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Analysis of EZW and SPIHT Algorithms for Compression of an Image

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ABSTRACT: The compression of an image is done to reduce the required storage space and to minimize the transmission bandwidth required for the communication of the image data. In this paper, the examination of two different algorithms like EZW and SPIHT is done and the result is evaluated by using an image on different wavelets. The analysis of quality of the image is done on the basis of the two main factors such as MSE, PSNR and CR. The analysis yields that the SPIHT algorithm gives higher compression ratio than that of the EZW algorithm and it was also observed that while using the EZW algorithm the symlet wavelet gives the best result but while using the SPIHT algorithm better results were given by the db7 wavelet transform. The estimation of the best wavelet was done on the basis of the high PSNR and low MSE value.

Keywords: EZW, SPIHT, PSNR, MSE, db7, symlet, CR

I. INTRODUCTION

The art and science of decreasing the amount of information required to signify any kind of image data is known as Image Compression which is considered as the most useful advancement in the field of processing of image [1]. Compression of any image results in reduction in the amount of bits required to store the information and represent the information present in the image so that a good amount of data can be stored in the given quantity of available storage space. It also helps in reducing the amount of time required for transmission of images over the Internet or to be downloaded from the web pages. There are basically two different mechanisms involved in compression process namely redundancy removal and irrelevancy decline. The reduction in redundancy aims at removal of the redundant bits from the image data only keeping the essential information required for the retrieval of the original image from the compressed image. Irrelevancy decline removes parts of the pointer that remain unnoticed by the receiver indicator. In general there are three kinds of redundancies: Coding redundancy, Interpixel redundancy, Psycho visual redundancy [4]

- Coding redundancy is present when fewer than optimal code words are used.
- Interpixel redundancy is resultant from relationships connecting the pixels of an image.
- Psycho visual redundancy is due to record that is without being seen by the human visual system.

There are basically four types of compression techniques such as: Lossy Compression, Lossless Compression, Predictive Coding and Transform Coding [4].

A. Lossy Compression

In the lossy compression method there occur some loss of information and the recovered image is not same as that of the original image. The process of lossy compression is irreversible. Most of the lossy data compression formats suffer from the problem of generation loss: repeatedly compressing and decompressing the file cause it to progressively loss quality. Lossy compression technique includes various kinds of schemes such as: Transformation coding, Vector quantization, Fractal coding, Block Truncation coding, and Sub-bands coding [1].

B. Lossless Compression

The process of lossless image compression method is to represent an image signed with the smallest possible number of bits without loss of any information, thereby speeding up transmission and minimizing storage space required which yields in the reproduction of the original image without any loss of information. This process is irreversible in nature [2]. The techniques used in lossless compression method are: Run length encoding, Huffman encoding, LZW coding, and Area coding.

C. Predictive coding

In the method of predictive coding the already sent information or obtained information is used to forecast future values, and the variation is hinted. Since this

redundancy is already present in the image or in the spatial area, thus it is relatively simple to realize it and is readily adapted to local image individuality. Differential Pulse Code Modulation (DPCM) [2] is one picky paradigm of predictive coding.

E. Transform coding

In transform coding, firstly the image is transformed from its spatial area representation to some different type of depiction by making use of some well-known renovate and then are coded to some different values [1]. This method provides larger data compression compared to analytical methods, although at the outlay of greater computation.

II. WAVELETS

The concept of wavelet theory was first introduced in the era of mid-1980s as a mathematical tool which is widely used in the field of image processing, specifically in area of compression. This is a kind of multi-resolution filter which analyzes the signal in frequency as well as in time domain simultaneously. The study of wavelet analysis is done with a mathematical function which is called "Mother Wavelet". The concept of multi-resolution of wavelet allows us to understand an image as a sum of details appearing as different resolutions. While in Fourier analysis a signal is broken into sine waves of different frequencies. But in case of wavelet analysis the signal is broken into scaled and translated (shifted) versions of the selected mother wavelet.

The wavelet is basically a wave which decays really fast i.e. it is a wavelike oscillation with amplitude which begins to increase from zero and then decreases back to zero. The fundamental idea behind wavelets is to analyze the signal at different scales or resolutions, which is called multi-resolution. The most important feature of wavelet transform is it allows multi-resolution decomposition. An image which is decomposed by using the wavelet transform technique can be reconstructed with desired resolution. The procedure required for the decomposition and reconstruction of the decomposed image evolves the use of a low pass filter and a high pass filter, such that they exactly halve the frequency range between themselves and this filter pair is known as the Analysis Filter pair. or "Wavelet Kernel." The wavelets are not only useful for the compression of the signals but can also be used to improve the signals in the medical imaging fields where each and every bit of information is very crucial, as well as in the field of edge detection and pattern recognition.

An improved quality of an image is achieved at the higher PSNR values and higher compression ratio. It also known as discrete wavelet transforms (DWT) which organizes the image information into a wave which is uninterrupted, typically with many peaks and dips and centers it on zero. The Discrete Wavelet Transform of a limited extent signal x(n) having N components, is uttered by an N x N matrix.

In this paper we have used four different kinds of wavelet transforms namely Haar, Daubechies, Coif and Symlet. The evaluation of the best wavelet on the application of the EZW and SPIHT algorithms is done on the basis of the highest PSNR value and the lowest MSE.

III. TYPES OF ALGORITHMS USED

A. EZW

EZW stands for Embedded Zero Tree Wavelet [9] that produces good compression results with all the practically known compression algorithms on regular test images. It was introduced by J. Shapiro. It is a lossless data compression algorithm which is achieved via adaptive arithmetic coding. The encoder of EZW is mainly based on progressive encoding which compress an image into a bit stream with increasing accuracy.

The EZW works on four concepts: A distinct wavelet transform or hierarchical sub band disintegration, Prediction coding, Entropy-coded successive-ballpark figure quantization, Universal lossless data compression which is reached via adaptive arithmetic coding.

Zero tree allow the successful prediction of insignificant coefficients cross scales to be efficiently represented as part of exponentially growing trees.

B. SPIHT

It stands for Set Partitioning in Hierarchical Trees [6]. It is actually an enhancement of the EZW algorithm which was proposed by Sayed and Peralman. It uses a tree structure and process all the non significant descendants of a wavelet coefficient like a set and use only one symbol to represent those data bits. It helps in producing image compression of lower complexities and higher performance and also helps in creating embedded bit streams with very fast execution.

SPIHT is a wavelet based image compression coder which first changes the image into its wavelet transform and then transmits data about the wavelet coefficients. The decoder uses the expected signal to rebuild the wavelet and performs an opposite transform to recover the image. Some of the most important features of the SPIHT algorithm are [14]: It produces the best quality of the image with a higher PSNR value. It can be used for lossless compression.

IV. RESULTS

The analysis has been carried out in the MATLAB software. The evaluation of the result using the two specified algorithms is carried on the test image which is an image of a cameraman in jpeg format of 256X256 resolutions. The number of encoding loops was taken to

be 14. The parameters that are evaluated are: PSNR, MSE, and CR which are given as:

CR stands for the compression ratio. which is calculated by using the following formula:

CR= (Original image File size)/ (compressed Image File size) (1)

As the compression ratio increases, reconstructed image is more and the quality of image degrades.

PSNR is the peak signal to noise ratio which is the measure of the peak error which is calculated in decibels and is calculated as:

$$PSNR = 10 \log_{10} 255^2/MSE \quad (2)$$

As the value PSNR increases, better becomes the quality of compressed or reconstructed image.

MSE stands for Mean Square Error which represents the mean squared error between the compressed and the original image and is given by:

$$MSE = \Sigma M, N [I_{1(m,n)} - I_{2(m,n)}]^2/M*N \quad (3)$$

The table below shows the obtained result using both EZW and SPIHT algorithms along with their respective PSNR, MSE and CR values on application over various wavelets.

Table1: PSNR, MSE and CR values using EZW and SPIHT algorithm

EZW Algorithm				SPIHT Algorithm		
Wavelets	**PSNR**	**MSE**	**CR%**	**PSNR**	**MSE**	**CR%**
Haar	52.48	0.3671	60.15%	41.50	4.598	27.74%
Db2	52.09	0.4019	62.58%	38.46	9.264	28.50%
Db4	52.36	0.3777	61.96%	42.57	3.599	28.45%
Db6	52.16	0.3950	64.22%	42.22	3.896	28.95%
Db7	52.47	0.3678	63.98%	42.18	3.933	29.03%
Db8	52.21	0.3909	65.29%	41.83	3.992	29.71%
Db10	52.49	0.3664	65.31%	38.46	4.267	29.61%
Sym2	52.09	0.4019	62.58%	41.15	9.264	28.50%
Sym4	52.15	0.3959	61.73%	41.98	4.989	27.86%
Sym5	52.53	0.3632	61.18%	42.21	3.905	27.49%
Sym6	52.23	0.3893	62.19%	41.98	4.126	27.84%
Sym7	52.35	0.3783	62.66%	41.79	4.301	28.51%
Sym8	52.32	0.3815	62.63%	42.14	3.968	27.89%
Coif1	52.34	0.3899	61.52%	42.10	4.007	28%
Coif2	52.34	0.3792	61.59%	41.80	4.293	28.19%
Coif4	52.34	0.3793	62.77%	40.97	5.204	28.44%

For the EZW algorithm the sym5 wavelet gives the highest PSNR and lowest MSE value. The obtained compressed image along with the original image from the sym5 wavelet is shown in figure1.

a. Original Image

b. Compressed Image

Fig1: (a) Original and (b) Compressed Image obtained from sym5 wavelet using EZW algorithm

For the SPIHT algorithm the db4 wavelet gives the highest PSNR and lowest MSE value. The obtained compressed image along with the original image from the db4 wavelet is shown in figure2.

a. Original Image

b. Compressed Image

Fig. 2. (a) Original and (b) Compressed Image obtained for db4 wavelet for SPIHT Algorithm

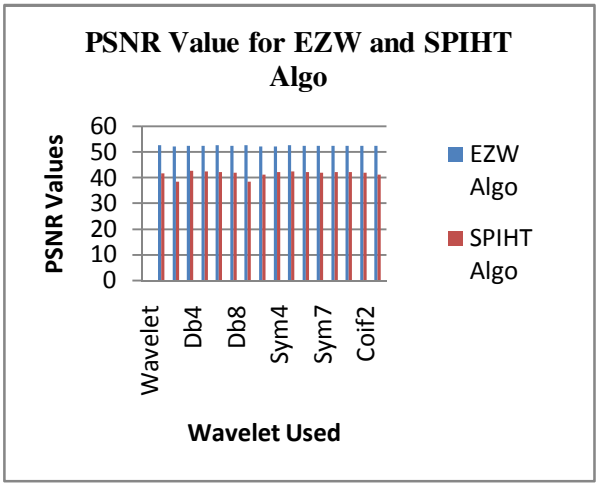

Fig. 3. PSNR values for EZW and SPIHT algorithm

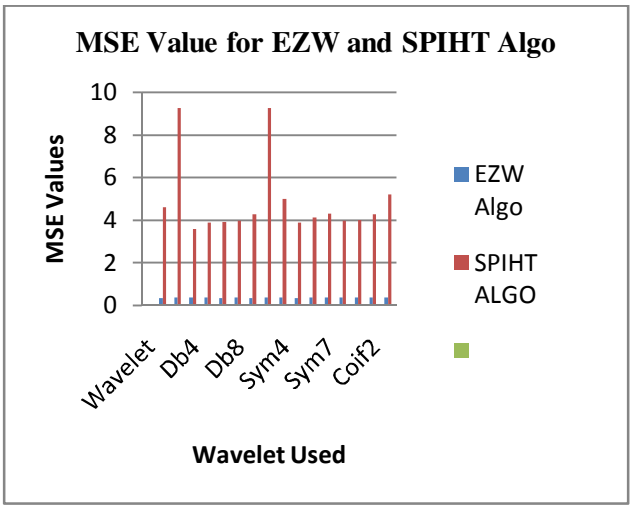

Fig. 4. MSE values for EZW and SPIHT algorithm.

V. CONCLUSION

This paper work is analyzed for the algorithms EZW & SPIHT on different wavelets. With the help of these algorithms each image is compressed and then decompressed. For the purpose to compare image quality, we consider MSE and PSNR as quality parameters. The experimental results shows that the EZW technique performs better when we want less MSE and high PSNR and SPIHT performs better for getting the less PSNR. The selection of the MAXLOOP for compression algorithms is done on the basis of CR and BPP. We have select MAXLOOP by keeping two things in mind that we require a low compression ratio and a better result. So the MAXLOOP is selected to be 14. For a specific value of CR , MSE and PSNR the results of db4 wavelet is best for SPIHT technique while for EZW algorithm the sym5 gives the best result giving high value of PSNR and low value of MSE. By the help of these algorithms we have sustained good reproduction of the images as well as compression and also we have preserved the quality of the image.

REFRENCES

[1] Subramanya A, "Image Compression Techniques", Potentials IEEE, Vol. **20**, Issue 1, pp 19- 23, Feb-March 2001.

[2] Hong Zhang, Xiaofei Zhang & Shun Cao, "Analysis & Evaluation of Some Image Compression Techniques", High Performance Computing in Asia Pacific Region, 2000 *Proceedings, 4th Int. Conference,* Vol. **2**, pp 799-803, 14-17 May, 2000.

[3] T. Karthikeyan, B. Praburaj, K. Kesavapandian," Wavelet Based Image Compression Algorithms – A Study", *International Journal of Advanced Computer Research.* Volume-**4** Number-1 Issue-14 March-2014.

[4] G. Langdon, A. Gulati, and E. Seiler, "On the JPEG model for Lossless image compression", In 2nd Data Compression Conference, pages 172– 180, 1992.

[5] Bhagyashree I. Kochi, B.B.S.Kumar," EZW and SPIHT Algorithms for Image Compression and Denoising", *ITSI*

Transactions on Electrical and Electronics Engineering (ITSI-TEEE), Volume -**4**, Issue -2, 2016
[6] Skodras, Athanassios N., and Touradj Ebrahimi. "JPEG2000 image coding system theory and applications." Circuits and Systems, 2006. ISCAS 2006. Proceedings. 2006 IEEE International Symposium on. IEEE, 2006.
[7] Asad Islam & Pearlman, "An embedded and efficient low-complexity, hierarchical image coder", *Visual Communication and Image processing'99proceedings of SPIE.,* Vol **3653**, pp294-305, Jan., 1999.
[8] X. Wu, N.D. Memon, and K. Sayood. A Context based, adaptive, lossless/nearly- lossless coding scheme for continuous- tone images. ISO working document ISO/IEC/SC29/WG1/N256, 1995.
[9] J. M. Shapiro, "An Embedded Hierarchical Image Coder using Zerotrees of Wavelet Coefficients," Data Compression Conference (Snowbird). pp. 214-223, 1993.
[10] R.C.Gonzalez and Wood, "Digital image processing using MATLAB" Reading, Second addition, McGraw Hill Companies, PP. 331-439, 2011.
[11] Ritu Chourasiya and Prof. Ajit Shrivastava, "study of image compression based Transmission algorithm using Spiht for Low bit rate application", *An International Journal Advanced (ACIJ),* Vol. **3**, No.6, November 2012.
[12] Christophe, E., C. Mailhes, P. Duhamel (2006), Adaptation of zerotrees using signed binary digit representations for 3 dimensional image coding," EURASIP Journal on Image and Video Processing, 2007, to appear in the special issue on Wavelets in Source Coding, Communications, and Networks, Paper ID 54679.
[13] Ram Singh, Ramesh Verma and Sushil Kumar "JPEG2000: Wavelet Based Image Compression", EE678 Wavelets Application Assignment 1.
[14] N. Memon, X. Wu, B.-L. Yeo, Entropy Coding Techniques for Lossless Image Compression with Reversible Integer Wavelet Transforms, IBM Research Report RC21010, October 1997.