ISSN: 2321-8169
2277 – 2284

# Wavelet Based Performance Analysis of Image Compression

Md. Taslim Arefin[1], Md. Zahirul Islam[1], Md. Asaduzzaman Khan[2], Md. Mahfujur Rahman[1] , A.S.M Shaem[1]

[1]Dept. of Electronics and Telecommunication Engineering
Faculty of Engineering
Daffodil International University
Dhaka, Bangladesh
*E-mail: arefin@daffodilvarsity.edu.bd,*
*zahirete@daffodilvarsity.edu.bd*
*mahfuj.ete@daffodilvarsity.edu.bd*

[2]Dept of Computer Science and Engineering
Leading University
Sylhet, Bangladesh
*E-mail: nepon_1979@yahoo.com*

*Abstract*—In this paper, our aim is to compare for the different wavelet-based image compression techniques. The effects of different wavelet functions filter orders, number of decompositions, image contents and compression ratios were examined. The results of the above techniques WDR, ASWDR, STW, SPIHT, EZW etc., were compared by using the parameters such as PSNR, MSE BPP values from the reconstructed image. These techniques are successfully tested by four different images.

***Keywords***- *Image compression, WDR, STW, PNSR*

*****

## I. INTRODUCTION

Present day large amounts of images are stored, processed and transmitted and hence there is a great need for the compression of an image to save memory, transmission bandwidth etc. For many applications, simply reducing the file size or simple compression is not sufficient some additional scalable and embedded properties are also required. Discrete Wavelet Transform (DWT) provides a multi resolution image representation and has become one of the most important tools in image analysis and coding over the last two decades.[1] Wavelet transforms have been widely studied over the last decade. At the present state technology, the only solution is to compress multimedia data before its storage and transmission, and decompress it at the receiver for playback. For example for a compression Ratio of 32:1 ,the space, bandwidth and the transmission time requirements can be reduced by a factor of 32,with acceptable quality. The fundamental goal of image compression is to reduce the bit rate for transmission or storage while maintaining an acceptable fidelity or image. One of the most successful applications of wavelet methods is transform-based image compression (also called coding).Wavelet-based coding provides substantial improvements in picture quality at higher compression ratios. This paper presents the Analysis of different wavelet based image compression Techniques. The existing Techniques, WDR, ASWDR, STW, SPHIT, EZW have been introduce and evaluated based on the parameters like PSNR, MSE, BPP. Acceptable image quality has been extracted in terms of the performance parameter and coding technique [3]. The result is extracted from the experiment empirically and shows that the EZW and STW technique performs better than WDR and other method in terms of the parameters. The analysis has been tested and verified Using MATLAB.

## II. WORKING METHODOLOGY

Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times.

As a mathematical tool, wavelets can be used to extract information from many different kinds of data, including – but certainly not limited to – audio signals and images. Sets of wavelets are generally needed to analyze data fully. A set of "complementary" wavelets will deconstruct data without gaps or overlap so that the deconstruction process is mathematically reversible. Thus, sets of complementary wavelets are useful in wavelet based compression/decompression algorithms where it is desirable to recover the original information with minimal loss. There are many compression methods in wavelet section like:

- EZW (Embedded Zero tree Wavelet)
- SPIHT (Set Partitioning in Hierarchical Trees)
- STW (Spatial-orientation Tree Wavelet)
- WDR (Wavelet Difference Reduction)
- ASWDR (Adaptively Scanned Wavelet Difference Reduction)

We have use those methods in this work and also checked performance analysis in different situation. The basic scheme for compressing images is shown in Figure 1 below. Compression consists of two steps to generate a compressed bit stream.

The rest step is a wavelet transform of the image and the second step is the compressed encoding of the image’s wavelet transform. Decompression simply consists of reversing these two steps, decoding the compressed bit stream to produce an (approximate) image transform. In the block diagram the total procedure is shown by flow chart in figure 1 and then described.

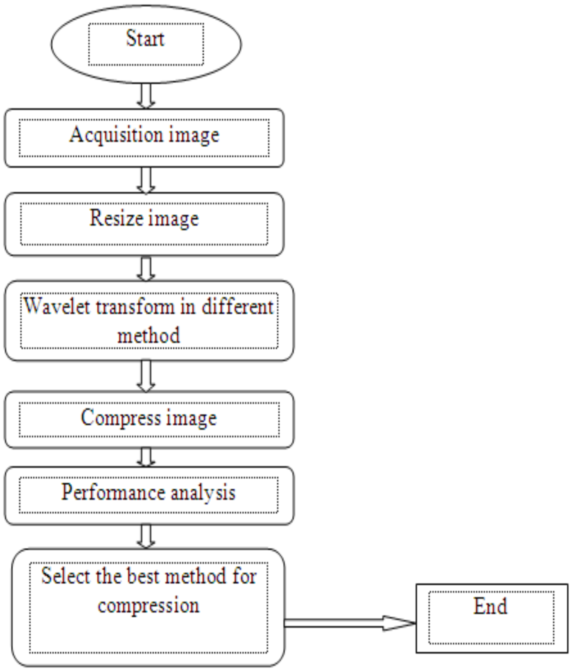



Fig 1: Basic scheme for compressing images

- At first some image has been taken from the camera.
- Then it's sent through the MATLAB basement and then resizes it to "512*512*3 "format because we know that for true compression, it is necessary to keep the size of rows and columns in the power of 2.
- Then take the Haar wavelet for compression then apply different types of method like as EZW, SPHIT, WDR, ASWDR, STW etc.
- Then It has been compared between different method and select the best method for compression here 4 photos are taken and then analyst it.

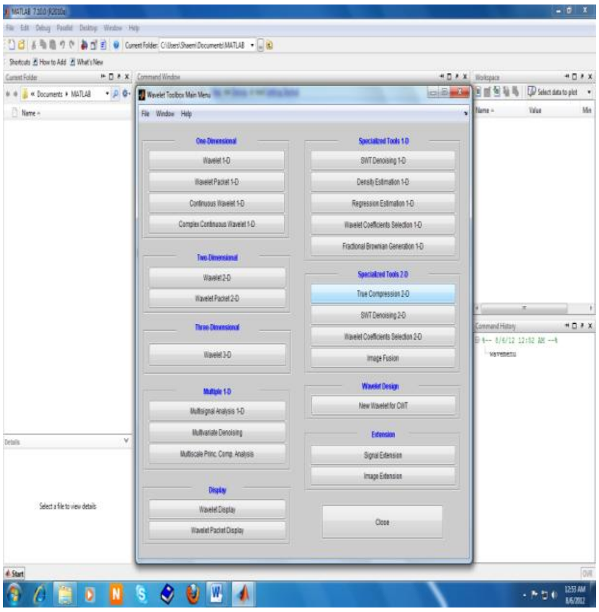


Figure 2a: Screen shot of the wavelet menu

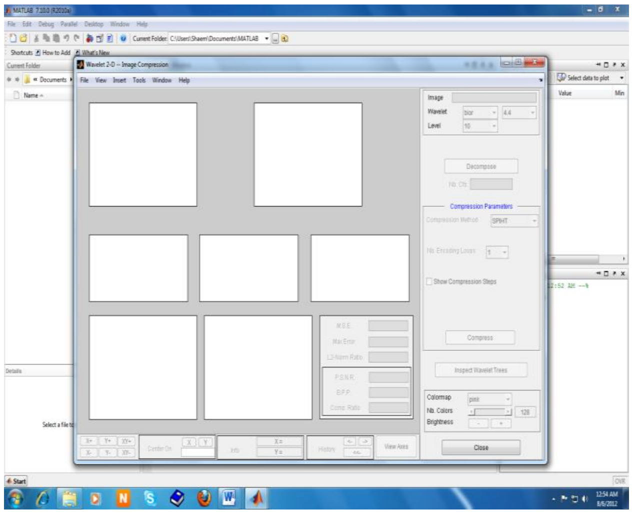


Figure 2b: MATLAB 2-D image compression interface

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, as discussed later, have been developed and implemented. Because of the many advantages, wavelet-based compression algorithms are the suitable candidates for the new JPEG-2000 standard. This is lossy compression. In many cases, it is not necessary or even desirable that there be error-free reproduction of the original image. Lossy compression is also acceptable in fast transmission of still images over the Internet. Over the past few years, a variety of novel and sophisticated wavelet-based image coding schemes have been developed. These include Embedded Zero tree Wavelet (EZW), Set-Partitioning in Hierarchical Trees (SPIHT), Wavelet Difference Reduction (WDR), Adaptively Scanned Wavelet Difference Reduction (ASWDR), and STW. This list is by no means exhaustive and many more such innovative techniques are being developed. A few of these algorithms are briefly discussed here.

## III. PERFORMANCE ANALYSIS

In this section the overall performance analysis will be discussed using different wavelet method like as EZW, SPIHT, WDR, ASWDR and STW etc. Before starting the work, our purpose in discussing the baseline compression algorithm was to introduce some basic concepts, such as scan order, effects of different wavelet functions filter orders, number of decompositions, image contents and compression ratios, P.S.N.R, B.P.P were examined, which are needed for my examination of the algorithms to follow.

**4.1 Embedded Zero tree Wavelet (EZW):** The EZW algorithm was one of the first algorithms to show the full power of wavelet-based image compression. It was introduced in the groundbreaking paper of Shapiro. An EZW encoder is an encoder specially designed to use with wavelet transforms. The EZW encoder is based on progressive encoding to compress an image into a bit stream with increasing accuracy [5].

 ISSN: 2321-8169
2277 – 2284

TABLE-1: Compression ratio Bit per pixel and PSNR Result for 512*512*3 image.

| Size | Level | CR | PSNR | BPP |
|---|---|---|---|---|
| 512*512 | 2 | 81.58 | 58.69 | 6.528 |
| 512*512 | 2 | 89.04 | 59.76 | 7.1232 |
| 512*512 | 2 | 58.07 | 51.95 | 4.6458 |
| 512*512 | 2 | 74.17 | 57.85 | 5.93 |

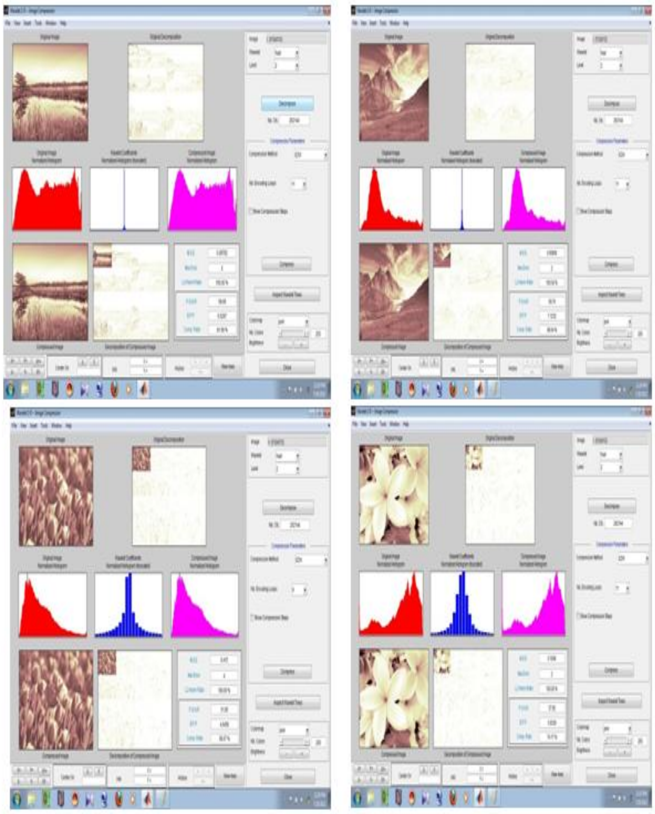


Figure: 3a Compress screenshot of four images using in EZW method

### 4.2 Set Partitioning in Hierarchical Trees (SPIHT)

SPIHT is a wavelet-based image compression coder. It first converts the image into its wavelet transform and then transmits information about the wavelet coefficients. The decoder uses the received signal to reconstruct the wavelet and performs an inverse transform to recover the image. We selected SPIHT because SPIHT and its predecessor, the embedded zero tree wavelet coder, were significant breakthroughs in still image compression in that they offered significantly improved quality over vector quantization, JPEG, and wavelets combined with quantization, while not requiring training and producing an embedded bit stream [4] .

TABLE-2: Compression ratio Bit per pixel and PSNR Result for (512*512*3) image.

| Sze | Level | CR | PSNR | BPP |
|---|---|---|---|---|
| 512*512 | 2 | 46.71 | 38.87 | 3.737 |
| 512*512 | 2 | 47.53 | 39.32 | 3.8028 |
| 512*512 | 2 | 39.16 | 39.9 | 3.13 |
| 512*512 | 2 | 35.73 | 40.74 | 2.8585 |

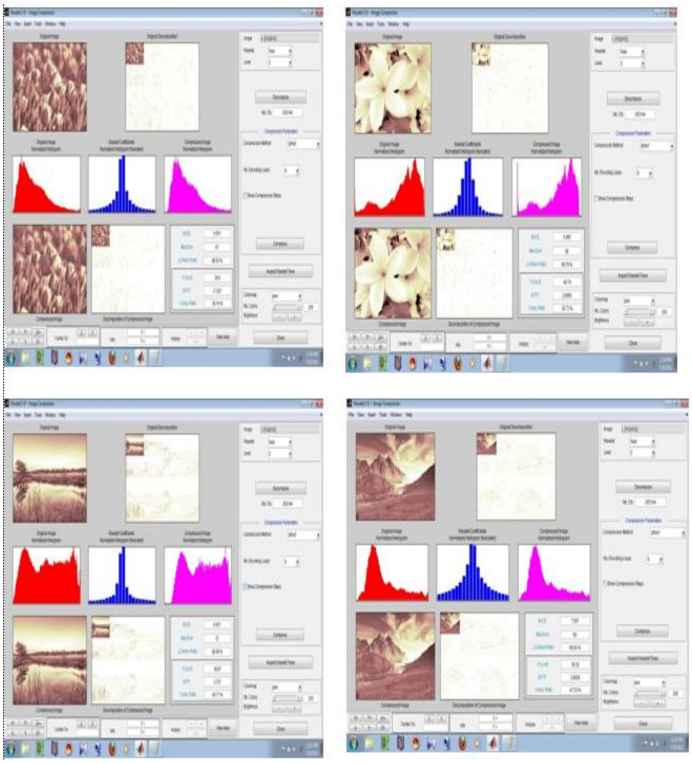


Figure: 3b Compress screenshot of four images using in SPIHT method

**Wavelet Difference Reduction (WDR):** One of the defects of SPIHT is that it only implicitly locates the position of significant coefficients. This makes it difficult to perform operations which depend on the position of significant transform values, such as region selection on compressed data. Region selection, also known as region of interest (ROI), means a portion of a compressed image that requires increased resolution [2].

TABLE-3: Compression ratio Bit per pixel and PSNR Result for (512*512*3) image.

| Size | Level | CR | PSNR | BPP |
|---|---|---|---|---|
| 512*512 | 2 | 80.02 | 40.16 | 6.4012 |
| 512*512 | 2 | 89.14 | 41.33 | 7.131 |
| 512*512 | 2 | 67.23 | 41.61 | 5.37 |
| 512*512 | 2 | 62.00 | 42.84 | 4.95 |

ISSN: 2321-8169
2277 – 2284

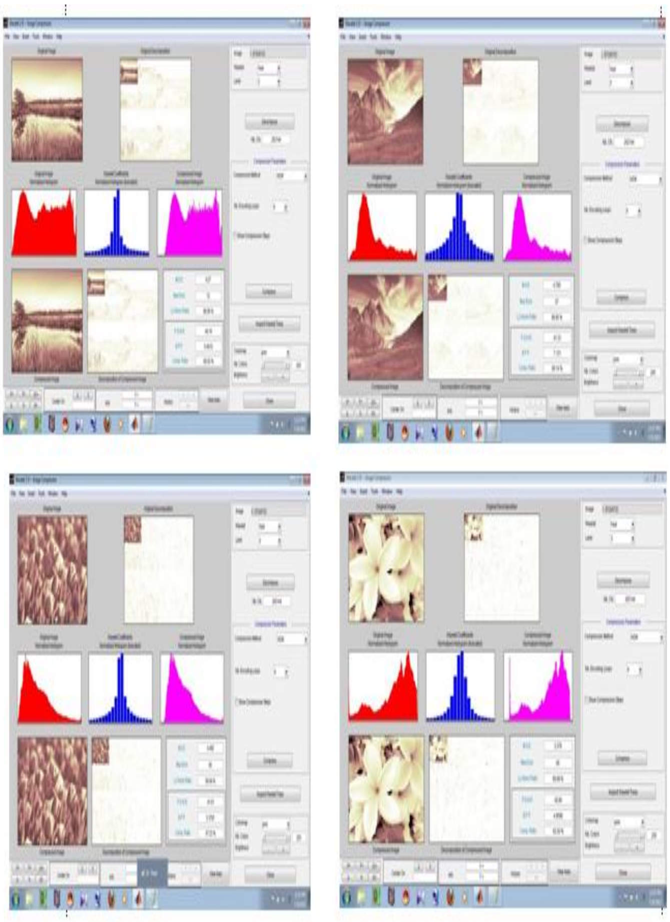


Figure: 3c Compress screenshot of four images using in WDR method

### Adaptively Scanned Wavelet Difference Reduction (ASWDR)

The ASWDR algorithm aims to improve the subjective perceptual qualities of compressed images and improve this result of objective distortion measures. We shall treat two distortion measures, PSNR and edge correlation, which we shall define in the section or experimental results. PSNR is a commonly used measure of error, while edge correlation is a measure that we have found useful in quantifying the preservation of edge details in compressed images, and seems to correspond well to subjective impressions of the perceptual quality of the compressed images. [2]

TABLE-4: Compression ratio Bit per pixel and PSNR Result for (512*512*3) image.

| Size | Level | CR | PSNR | BPP |
|---|---|---|---|---|
| 512*512 | 2 | 76.22 | 40.16 | 6.0975 |
| 512*512 | 2 | 84.64 | 41.33 | 6.7708 |
| 512*512 | 2 | 62.88 | 41.61 | 5.0306 |
| 512*512 | 2 | 59.27 | 42.84 | 4.7419 |

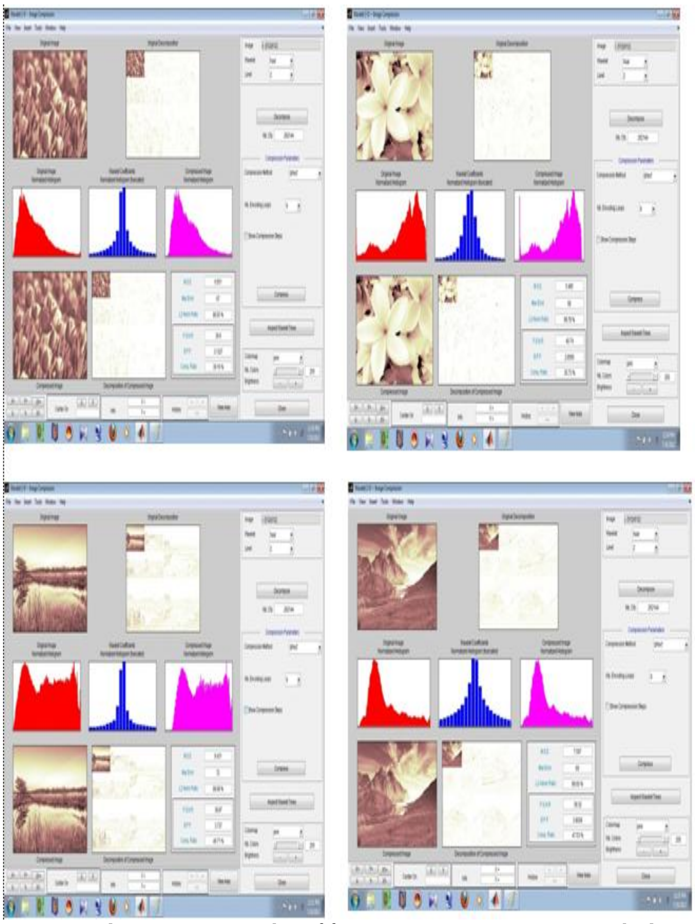


Figure: 3d Compress screenshot of four images using in ASWDR method

### 4.5 Spatial-orientation Tree Wavelet (STW)

STW is essentially for the SPIHT algorithm. The only difference is that SPIHT is slightly more careful in its organization of coding output. Second, we describe the SPIHT algorithm. It is easier to explain SPIHT using the concepts underlying STW. Third, we see how well SPIHT compresses images. The only difference between STW and EZW is that STW uses a different approach to encoding the zero tree information. STW uses a state transition model. From one threshold to the next, the locations of transform values undergo state transitions. This model allows STW to reduce the number of bits needed for encoding. Instead of code for the symbols R and I output by EZW to mark locations, the STW algorithm uses states IR, IV , SR, and SV and outputs code for state-transitions such as IR → IV , SR → SV , etc.

TABLE-5: Compression ratio Bit per pixel and PSNR Result for (512*512*3) image.

| Size | Level | CR | PSNR | BPP |
|---|---|---|---|---|
| 512*512 | 2 | 54.37 | 47.52 | 4.3497 |
| 512*512 | 2 | 58.55 | 45.91 | 4.68 |
| 512*512 | 2 | 41.87 | 46.53 | 3.34 |
| 512*512 | 2 | 37.74 | 45.45 | 3.019 |

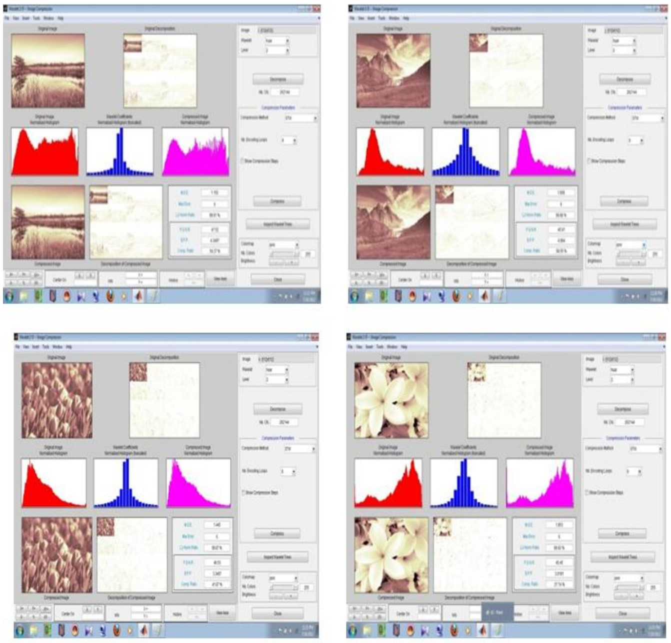


Figure: 3e Compress screenshot of four images using in STW method

## IV. SIMULATION AND RESULTS

In this paper it have been said that the overall performance of the four images are shown in the below table. Here we have been said that, in case of EZW method MSE is 0.0868 & PSNR is 58 & BPP is 6.5267. For SPIHT method, MSE is 7.04 & PSNR is 39.50 & BPP is 3.379. For STW method, MSE is 1.6& PSNR is 45.91 & BPP is 3.84. For WDR method, MSE is 4.72& PSNR is 41.29& BPP is5.97. For ASWDR method, MSE is 4.752 & PSNR is 41.49 & BPP is5.660.Among all these methods, EZW are best performed though STW is averagely good as compared to the other method.

TABLE-6: Total Analytical Result for (512*512*3) image.

| | EZW (a,b,c,d) | SPIHT (a,b,c,d) | STW (a,b,c,d) | WDR (a,b,c,d) | ASWDR (a,b,c,d) |
|---|---|---|---|---|---|
| M.S.E | 0.08782 | 8.431 | 1.152 | 6.27 | 6.27 |
| | 0.6868 | 7.597 | 1.668 | 4.785 | 4.875 |
| | 0.415 | 6.651 | 1.445 | 4.492 | 4.492 |
| | 0.1068 | 5.485 | 1.853 | 3.378 | 3.378 |
| P.S.N.R | 58.69 | 38.87 | 47.52 | 41.33 | 40.16 |
| | 59.76 | 39.32 | 45.91 | 39.38 | 41.33 |
| | 51.95 | 39.1 | 46.53 | 41.61 | 41.61 |
| | 57.85 | 40.74 | 45.45 | 42.84 | 42.84 |
| B.P.P | 6.5267 | 3.737 | 4.3497 | 6.4012 | 6.0975 |
| | 7.1232 | 3.8028 | 4.684 | 7.131 | 6.7708 |
| | 4.6458 | 3.1327 | 3.3497 | 5.3781 | 5.0306 |
| | 5.9339 | 2.8585 | 3.0191 | 4.9598 | 4.7419 |

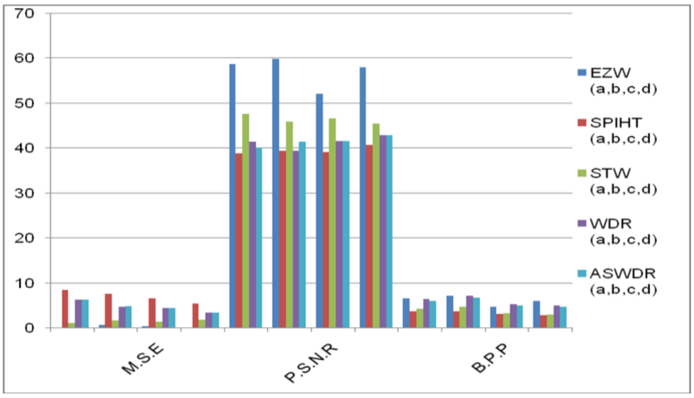



Figure: 4 Graph 1(For total analytical result)

The graph in figure 4 represents that the overall performance for different method. Here it has been seen that among the five methods, EZW perform better than other method here MSE of EZW method is lower and peak signal to noise ratio is higher than the other method. The below table state that the average performance for five method here different types of parameter like as compression ratio, Peak signal to noise ratio and Bit per pixel have been discussed.

TABLE-7: Average Result for 4 (512*512*3) image

| | WDR | ASWDR | EZW | SPIHT | STW |
|---|---|---|---|---|---|
| CR | 74.597 | 70.7525 | 75.715 | 42.29075 | 48.1325 |
| PSNR | 41.485 | 41.485 | 57.0625 | 39.5075 | 41.29 |
| BPP | 5.963 | 5.6602 | 6.0574 | 3.38275 | 3.850625 |
| MSE | 4.73125 | 4.73125 | 0.324105 | 7.041 | 1.5295 |

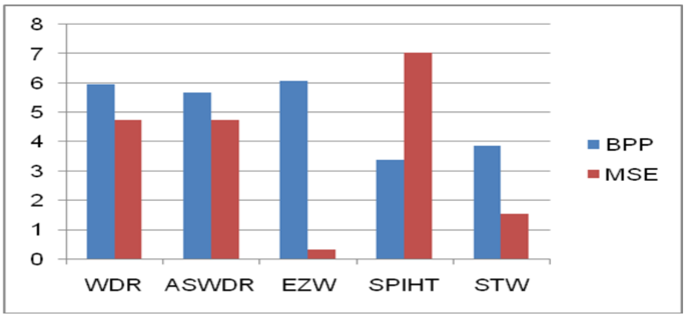



Figure: 5a Graph 2 (For BPP vs.MSE)

In figure 5a the graph represents that the average compares between Bit per pixel and Mean square error for different method .here it have been seen that for EZW method the mean square error is lesser then the another method where the Bit per pixel is medium.

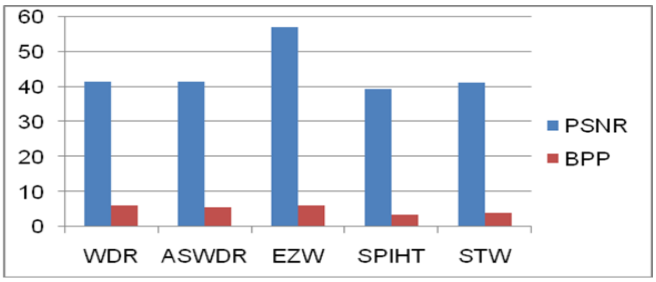



Figure: 5b Graph 3 (For BPP vs. PSNR)

In the figure 5b two types of parameter have been discussed and compare between them here it has been seen that the peak signal to noise ratio is higher than the others method where the Bit per pixel is lower

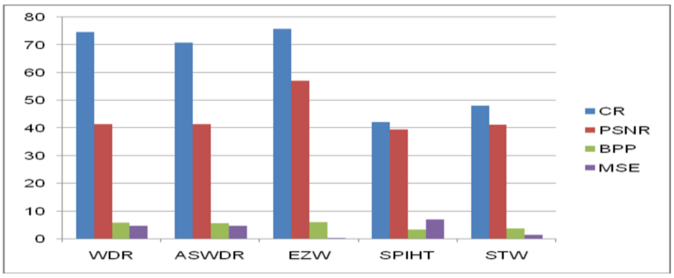



Figure: 5c Graph 4 (Overall performance for CR, PSNR, BPP, MSE)

In the graph in figure 5c represents that the overall performance for CR, PSNR, BPP, MSE. And it have been seen that for EZW method BPP is lower where PSNR is higher than the other method so in case of the total overall performance analysis it has been said that EZW perform better than other.

## MATLAB Analysis

The figure 6a shows B.P.P VS. MSE The simulation result of the graph represents that EZW performed best among all other method .Here B.P.P & M.S.E is less for EZW and all the other method does not perform as well.

The Figure 6b shows B.P.P VS PSNR The simulation result of the second graph represents that EZW is perform best as compared to other method. Here B.P.P is less as well M.S.E. is less that time P.S.N.R is high and it shows maximum output performance.

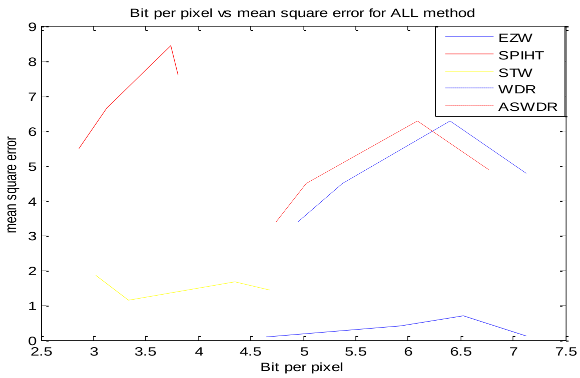



Figure 6a: Bit per Pixel vs. Mean Square error.

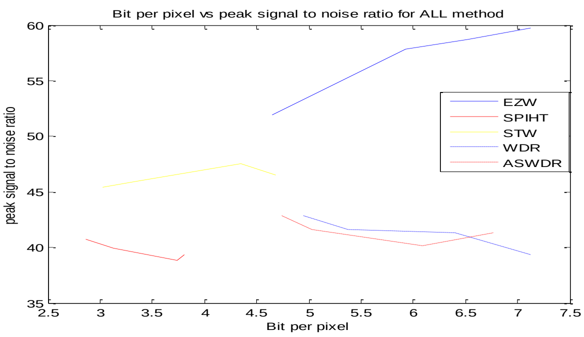



Figure :6b: Bit per Pixel vs. Peak Signal to Noise Ratio.

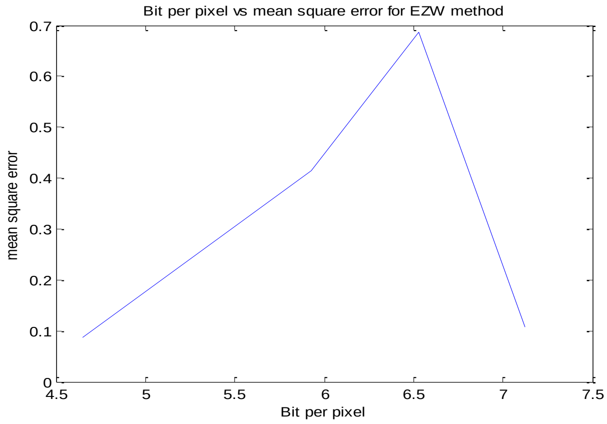



Figure 7a: BPP vs. MSE for EZW method

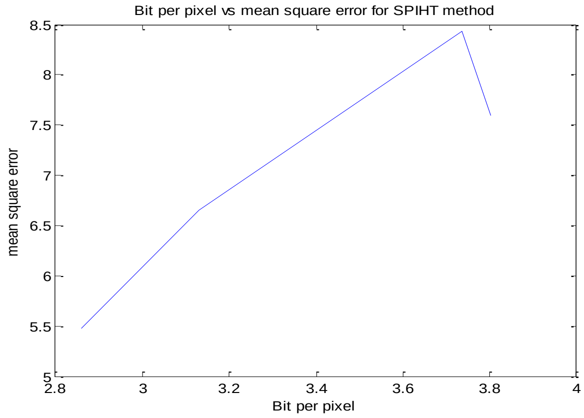



Figure 7b: BPP vs. MSE for SPIHT method

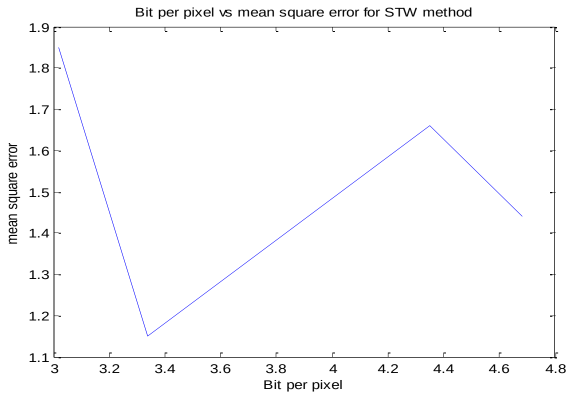
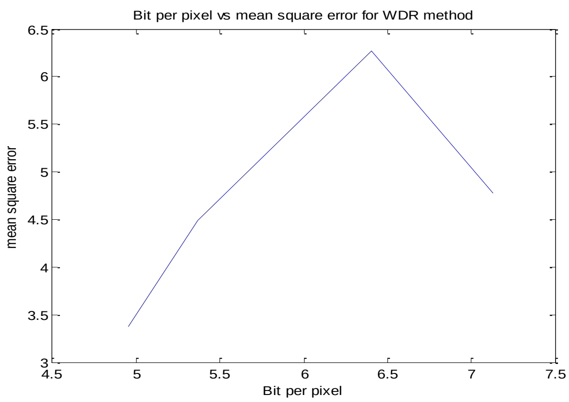



Figure 7c : BPP vs. MSE for STW method



ISSN: 2321-8169
2277 – 2284

Figure 7d : BPP vs. MSE for WDR method

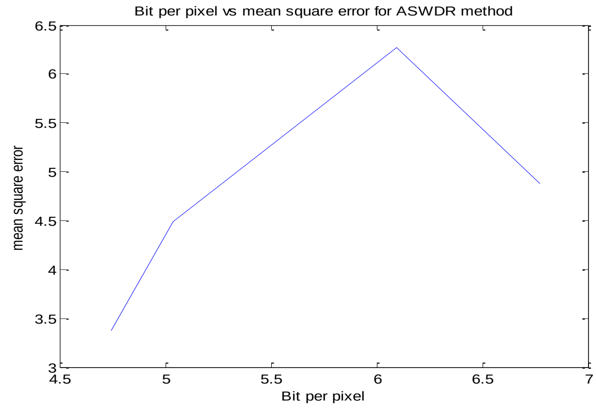



Figure 7e: BPP vs. MSE for ASWDR method

Figure: 7 a- 7e : Graphical representation of four images in five methods. Figure: 8: Graphical representation of BPP vs. MSE for all Methods

In the figure it have been seen that BPP vs. MSE compares where in 4.5 to 6 BPP the MSE is lower in EZW method but other method its higher up to 9.5 where EZW method the MSE is .08 to 1.5.

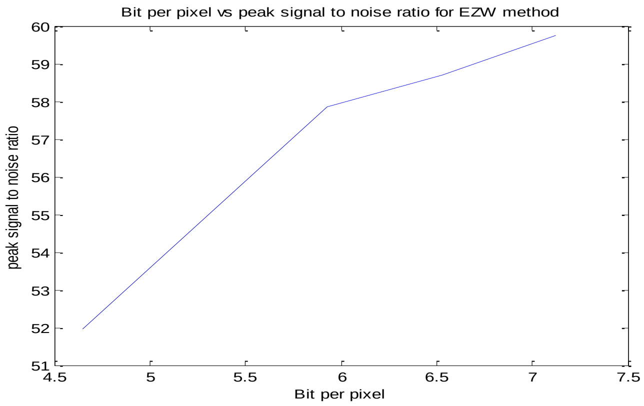



Figure 8a : BPP vs. PSNR for EZW method

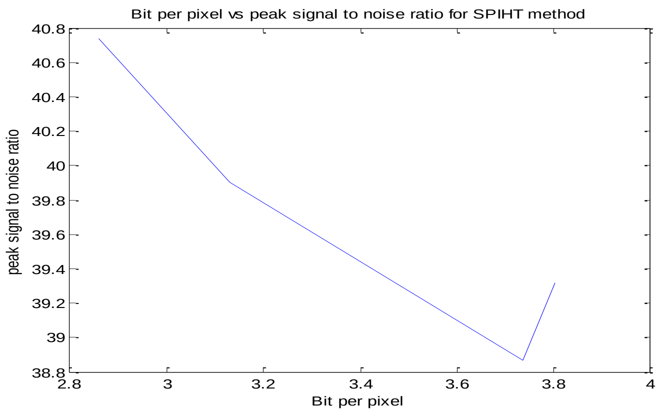



Figure 8b : BPP vs. PSNR for SPIHT method

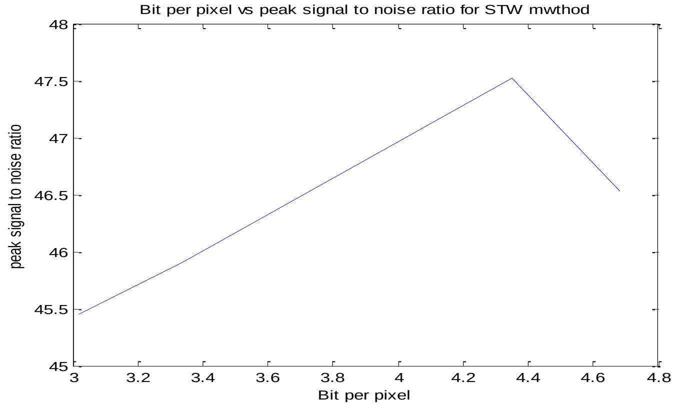



Figure 8c: BPP vs. PSNR for STW method

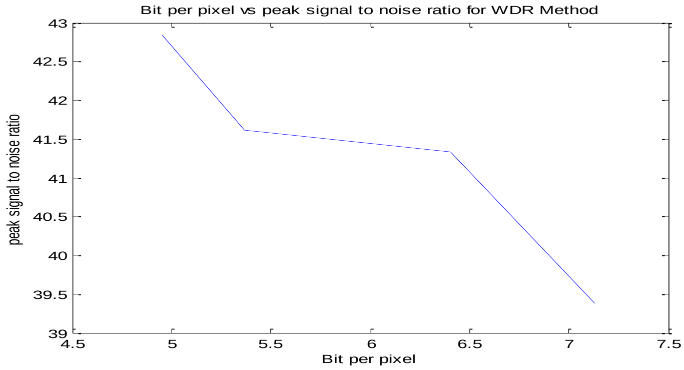



Figure 8d: BPP vs. PSNR for WDR method

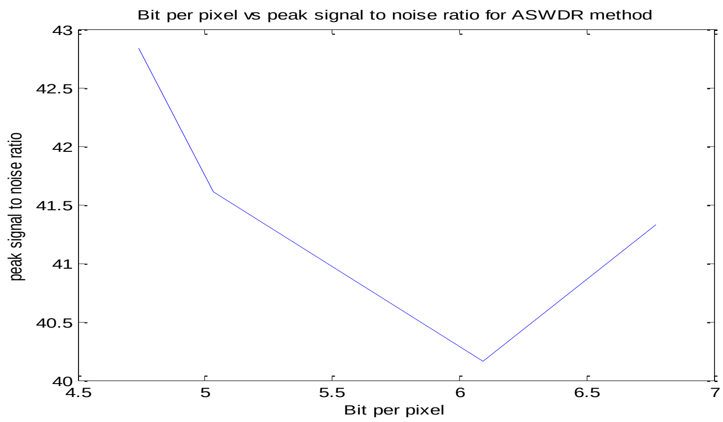



Figure 8e : BPP vs. PSNR for ASWDR method

Figure: 8a – 8e: Graphical representation of BPP vs. PSNR for all methods

The figure represents that the Bit per Pixel vs. Peak signal to noise ratio in different method. Here it have been seen that for EZW method is performed from 4.5 to 6 the PSNR is higher and it almost 58.44.In case of other method we see for 4.5 to 6 BPP the PSNR not more than 45 .so Here the individual EZW method performed better.

From the analysis it have been seen that, the various features of the main coding schemes are summarized. The latest coding techniques such as EZW perform better than the other method.

ISSN: 2321-8169
2277 – 2284

Here we see that from the EZW method we can get the maximum peak signal to noise ratio and low Bit per pixel.

## V. CONCLUSION

In this paper, the results were compared for the different wavelet-based image compression techniques. The effects of different wavelet functions filter orders, number of decompositions, image contents and compression ratios were examined. The results of the above techniques WDR, ASWDR, STW, SPIHT, EZW etc., were compared by using the parameters such as PSNR, MSE BPP values from the reconstructed image. These techniques are successfully tested in many images. The experimental results show that the EZW technique performs better than the WDR & other method in terms of the performance parameters and coding time with acceptable image quality. From the experimental results, it is identified that the PSNR values from the compressed images by using EZW compression is higher than other compression. And also it is shown that the MSE values from the reconstructed images by using EZW compression are lower than other compression. Finally, it is identified that EZW compression performs better when compare to WDR, ASWDR and other compression

## REFERENCES

[1] V. R. Algazi, R. R. Estes. "Analysis based coding of image transform and sub band coefficients," Applications of Digital Image Processing XVIII, volume 2564 of SPIE Proceedings, pages 11-21, 1995.

[2] S.P.Raja1, Dr. A. Suruliandi2, Image Compression using WDR & ASWDR Techniques with different Wavelet Codecs, Proc. of Int. Conf. on Advances in Computer Engineering 2011.

[3] Strang, G. and Nguyen, T. Wavelets and Filter Banks, Wellesley-Cambridge Press, Wellesley, MA, 1996, http://www-math.mit.edu/~gs/books/wfb.html.

[4] R.Sudhakar, Ms R Karthiga, S.Jayaraman, Image Compression using Coding of Wavelet Coefficients – A Survey,ICGST-GVIT journal, volume(5), issue(6),june 2005

[5] James S. Walker, A Lossy Image Codec Based on Adaptively Scanned Wavelet Difference Reduction.