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Comparative Analysis of Wavelet Based Image Compression Techniques

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Abstract

This paper presents the comparative analysis of different wavelet based image compression techniques. The existing techniques, WDR, ASWDR, STW, SPHIT, and EZW have been discussed and evaluated based on the parameters like PSNR, MSE, and BPP. Acceptable image quality has been extracted in terms of the performance parameter and coding technique. The result is extracted from the experiment empirically and shows that the EZW and STW technique performs better then WDR and other methods in terms of the parameters. The analysis has been tested and verified Using MATLAB.

1. INTRODUCTION

Present day a lot of images are stored, and hence there is a great need for the stress of an image to preserve storage space, sign data transfer use age etc. For many applications, simply reducing the excellent or easy stress is not sufficient some additional scalable and provided features are also necessary [1]. Discrete Wavelet Transform (DWT) provides a multiple quality picture counsel and has become one of the most essential resources in picture research and programming over the last two decades.[2] Wavelet changes have been commonly examined over the last several years [3]. At the present state technological innovation, the only solution is to constrict multi-media information before its storage space and indication, and relax it at the device for play-back. For example for a pressure Rate of 32:1 ,the space, bandwidth and the indication time specifications can be decreased by a aspect of 32,with appropriate quality.[4].

The basic scheme for compressing images is shown in Figure 1 below.

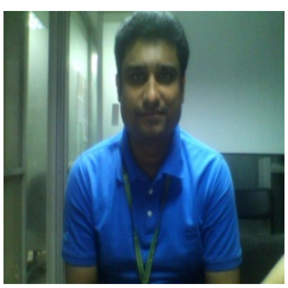

Fig: A

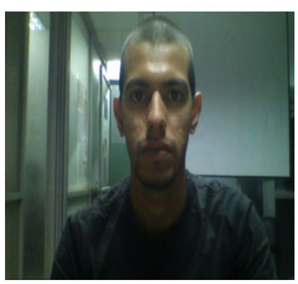

Fig: B

Fig: C

Fig: D

Figure-1: Different Images of compression

In many situations, it is not necessary or even suitable that there be error-free imitation of the unique picture. Lossy pressure is also suitable in quick indication of still pictures over the Online [5]. Over modern times, a variety of novel and sophisticated wavelet-based image programming systems have been developed. These include Included Zero shrub Wavelet (EZW) [6], Set-Partitioning in Ordered Plants (SPIHT) [4], Wavelet Change Decrease (WDR), Adaptively Looked at Wavelet Change Decrease (ASWDR), Pressure with Undoable Embedded Wavelet (CREW) [3], Embedded Predictive Wavelet Image Coder (EPWIC)[5]. This record is under no circumstances thorough and many more such modern methods are being designed. A few of these methods are temporarily mentioned here [5].

2. THEORY

Two of the error statistics used to assess the various image stress techniques are the Mean Squire Error (MSE) and the best Peak Signal to Noise Ratio (PSNR). The MSE is the final squared Error between the compacted and the unique picture, whereas PSNR is an evaluation of the optimum mistake. The statistical treatments are given below

Error E = Original image – Reconstructed image

MSE = E / (SIZE OF IMAGE)

$$PSNR=20*\log_{10}\left(\frac{255}{\sqrt{MSE}}\right)$$

A reduced value for MSE indicates smaller mistake, and as seen from the inverse regards between the MSE and PSNR, this results in a very great value of PSNR. Practically, a greater value of PSNR is excellent because this implies that the rate of indication to disturbance is greater. Here, the 'signal' is the unique picture, and the 'noise' is the mistake in renovation. So, a pressure program having a reduced MSE (and a very great PSNR), can be identified as a better one.

3. PERFORMANCE ANALYSIS

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. The working procedure block diagram is given below.

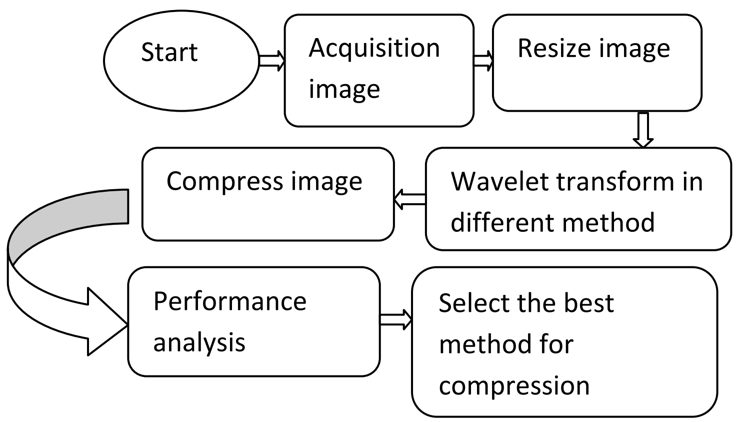

Figure 2: Block diagram of compression

The working algorithm is given below

- At first some images have been taken from the camera.
- Then it's sent through the MATLAB basement and then resizes it to "128*128*3 "format because it is well known that for true compression, it is necessary to keep the size of rows and columns in the power of 2.
- Then the Haar wavelet is taken for compression then applies different types of method like as EZW, SPHIT, WDR, ASWDR, STW etc.
- After the compression, it has been compared among different methods and the best method is selected for compression.

3.1 Embedded Zero tree Wavelet (EZW)

The EZW algorithm [4] was one of the first methods to demonstrate the complete energy of wavelet-based picture pressure. It was presented in the innovative document of Shapiro [5]. An EZW encoder [7] is an encoder specifically developed to use with wavelet changes. The EZW encoder is according to modern development to constrict a picture into a bit flow with improving Accuracy

In the table 1, the result of compression ratio using EZW algorithm for 4 images A, B, C, and D of size 128*128*3 is shown. EZW encoder does not really compress anything; it only reorders wavelet coefficients in such a way that they can be compressed very efficiently.

TABLE-1: Compression ratio Bit per pixel and PSNR Result for 128*128*3 image.

size	Level	CR	PSNR	BPP
128*128	7	8.89	31.31	7.1143
128*128	1	93.18	58.37	7.4541
128*128	1	100.17	58.51	8.0137
128*128	1	89.25	58.56	7.1401

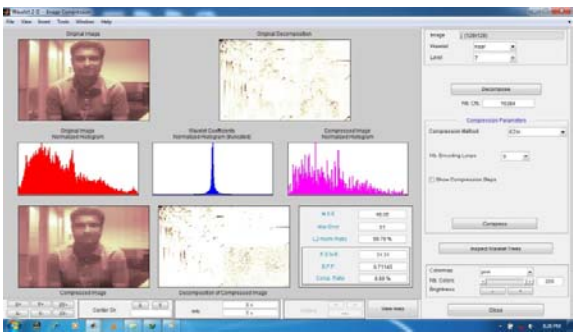

Figure-3: EZW compression for 'A' image

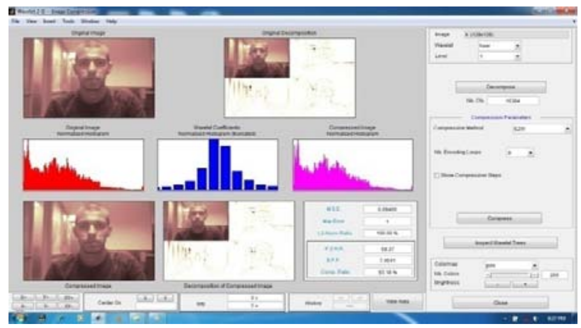

Figure-4: EZW compression for 'B' image

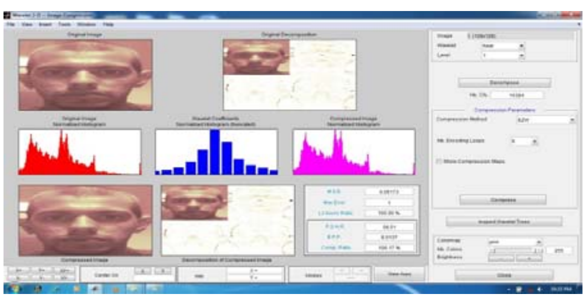

Figure-5: EZW compression for 'C' image

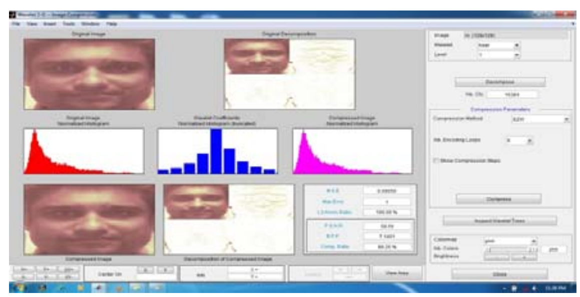

Figure-6: EZW compression for 'D' image

3.2 Set Partitioning in Hierarchical Trees (SPIHT) Coding

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. SPIHT is selected because 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. SPIHT displays exceptional characteristics over several properties all at once including: ·

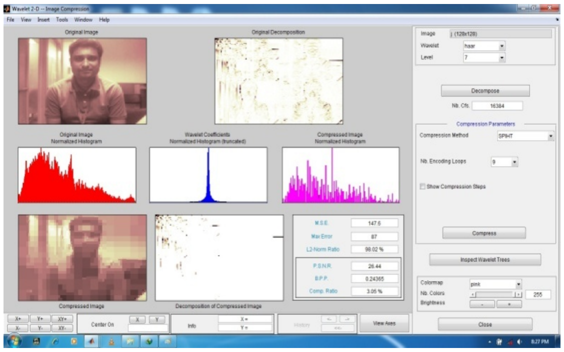

Figure-7: SPIHT compression for A image

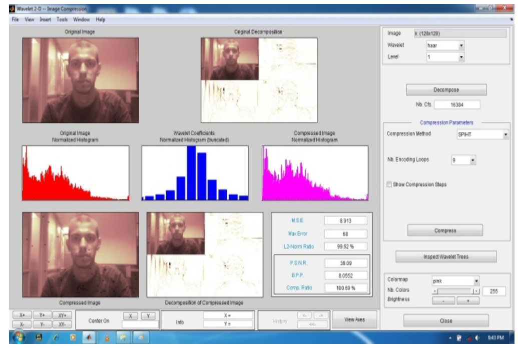

Figure-8: SPIHT compression for B image

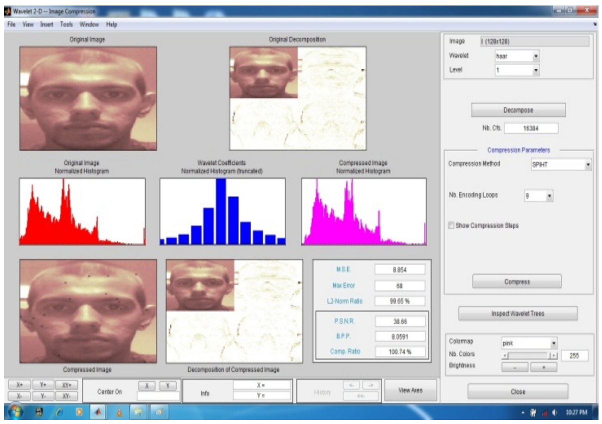

Figure-9: SPIHT compression for ***C*** image

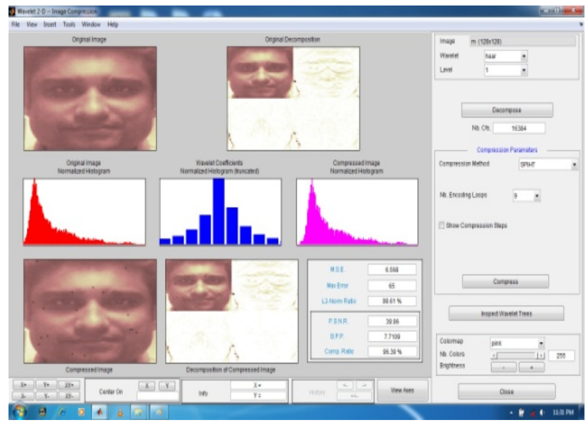

Figure-10: SPIHT compression for ***D*** image

TABLE-2: Compression ratio bit per pixel and PSNR result for 128*128*3 image.

size	Level	CR	PSNR	BPP
128*128	7	8.89	31.31	7.1143
128*128	1	93.18	58.37	7.4541
128*128	1	100.17	58.51	8.0137
128*128	1	89.25	58.56	7.1401

Discrete Wavelet Transform (DWT) runs a high and low-pass filter over the signal in one dimension. The result is a new image comprising of a high and low-pass sub band. The next wavelet level is calculated by repeating the horizontal and vertical transformations on the low-pass sub band from the previous level. The DWT repeats this procedure for however many levels are required. Each procedure is fully reversible (within the limits of fixed precision) so that the original image can be reconstructed from the wavelet transformed image. SPIHT is a method of coding and decoding.

3.3 Wavelet Difference Reduction (WDR)

One of the problems of SPIHT is that it only unconditionally detects the place of considerable coefficients. This makes it difficult to execute functions which rely on the place of considerable convert principles, such as area choice on compacted data. Region choice, also known as area of interest (ROI), means a part of a compacted picture that needs improved quality. The only difference between WDR and bit-plane development is the significant finish. In WDR, the result from the significance finish contains signs of significant concepts along with sequence of pieces which temporarily describe the precise places of significant concepts [4].

3.4 ASWDR

The ASWDR algorithm aims to improve the subjective perceptual qualities of compressed images and improve this result of objective distortion measures. PSNR is a commonly used measure of error, while edge correlation is a measure that it is 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 [8].

High compression ratio images are used in reconnaissance and in medical applications, where fast transmission and ROI are employed, as well as multi-resolution detection. Table-3 shows the improved PSNR values for ASWDR compared to WDR. The WDR and ASWDR algorithms do allow for ROI while SPIHT does not. Furthermore, their superior performance in displaying edge details at low bit rates facilitates multi-resolution detection. Fig.11. shows magnifications of 128:1 and 64:1 compressions of the "*A, B, C, D*" image. At 0.0625 BPP, the WDR compression does a better job in preserving the shape of Lena's nose and in retaining some of the striping in the band around her hat. Similar remarks apply to the 0.125 BPP compressions. SPIHT, however, does a better job in preserving parts of the different image.

3.5 STW (Spatial-orientation Tree Wavelet)

STW is essentially for the SPIHT algorithm. The only difference is that SPIHT is slightly more careful in its organization of coding output.

Second, the SPIHT algorithm has been described. It is easier to explain SPIHT using the concepts underlying STW. Third, it is shown that 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. Here some types of methods are used, like as SPIHT, STW, WDR, ASWDR, SPIST3d, LVLMMC, GBLMMCF, GBLMMCH, EZW and different types of analytical results are found which are shown in the below figure.

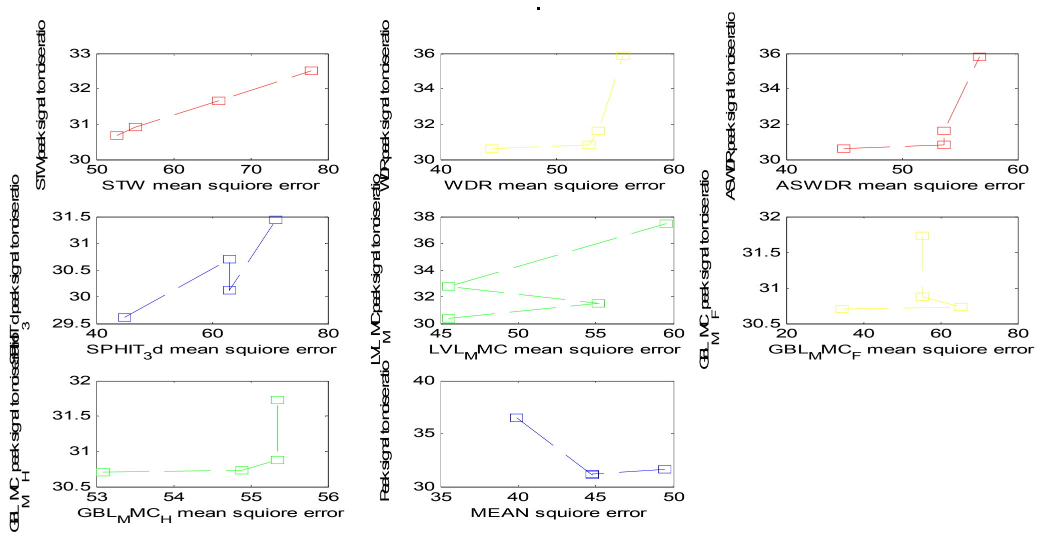

Figure-11: Performance of different methods

Here It has been seen that in case of different method like as stw, when mean squire error is increased then the peak signal to noise ratio is also increased linearly, and the other sector when MSE is increased then PSNR is decreased in EZW method.

Table-3: Performance parameter for different images

	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.C	0.08062	7.017	0.2701	6.469	6.469
	0.09466	8.013	0.2770	7.5	7.5
	0.09173	8.854	0.2768	8.318	8.318
	0.09056	6.568	0.2665	6.06	6.06
P.S.N.R	59.07	39.67	53.82	40.02	40.02
	58.37	39.09	53.71	39.38	39.38
	58.51	38.66	53.71	38.93	38.93
	58.56	39.96	53.87	40.31	40.31
B.P.P	7.9575	8.4888	6.9565	8.3667	7.8311
	7.4541	8.0552	6.5107	7.5752	7.1733
	8.0137	8.0591	6.4966	7.7773	7.6396
	7.1401	7.7109	5.9839	7.0591	6.9526

In this figure, it has been seen that in EZW method when Bit Per Pixel(BPP) is low PSNR is high and in other methods of BPP, it is increased with PSNR. Here ezw and STW perform better . Because when Bit Per Pixel(BPP) is average 7 then PSNR shows the maximum 58% on an average.

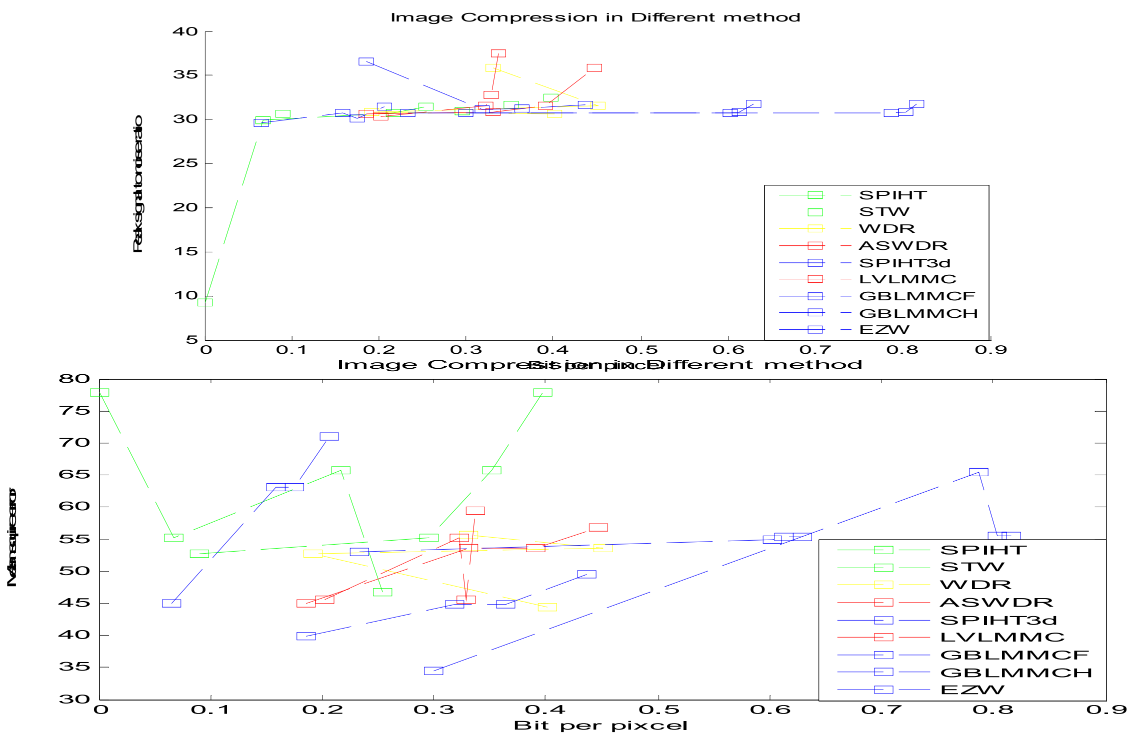

Figure-13:BPP vs. MSE

In this figure It has been seen that in case of EZW method when Bit Per Pixel(BPP) is increased then eerror is also increased . so it has been said that EZW method performs better because in case of low Bit Per Pixel(BPP), the compression performance is better.

4. DISCUSSION

From the analysis, the various features of the main coding schemes are summarized. The latest coding techniques such as EZW and STW perform better than the other methods. From the EZW method, the maximum peak signal to noise ratio and low bit per pixel are found. Here different types of method have also been analyzed and it is found that the EZW & STW perform better for image compression.

5. CONCLUSION

In this paper, the results have been 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 are also 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 & STW technique performs better than the WDR & other methods 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 & STW compression is higher than other compression techniques. And also it is shown that the MSE values from the reconstructed images by using STW compression are lower than other compression techniques. Finally, it is identified that EZW & STW compression performs better when it is compared to WDR, ASWDR and other compression techniques.

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