ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

3D MR Image Compression Techniques based on Decimated Wavelet Thresholding Scheme

Dr. P.V. Naganjaneyulu
Professor & Principal,
Department of ECE,
PNC & Vijai Institute of Engineering & Technology,
Repudi, Phirangipuram, Guntur (Dist), Andra Pradesh.

ABSTRACT: Optimum usage of bandwidth, storage space and easy transmission over communication channel are important and challenging tasks in recent multimedia world. One possible solution to overcome this features is image compression, which will be used to reduce the storage capacity of images i.e., gray scale MR and true color images and also to transmit an image with limited bandwidth. It plays an important role to utilize the bandwidth in a valuable manner and economical by diminishing the size of image without degrading the perceptual visual quality of an image. Here in this proposal we explored the performance and analysis of decimated wavelet thresholding based 3D MR image compression techniques. The type of thresholding used here are hard and soft thresholding for neglecting the wavelet coefficients, global and local thresholding techniques were used to compress the image. Experimental analysis of these techniques has been analyzed using image quality metrics such as Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE) and Compression Ratio (CR).

1. INTRODUCTION

Recent years there is a rapid growth in multimedia world, telecommunications, and cellular communication and even in Web communication, everyone must need to store the data in a limited bandwidth which is available. In order to store more data in limited space, we must need the technique called compressing the data [1] to the reduced size from the actual size it has. Every day Gega bytes of images are sharing among the various communication channels, in order sent or transmit the images over communication channel, one must reduce the size of image without degrading the perceptual visual quality of image to download it by the receiver easily. To minimize the size of image file without disturbing the original visual quality of image and which allows being stored up many more images in a single storage disk or in available memory space, one possible solution is image compression [2]. Minimizing the size of graphic file give us an advantage of transferring it through the web in lesser time than it required and also it reduces the bandwidth requirement. To transmit data in an efficient manner by minimizing the irrelevance and to improve the redundancy, one might have to use image compression as an effective tool. The most popular image compression techniques such as JPEG [2-4] and JPEG2000 [5] have been implemented due to the bandwidth demand and to achieve less capacity storage. However, these techniques were suffering from higher bit error rate. From the past decades, so many image compression schemes have been developed and executed successfully, but still there are more researchers trying to propose innovative algorithms. Recently, a new image compression algorithm employed, which is called as discrete wavelet transform, to overcome the drawbacks in JPEG [2-4] and JPEG2000 [5], because of its multi resolution nature, flexibility and scalability. The wavelet transform isolates the image into several sub bands like approximation coefficients and detail coefficients i.e., approximation as LL and details as LH, HL and HH. LL sub band contains the original information of pixels or image and detail sub bands consists of horizontal, vertical and diagonal information of image. The threshold value will depends on the information which we obtained from the detail sub bands. Image compression has been divided into two segments first, lossless image compression, in which 100% energy retained after the compression of image and second, lossy image compression, in which the information will be lost after compressing the

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

image. The Higher compression ratio is the main goal of image compression techniques; this will be obtained by selecting the optimal threshold value.

2. LITERATURE SURVEY

Form the past years many researchers have developed image compression algorithms based on various standards, spatial methods and transformation techniques. All of them have their own drawbacks in terms of perceptual visual quality, compression ratio and mean square error. In 1990, Hui *et. al.* proposed [1] an adaptive block truncated coding (ABTC) method for compressing the image, here in this thesis he designed a minimum mean square error (MMSE) quantizer to compress the image. This method tried to optimize the output levels of quantization based on the image pixel blocks locality. Performance results were superior to standard BTC and absolute moment BTC (AMBTC). Error rate could not be reduced by ABTC and more over it degrades the image quality, because of image blocks, it is impossible to recover lossless image at the receiver end. Later in 2004 Joint Photograph Expert Group (JPEG) standards have been developed to compress the image based on discrete cosine transform [2-5]. This standard was well suited for any type of image such as medical, satellite, synthetic aperture RADAR (SAR), remote sensing and even for natural images. But, it will not reduce the number bit errors after decompressing the image.

Afterwards, the extension to the JPEG standard image compression called JPEG 2000 has been proposed [6], it gives somewhat better performance than the JPEG but, it doesn’t have the ability to reduce the bit error rate (BER). Later years, many scholars have proposed the compression algorithm based on arithmetic coding [7,8], Huffman coding [7-10], EZW coding [10-11] and etc., but all of them were fail to produce the error checking in image compression to recover the image at receiver end and much complex to implement, time consuming processes. To overcome these drawbacks, researchers had developed the transformation based compression techniques by using discrete cosine transform (DCT) [17] and wavelet transform with sub band coding techniques [12-16].

2.1 Fourier Transform

The signal can be analyzed more effectively in frequency domain than the time domain, because the characteristics of a signal will be more in frequency domain. One possible way to convert or transform the signal from time to frequency domain is Fourier transform (FT). FT is an approach which breaks down the signal into different frequencies of sinusoids and it is defined as a mathematical approach for transforming the signal from time domain to frequency domain.

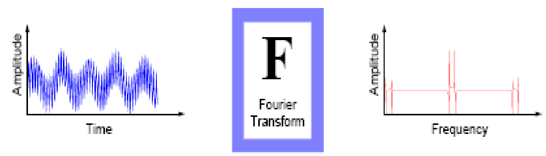


Fig.1. Analysis of FT with an example

FT has a drawback that it will work out for only stationary signals, which will not vary with the time period. Because, the FT applied for the entire signal but not segments of a signal, if we consider non-stationary signal the signal will vary with the time period, which could not be transformed by FT. and one more drawback that we have with the FT is we cannot say that at what time the particular event will has occurred.

2.2 Short-Time Fourier Analysis

To correct the deficiency in FT, Dennis Gabor in 1946 introduced a new technique called windowing, which can be applied to the signal to analyze a small section of a signal. This adaptation has been called as the Short-Time Fourier Transform (STFT), in which the signal will be mapped into time and frequency information.

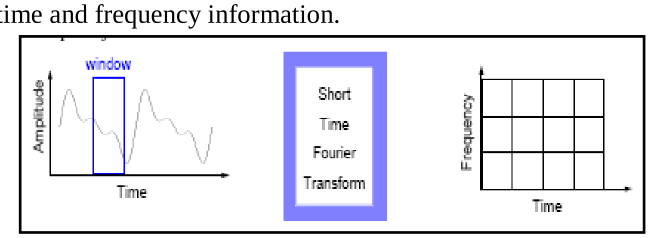


Fig.2. STFT analysis of a signal

In STFT, the window is fixed. So, we this window will not change with the time period of the signal i.e., for both narrow resolution and wide resolution. And we cannot predict the frequency content at each time interval section.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

3. PROPOSED SCHEME AND THRESHOLDING

3.1 WAVELET ANALYSIS

To overcome the drawbacks of STFT, a wavelet technique has been introduced with variable window size. Wavelet analysis allows the use of long time intervals where we want more precise low-frequency information, and shorter regions where we want high-frequency information.

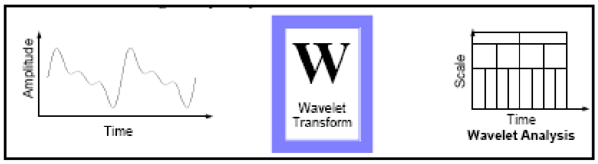


Fig.3. Wavelet analysis with an example

In fig.4 it is shown that the comparison of FT, STFT and wavelet transform by considering an example input signal and how the analysis of transformation techniques will apply to get the frequency information of input signal. We can observe that in wavelet analysis the graphical representation shows that the wavelet has more number of features than the FT and STFT. Wavelet is also called as multi resolution analysis (MRA). Here's what this looks like in contrast with the time-based, frequency-based, and STFT views of a signal:

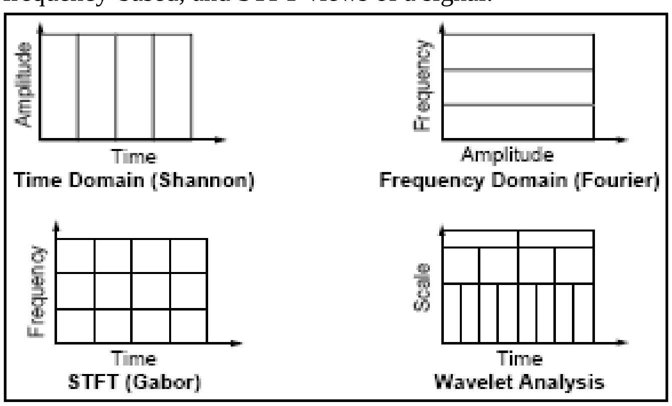


Fig.4. Comparison of FT, STFT and Wavelet analysis of a signal

To split objects from the image background, the best approach is thresholding; the purpose of thresholding is to extract the object from an image. If background brightness is less than the object called threshold above and if the object brightness is less than the background it is called the threshold below. Here in this letter, we have used two types of thresholding approaches. Those are,

- Hard threshold
- Soft threshold

Fig5. Shows that the block diagram of proposed scheme, which explains that the discrete wavelet transform (DWT) is applied to the input image of size 256x256 to decompose the image into several sub bands i.e., four sub bands LL, LH,HL and HH. LL is known as approximation coefficients and LH, HL, HH called as detail coefficients in which the high frequency information is available. Here we used different types of wavelet to analyze the compression ratio and PSNR. To get the AC and DC coefficients, DWT will applied to each row and column of the image. LL displays the original pixel values of input image, LH displays horizontal, HL displays vertical and HH displays diagonal pixel information of input image. After applying DWT, the next step is to define the threshold value, which can be done in two methods namely global threshold and local threshold. Global threshold value will be constant for entire image where as the local threshold value vary from region to region in an image. Then, the unwanted information in an input image will be removed by means of quantization.

3.2 Quality Metrics of image

Here we are used CR, PSNR and MSE to measure the quality of image, where PSNR will be used to measure the quality of image using a mathematical expression which as follows:

$$PSNR = 10 * log_{10}\left(\frac{255^2}{MSE}\right)$$

Where, $MSE = \frac{1}{M*N}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\left(I_{x,y} - O_{x,y}\right)^2$

Compression ratio (CR) is defined as follows:

$$CR = \frac{Ratio\ of\ number\ zeros\ of\ current\ decomposition\ level}{number\ of\ coefficients}$$

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

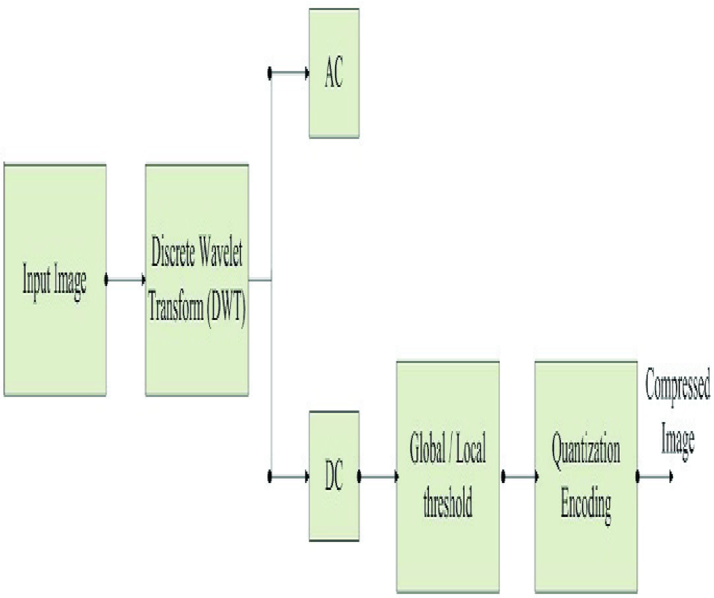
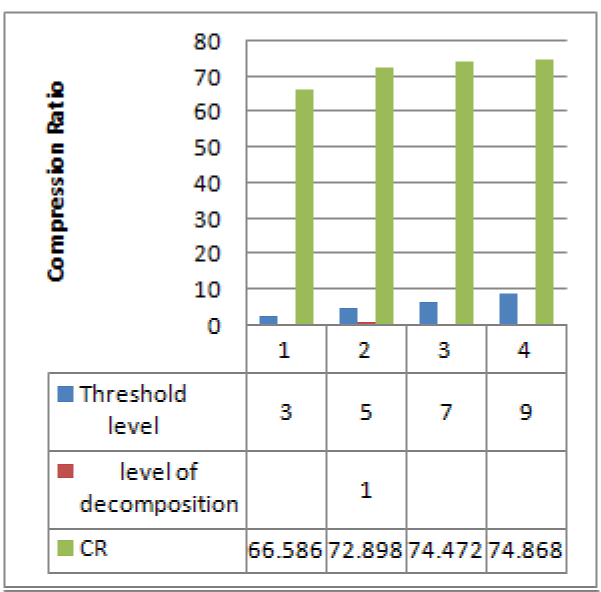
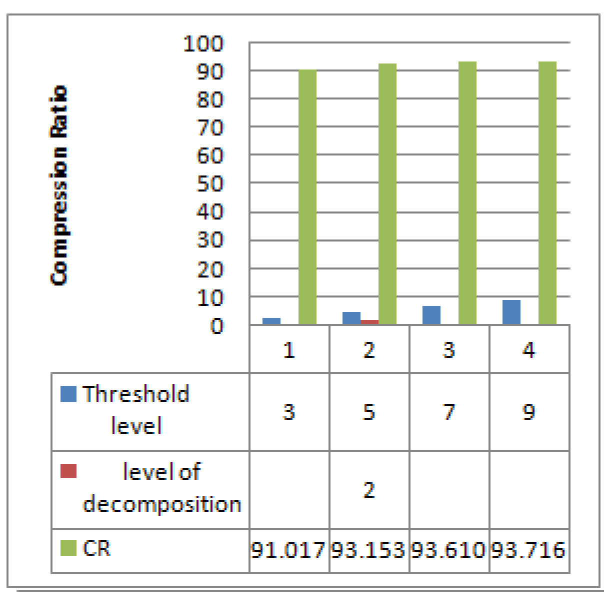


Fig5. Proposed block diagram of image compression technique

4. SIMULATION RESULTS

Experimental results have been done in MATLAB 2014a version with 4.00 GB RAM and i3 processor, Here we had done the simulations for various images and also gives the comparison for both Haar and Biorthogonal wavelets in terms of compression ratio and peak signal to noise ratio. Fig 6 shows that the comparison of compression ratio (CR) with the threshold values 3, 5, 6 and 7, decomposition level of 1 with Haar wavelet. By seeing the fig.6, we can conclude that the CR is improving while increasing the threshold values and also it is improving for further to achieve almost 99.6% at the 4th level of wavelet decomposition. Fig.7 shows that the comparison analysis of compression ratio with the bior4.4 wavelet decomposition at 1, 2, 3 and 4th levels with the various thresholding values. When we compare the both fig.6 and fig.7, we can say that the Haar is performing better compression and it has given superior results to biorthogonal wavelet. In fig. 8 and fig. 9, we had compared the PSNR analysis of input and reconstructed image, which has been reconstructed from the compressed image using both Haar and biorthogonal.





ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

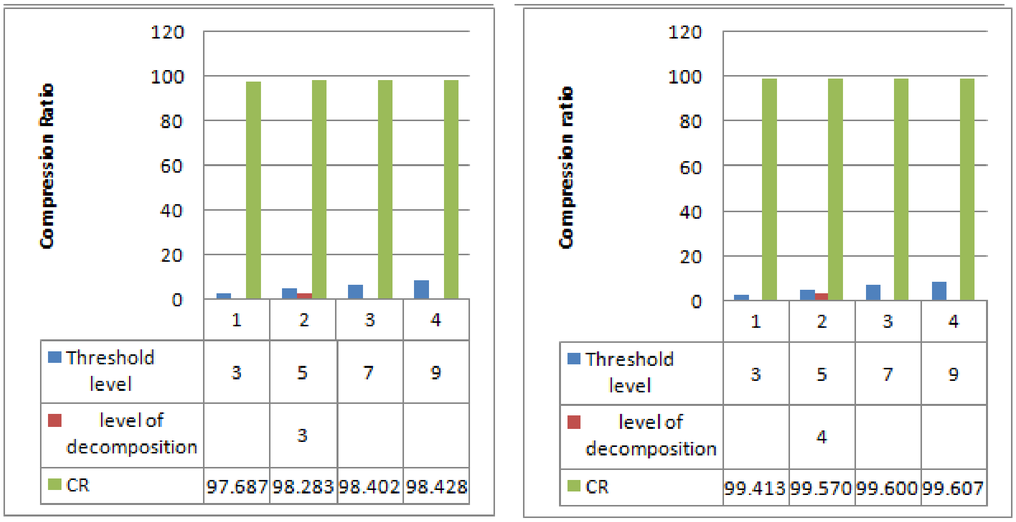


Fig6. Performance of compression ratios for Haar wavelet with different threshold values and decomposition levels

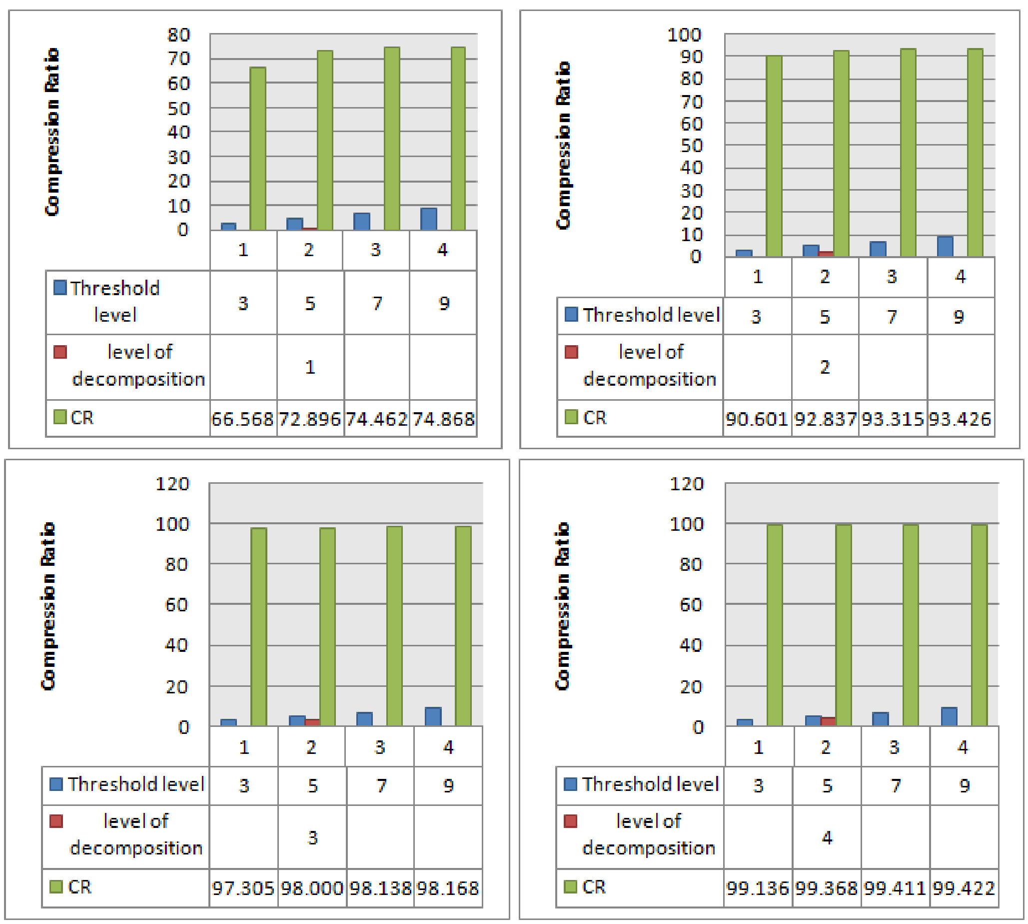


Fig7. Performance of compression ratios for Biorthogonal wavelet with different threshold values and decomposition levels

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

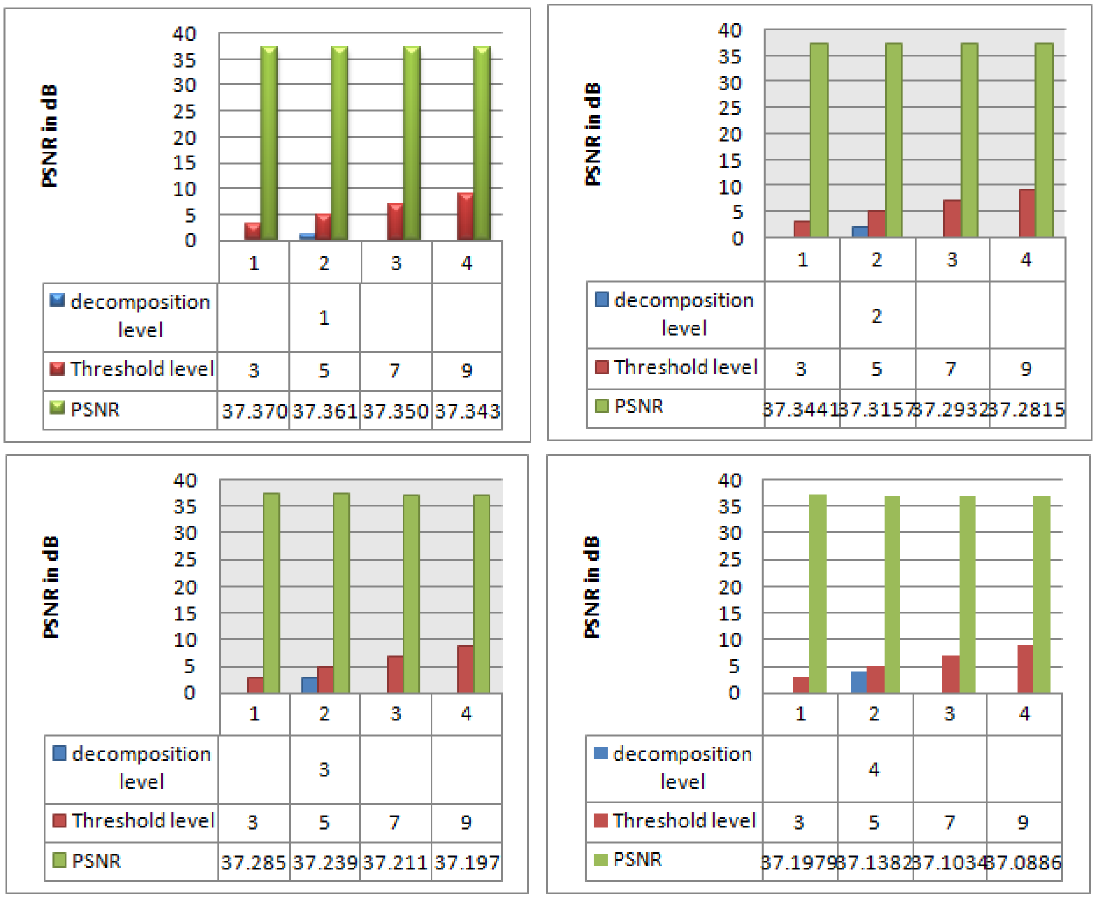
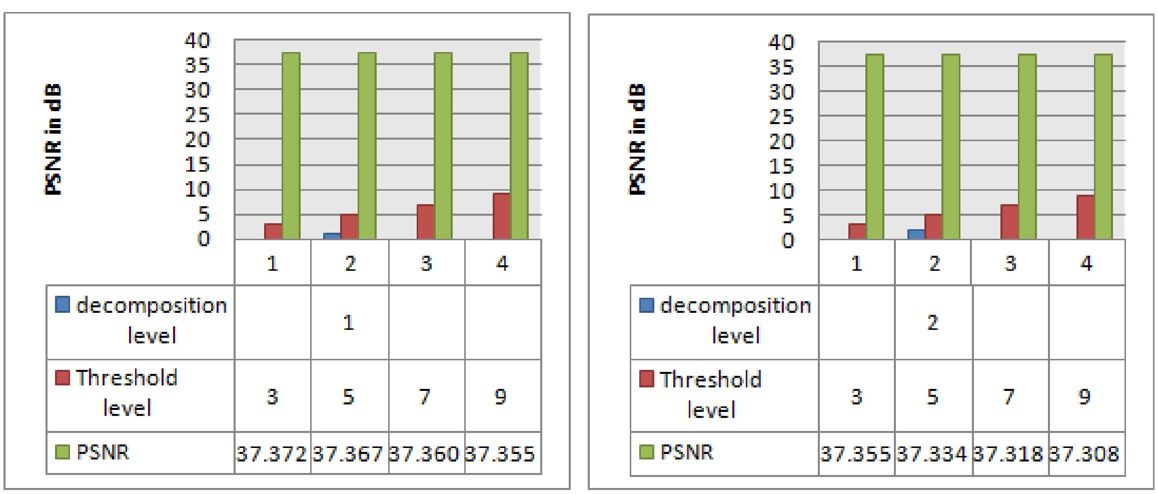


Fig8. PSNR analysis of original and reconstructed images with Haar wavelet for different threshold values and decomposition levels



ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

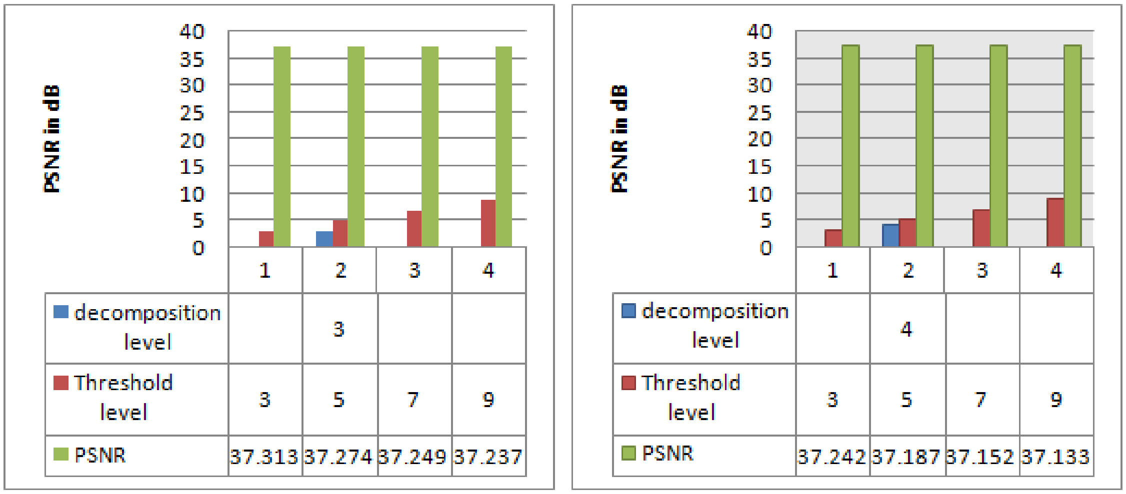


Fig9. PSNR analysis of original and reconstructed images with Biorthogonal wavelet for different threshold values and decomposition levels

The comparison of PSNR saying that the biorthogonal wavelet has performing well in terms of image quality after decompressing or reconstructing an image from the compressed image, and when we compare the same image with the original input image.

5. CONCLUSION

Here in this thesis, we had implemented and performed a simple discrete wavelet thresholding based 3D MR image compression also analyzed the performance of proposed scheme with both Haar and biorthogonal wavelet decompositions at different levels and with various threshold values. Simulation results shows that when the CR is much high, at that level quality of image is less when compared to the less CR level. However, it has given that the Haar wavelet has being performed well in terms of compression ratio and biorthogonal has been performed better with quality of image after reconstructing the image from the compressed image.

REFERENCES

1. Hui, L. An adaptive block truncating coding algorithm for image compression, *IEEE International Conference on ICASSP*, *Albuquerque, NM*, Vol.4, pp: 2233-2236, 1990.

2. Ahn, C.B.; Kim, I.Y.; Han, S.W., Medical image Compression Using JPEG Progressive Coding, IEEE *International Conference on Nuclear Science Symposium and Medical Imaging Conference*, pp: 1336-1339, 1994

3. Wang Shengke, Wang Zhiyan, Zhang Yanqig, An efficient image compression scheme for air tickets storage, *IEEE International Conference on Communications, Circuits and Systems*, Vol. 2, pp: 1, 2005.

4. Shaou-Gang Miaou, Fu-Sheng Ke, Shu-Ching Chen, *A Lossless Compression Method for Medical Image Sequences Using JPEG-LS Interface Coding*, IEEE Transaction on Information Technology in Biomedicine, Vol. 13, No. 5, pp: 818-821, 2009.

5. Yuebing Jiang, Pattichis, M.S., JPEG image compression using quantization table optimization based on perceptual image quality assessment, *Conference record of the 45th Asilomar Conference on Signals, Systems and Computers*, pp: 225-229, 2011.

6. Li, K., Xiao-Ping Zhang, An image watermarking method integrating with JPEG-2000 still image compression standard, *IEEE Canadian Conference on CCECE*, Vol. 3, pp: 2051-2054, 2003.

7. Paul G. Howard, Jeffrey Scott Vitter, *Arithmetic Coding for Data Compression*, Proceedings of IEEE, vol. 82, No. 6, pp: 857-865, 1994.

8. Howard, P.G. ; Vitter, J.S., Parallel lossless image compression using Huffman and arithmetic coding, *IEEE Data Compression Conference*, pp: 299-308, 1992.

9. Debin Zhao, Y. K. Chan, Wen Gao, *Low-Complexity and Low-memory entropy coder for Image Compression*, IEEE Transaction on CSVT, vol. 11, no. 10, pp: 1140-1145, 2001.

10. Rufai, A.M., Anbarjafari, G., Demirel, H., Lossy medical image compression using Huffman coding and singular value decomposition, 21st *IEEE Conference on Signal Processing and Communications Applications*, pp: 1-4, 2013.

11. Puandolini, R., On EZW encoding of surveillance imagery matched for spatial scale on viewer resolution, *IEEE 5th International Symposium on Signal Processing and Its Applications*, vol. 1, pp: 289-292, 1999.

12. Nagamani, K. ; Ananth, A., Study of EZW compression techniques for high and low resolution satellite imageries, *IEEE International Conference on Computing Communication and Networking Technologies*, pp: 1-7, 2010.

13. Sonja Grgic, Mislav Grgic, and Branka Zovko-Cihlar, "Performance Analysis of Image Compression using Wavelets", *IEEE Trans. On industrial Electronics*, Vol. 48, No. 3, June 2001

14. W. R. Tettler, J. Huffman and D. C. P. Linden, "Application of compactly supported wavelets to image compression", *Proceeding SPIE-1244*, 1990, pp. 150-160.

15. E.Yeung, "Image compression using wavelets", Waterloo, Canada N2L3G1, IEEE, CCECE, 1997.

16. Amir Averbuch, Danny Lazar, and Moshe Israeli "Image Compression using Wavelet Transform and Multi resolution Decomposition", *IEEE Trans. on Image Processing*, vol. 5, No. 1, January 1996.

17. Robinson, J., Kecman, V.: *Combing Support Vector Machine Learning with the Discrete Cosine Transform in Image Compression*. IEEE Transactions on Neural Networks, Vol. 14, No 4(2003) 950–958