# Medical Image Lossy Compression using DWT Technique

B.B.S.Kumar[1], Dr.P.S.Satyanarayana[2], Savitha N[3],

[1]*Ph.D Research Scholar, JU, Asst Prof., ECE Dept, Rajarajeswari College of Engineering, Bengaluru, Karnataka, India.*

[2]*Professor, PG-Studies, Dept. of ECE, Don Bosco Institute of Technology, Bangalore, Karnataka, India.*

[3]*M.Tech Research Scholar, Rajarajeswari College of Engineering, Bengaluru, Karnataka, India.*

## ABSTRACT

*Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The objective of image compression is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Existing compression techniques can't satisfy all type of images.*

*The scope of the paper is to evaluate the Medical Image Compression & Denoising using DWT technique, PSNR & MSE, implemented using MATLAB and simulation carried out on using jpeg image format. The lossy image compression technique for a medical images which is used at the lower bit rates, and then applied to DWT to obtain good quality image. PSNR and MSE is used to find image quality.*

**Keywords:** – *DWT, PSNR, MSE, Compression*

---

## 1. INTRODUCTION

One of the major goal of image processing is to retrieve required information from the given image in a way that it will not effects the other features of that image. De-noising enhancement of an image is the most important step required to fulfill this requirement. After removing noise from an image, can perform any operation on that image.

Digital image compression[3], [4], [5] and processing techniques play an important role in current day medical diagnosis, satellite imaging, machine vision, computer vision, biometrics, military, Image Retrieval, extracting features and recognizing objects from the given image.

Images of living objects are taken using different modalities like X-ray, Ultrasound, Computed Tomography (CT), Medical Resonance Imaging (MRI) tells the need of applying digital image processing techniques like image compression for improving the quality of image by removing noise. The main goal of such system is to reduce the storage quantity as much as possible, and the decoded image displayed in can be similar to the original image as much as can be. Image compression coding is to store the image into bit-stream as compact as possible and to display the decoded image as exact as possible.

Compressing an image is significantly different than compressing raw binary data. Of course, general purpose compression programs can be used to compress images, but the result is less than optimal. This is because images have certain statistical properties which can be exploited by encoders specifically designed for them. Also, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space. This also means that lossy compression techniques can be used in this area. 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 technologies. For still image compression, the `Joint Photographic Experts Group' or JPEG standard has been established by ISO (International Standards Organization) and IEC (International Electro-Technical Commission).

## 2. RESEARCH REVIEW

Literature survey enables and directs a researcher in the right direction when reviewing the previous publications. Review papers provide the loop holes of previous and existing systems the work to be carried out to apply a correct methodology to move forward a researcher. The literature survey helps proving and disproving of any work.

Image compression has become an important process in today's world of information exchange. We can compress image either by using lossy or lossless compression algorithms. For lossy compression technique, many sophisticated standards have been intensively developed such as JPEG and JPEG2000 for still image and MPEG-4 for multimedia communications.

In previous method the Algorithm of Intelligent Compression was used Multilayer neural network can be employed to achieve intelligent image compression. The network parameters will be adjusted using different learning rules for comparison purposes. Mainly, the input pixels will be used as target values so that assigned mean square error can be obtained, and then the hidden layer output will be the compressed image.

Artificial Neural network have found increasing applications in image compression due to their noise suppression and learning capabilities. A number of different neural network models, based on learning approach have been proposed. Models can be categorized as either linear or nonlinear neural nets according to their activation function. The network will be trained by back propagation, using different learning algorithms. Mainly Newton's method, gradient descent and adaptive gradient descent learning algorithms will be used for this purpose.

Denoising method used previously was by adding Additive White Gaussian noise, using DWT transformations and by using Weiner filter.

Many papers were reviewed on image compression using DWT, it is found that demerits in the previous existing method, this has motivated to have problem statement to do research work.

Types of Compression Systems: There are two types of compression systems

**Lossy Compression System:** Lossy compression techniques can be used in images where some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space.

**Loss less compression system:** Lossless Compression System which aim at minimizing the bit rate of the compressed output without any distortion of the image. The decompressed bit-stream is identical to original bit-stream.

## 3. METHODOLOGY

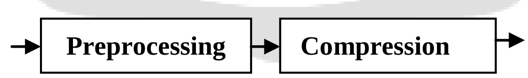



**Fig-1.** General Block diagram

**Preprocessing:** In general the images are taken with both digital cameras and conventional film cameras will pick up noise from a variety of sources. Many further uses of these images require that the noise will be partially removed for aesthetic purposes as in artistic work or marketing, or for practical purposes.

To enhance the image quality pre-processing stage is used. Here contrast enhancement technique is used to enhance the image where in initially the image of 256x256 is resized into 100x150 which is enhanced by using the feature imadjust. The imadjust increases the contrast of the image by mapping the values of the input intensity image to a new values such that by default, 1% of the data is saturated at low & high intensities of the input data.

**Compression:** Compression technique[6], [7], [8] used now in this project implementation is the lossy compression technique. Lossy file compression results in lost data and quality from the original version. Lossy compression is typically associated with image files, such as JPEGs, but can also be used for audio files, like MP3s or AAC files. The "lossyness" of an image file may show up as jagged edges or pixelated areas. In audio files, the lossyness may produce a watery sound or reduce the dynamic range of the audio. Because lossy compression removes data from the original file, the resulting file often takes up much less disk space than the original. For example, a JPEG image may reduce an image's file size by more than 80%, with little noticeable effect. Similarly, a compressed MP3 file may be one tenth the size of the original audio file and may sound almost identical.

Lossy compression is most commonly used to compress multimedia data (audio, video, and still images), especially in applications such as streaming media and internet telephony. By contrast, lossless compression is typically required for text and data files, such as bank records and text articles. In many cases it is advantageous to make a master lossless file that can then be used to produce compressed files for different purposes.

Developing lossy compression techniques as closely matched to human perception as possible is a complex task. Sometimes the ideal is a file that provides exactly the same perception as the original, with as much digital information as possible removed; other times, perceptible loss of quality is considered a valid trade-off for the reduced data. "Lossy" compression is the class of data encoding methods that uses inexact approximations (or partial data discarding) for representing the content that has been encoded. Such compression techniques are used to reduce the amount of data that would otherwise be needed to store, handle, and/or transmit the represented content.

### 3.1 DWT

The Wavelet technique is age old signal processing method; it is a mathematical representation or expression having the data. So Discrete Wavelet Transform(DWT) is derived from FT (Fourier Transform), STFT (Short Time Fourier Transform), FFT (Fast Fourier Transform), DFT (Discrete Fourier Transform), CWT (Continuous Wavelet Transform). The wavelets having advantage over Fourier transform because the image can be represented in both frequency attributes of characteristics and spatial domain but Fourier transform can be represent only in frequency attributes of an image.

Wavelets having the properties scalability, transability, multi resolution, compatibility and orthogonality. Wavelets provide better resolution of an image for pre- processing and post processing technique.

### 3.4 MSE and PSNR

The quality of the image is measured by calculating the two important quality metrics are as namely:
Peak Signal to Noise Ratio(PSNR) & Mean Square Error(MSE)

Peak signal to noise ratio is often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

PSNR is most commonly used to measure the quality of reconstruction of lossy compression codec (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codec, PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. One has to be extremely careful with the range of validity of this metric.

PSNR is most easily defined via the mean squared error (MSE). Given a noise-free m×n monochrome image I and its noisy approximation K, MSE is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

The PSNR (in dB) is defined as:

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \end{aligned}$$

Here, $MAX_I$ is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255.

## 4. ALGORITHMS

**4.1 Decomposition**
Step 1: Start-Load the source image data from a file into an array.
Step 2: Choose a Haar Wavelet.
Step 3: Decompose-choose a level N, compute the wavelet decomposition of the signals at level N.
Step 4: Compute the DWT of the data.
Step 5: Read the 2-D decomposed image to a matrix.
Step 6: Retrieve the low pass filter from the list based on the wavelet type.
Step 7: Compute the high pass filter i=1.
Step 8: i >= 1decomposed level, then if Yes goto step 10, otherwise if No goto step 9.
Step 9: Perform 2-D decomposition on the image i++ and goto to step 8.
Step 10: Decomposed image.
Step 11: End.

**4.2 Reconstruction**
Step 1: Start-Load the source image data from a file into an array.
Step 2: Choose a Haar Wavelet.
Step 3: Decompose-choose a level N, compute the wavelet decomposition of the signals at level N.
Step 4: Compute the DWT of the data.
Step 5: Read the 2-D decomposed image to a matrix.
Step 6: Retrieve the low pass filter from the list based on the wavelet type.
Step 7: Compute the high pass filter i= decomp level.
Step 8: i <= 1 decomposed level, then if Yes goto step 10, otherwise if No goto step 9.
Step 9: Perform 2-D decomposition on the image i++ and goto to step 8.
Step 10: Reconstructed image.
Step 11: End.

**4.3 Compression**
Step 1: Start-Load the source image data from a file into an array.
Step 2: Choose a Haar Wavelet.
Step 3: Decompose-choose a level N, compute the wavelet decomposition of signals at level N.
Step 4: Threshold detail coefficients, for each level 1 to N, a threshold is selected and hard thresholding is applied to the detail coefficients.
Step 5: Remove (set to zero) all coefficients whose value is below a threshold (this is the compression step).
Step 6: Reconstruct, compute wavelet reconstruction using the original approximation coefficients of level N and the modified detail coefficients of levels from 1 to N.
Step 7: Compare the resulting reconstruction of the compressed image to the original image.
Step 8: End.

## 5. EXPERIMENTAL RESULTS

**5.1 Preprocessing**
In general, we should do preprocessing of the image before applying the compression technique. For the testing purpose we have taken the medical image of brain having the dimension of 256x256, which is in the jpeg format.

**Steps involved in preprocessing are as follows:**

**Step 1: Read the image.**
Reading the image from the file, I have used an image 'mri.jpg'.

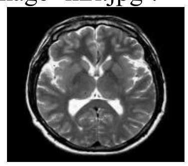


**Fig-2(a):** Original Image of Brain (256x256)

**Step 2: Resize the image.**
Resize the image from 256x256 to 100x150 dimensions.

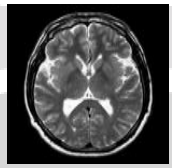
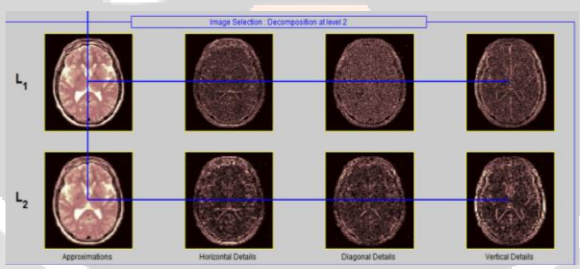


**Fig-3(b):** Resized Image

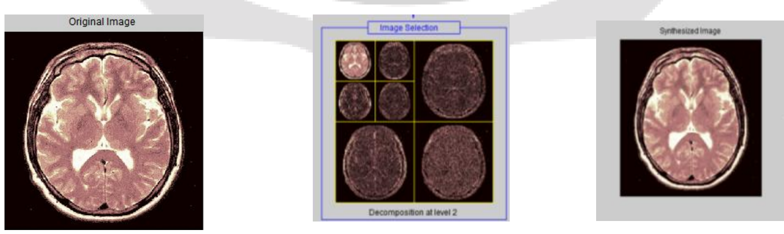
**Step 3: Apply any one of the pre-processing method.**
Imadjust method is implemented for the pre-processing stage.

**Fig-4(c):** Imadjust image

**5.2 Decomposition Levels**
Obtaining Decomposition and thresholding level output:



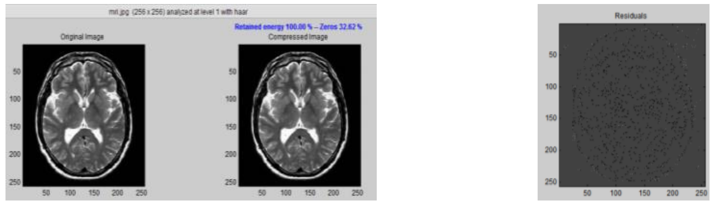

(d)



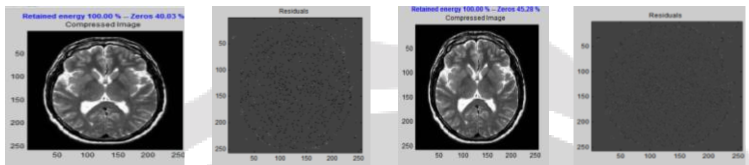

(a) (b) (c)

**Fig-5:** (a)Original image, (b) After applying DWT Decomposition at level 2, (c) Output or Reconstructed image after applying IDWT and (d) Decomposition level output (before enhancement).

**5.3 Analyzing Haar Wavelet for 3 Decomposition levels**



(a) (b)



(c) (d) (e) (f)

**Fig-6:** (a) & (b) Haar Wavelet, Global Thresholding with level 1 decomposition at Threshold value 1 & 2 with their residuals respectively, (c) & (d) level 2 decomposition,

**5.4 Lossy Compression output**

(a) Original (b) Compressed

**Fig-7:** (a) & (b) Resized Original image and Compressed image after enhancement.

**5.5 Comparison of MSE & PSNR for different wavelets**

**Table-1:** Representing Compression Ratio, Retained energy, MSE & PSNR of different wavelet analysis

| Wavelets | Compression Ratio | Retained Energy | PSNR | MSE |
|---|---|---|---|---|
| Haar | 41.235 | 99.9996 | 64.0160 | 0.0258 |
| db1 | 41.235 | 99.9996 | 64.0160 | 0.0258 |
| Sym2 | 41.830 | 99.9996 | 64.0162 | 0.0258 |
| Coif 1 | 44.037 | 99.9996 | 63.9363 | 0.0263 |
| Bior 1.1 | 41.2359 | 99.9995 | 64.0160 | 0.0258 |

From the above table using Haar, daubechies(db1), Symlet(sym2), Coiflet(coif10, Biorthogonal(bio1.1) wavelets having the compression ratio same and but having coif1 higher ratio, energy retaining & PSNR is good for all the wavelets, but coif1 having lower PSNR. If PSNR is higher and lower MSE value than image quality is good[10-15].

## 6. CONCLUSION

In this paper is very useful in the medical images where the compression techniques are to be implemented wherever the image has to retain its same property of the image as it was in the original image, where some loss of data can be acceptable as we are using lossy compression technique where this can also be implemented by using lossless compression also where loss of some data is also not acceptable.

## REFERENCES

[1] International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume2, Issue1, January2013 ISSN 2319 – 4847

[2] International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 2, Issue 6, June 2013 ISSN 2319 – 484

[3] Digital Image Processing (Pearson Education, Second Edition) By Rafael C. Gonzalez and Richard E.Woods.

[4] Digital Image Processing by Athur R.Weak.

[5] Digital Image Processing using MATLAB (Pearson Education) By Rafael C. Gonzalez, Richard E. Woods and Steven L.Eddins.

[6] T Hong LIU , Lin-pei ZHAIV , Ying GAO, Wen-ming LI‟, Jiu-fei HOU‟, "Image Compression Based on Biorthogonal Wavelet Transform", IEEE Proceedings of ISCIT2005.

[7] De Vore , et al.,n"Image Compression through Wavelet Transform Coding", IEEE Transaction on Information Theory.

[8] "A Comparative Study of Image Compression Techniques Based on Svd, Dwt-Svt , Dwt- Dct" ICSCI2008 proceedings pg 494-496.

[9] Dept. of Computer Science and Engineering, Aryabhatta Institute of Engineering and Management Durgapur, India 713148,Dept. of Computer Science and Engineering, University of Kalyani, India 741235

[10] International Journal of Signal Processing, Image Processing and Pattern Recognition Vol.4, No.3,September,2011

[11] Indo Global College of Engineering, Abhipur, SAS Nagar, Mohali, Punjab Proceedings of SARC-IRAJ International Conference, 22nd June 2013, New Delhi, India, ISBN: 978-81-927147-6-9

[12] International Journal of Computer Applications in Engineering Science [ISSN: 2231-4946]

[13] International Journal of Technology Enhancements and Emerging Engineering Research, Vol 1, Issue 444 ISSN 2347-4289 Copyright © 2013 IJTEEE.

[14] IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p- ISSN: 2278-8727Volume12,Issue5(Jul.-Aug.2013),PP39-44

[15] Iram Sami, Abhishek Thakur, Rajesh Kumar Dept. of ECE, Indo Global College of Engineering, Abhipur, Mohali, Punjab, India IJECT Vol. 4, Issue Spl - 3, April - June 2013 ISSN: 2230-7109 (Online) | ISSN : 2230-9543