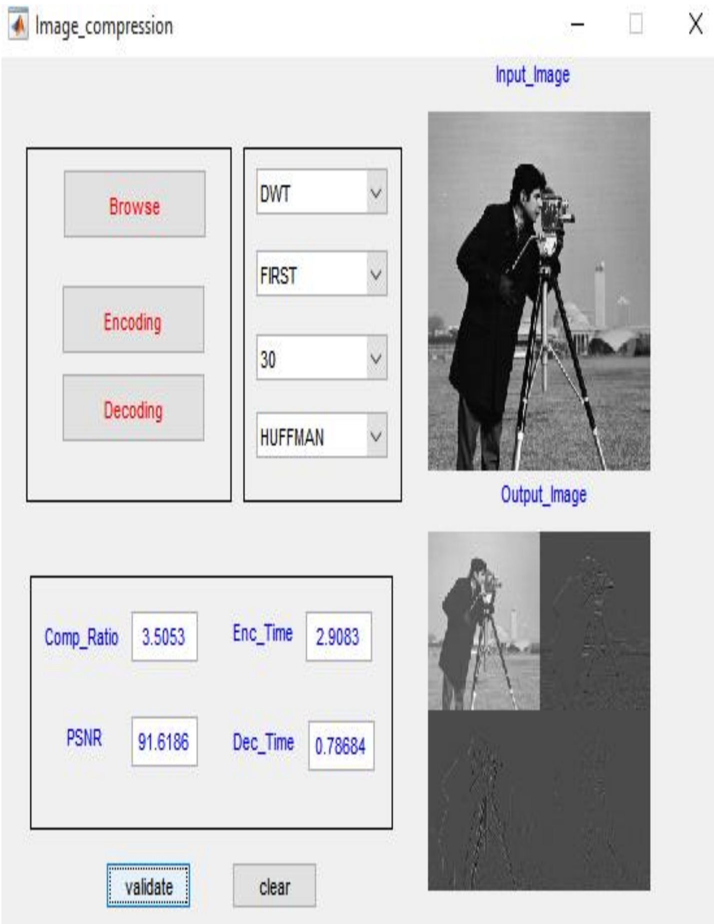

Fig 5b.GUI image compression MATLAB(30)

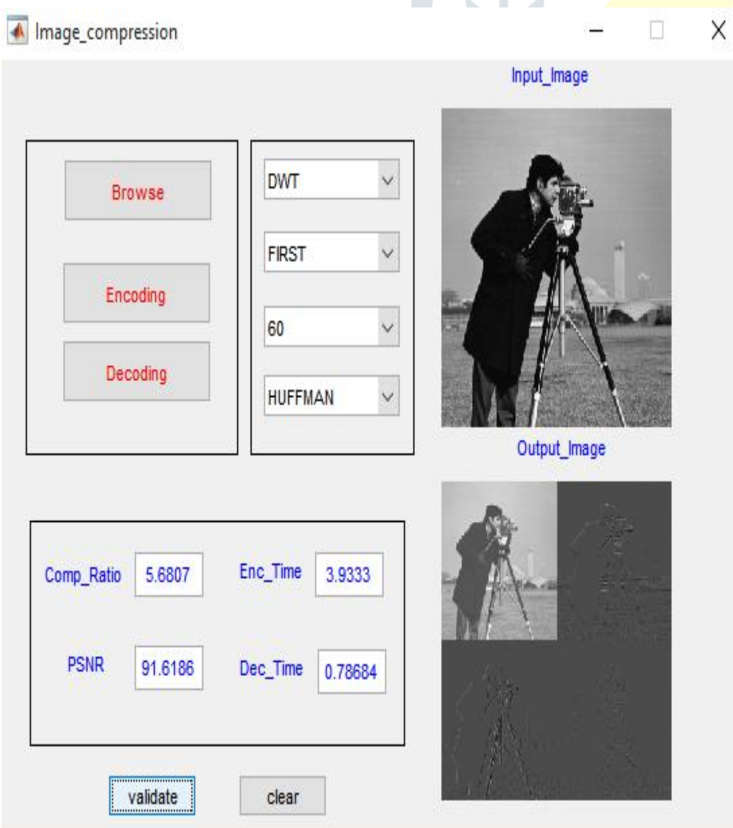

Fig5c.GUI image compression MATLAB(60)

VIII. CONCLUSION

We have briefly reviewed some of the more sophisticated techniques that take advantage of the statistics of the wavelet coefficients.Wavelet- based coding on the other hand provides substantial improvement in picture quality at low bit rates becauseof overlapping basis functions and better energy compaction property of wavelet transforms.The quality of the compressed images has been evaluated using some factors like Compression Ratio (CR), Peak Signal to Noise Ratio (PSNR).

REFRENCES :-

[1].Ch.SathiRaju, D.V.RamaKoti Reddy, "On Compression Characteristics of White Band and Narrow Band Images Using Hybrid DCT and DWT

[2]G. K. Kharate, V. H. Pati, "Color Image Compression Based On Wavelet Packet Best Tree", International Journal of Computer Science, Vol. 7, No.3, March 2010

[3] Ahmed A. Nashat, N. M. Hussain Hassan, "Image Compression Based upon Wavelet Transform and a Statistical Threshold

[4]Umbaugh,Computer Vision and Image Processing, Prentice Hall PTR, New Jersey, S. E. 1998

[5]N.SKODRAS,T.Evrahmi "JPEG2000 image coding system theory and application".

[6] Macro Grangetto, Ecrico magli, MaurizioMartina and Gabriellaolmo "Optimization and implementation of the integer Wavelet transform for image coding"

[7] K. R. Rao and P. Yip, Discrete Cosine Transform: Algorithms, Advantages, Applications, London, U. K., Academic Press, 1990.

[8] M. Vetterli, And C. Herley, "Wavelets and filters banks: Theory and design," IEEE Transactions on Signal Processing, vol. 40,pp.2207-2231, Sep. 1992.

[5]B.J. Kim and W.A Pearlman " An embedded video coder using three dimensional set partitioning in hierarchical trees (SPIHT) in Proc .IEEE DCC'97,1997 ,pp.251-260.

[6] G.K.Wallace,"The JPEG still compression standard".Commun.ACM.vol. 34,pp.30-44,Apr.1991.

[7] R.de Queiroz, C.Choi ,Y.Huh and K.Rao ,“ Wavelet transforms in a JPEG-like image coder ,” IEEE Tran.Circuits Syst.Video.Technol.,vol.7 ,pp.419-424,Apr.1997

[8] Z.Xiong ,O.Guleryuz and M.T. Orchard, “ A DCT- based embedded image coder ,” IEEE Signal Processing Lett., vol. 3,pp.289-290.Nov.1996.

[9] T.Acharya and Ping-Sing Tsai, JPEG2000 Standard for Image Compression Concepts, algorithms and VLSI Architectures. JohnWiley & Sons press,2005.

[10] E.farzad,C.Matthieu,and W.stefan,“JPEG versus JPEG2000: An objective comparison of image encoding quality,” SPIE Proceedings ,vol 5558,pp.300-308,2004

[11] Rao, K. R. and Yip, P. Discrete Cosine Transforms - Algorithms, Advantages, Applications,Academic Press, 1990

[12]R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Reading. MA:Addison Wesley, 2004**.**

[13] David Salomon, Data Compression, The Complete Reference, 2nd EditionSpringer-Verlag 1998

[14] Mohammed Abo-Zahhad, Sabah M. Ahmed and Nabil Sabor,Wavelet Threshold Based ECG Data Compression Technique UsingImmune Optimization Algorithm, International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 8, No. 2 (2015), pp. 347-360

[15] S. A. Chouakri, O. Djaafri and A. Taleb-Ahmed, “Wavelet Transform and Huffman Coding Based Electrocardiogram Compression Algorithm: Application to Telecardiology”, 24th IUPAP Conf. on Computational Physics, (2012) October 14-18, Kobe, Japan.

[16] H. Kanagaraj and V. Muneeswaran, "Image compression using HAAR discrete wavelet transform," 2020 5th International Conference on Devices, Circuits and Systems (ICDCS)