Image Lossless Compression using Improved ESPIHT Technique

Anjali[1], Dr. Sandeep Tayal[2], Ankit Bansal[3] , Bijender Bansal[4] , Monika Goyal[5]
[1]M.Tech Student, Deptt of ECE, VCE, Rohtak
[2]H.O.D, Deptt of ECE , VCE , Rohtak
[3] Associate Professor, Deptt of EE , VCE , Rohtak
[4]Associate Professor, Deptt of CSE, VCE, Rohtak
[5]Associate Professor, Vaish Mahila Mahavidalya, Rohtak.

Abstract: Lossless compression is a new technique for reduction of data quantity without reducing the quality of an image. The storage and transfer of compressed data is faster as compared to uncompressed data. To achieve high compression ratio and compression time, we use modified Embedded Zero Tree Wavelet (EZW), improved Enhanced Set-Partitioning In Hierarchical trees (ESPIHT) techniques. These techniques are best suited for large sized multimedia data. Peak signal to noise ratio are improved up to 44.17 db. The Mean square error is reduced up to 0.503007.

Key words: Image compression, Video Compression, EZW, LZW, ESPIHT, Compression Ratio.

I. INTRODUCTION

Digital image or video compression may be lossless or lossy depending upon the quality of images. For medical image, comics and technical drawing, lossless image compression is used. These methods are used specially for high bit rate transfer of an image. The most common quality of a digital image is that neighborhood pixels are convoluted to the main pixels. Hence, neighborhood pixels have redundant information [1]. Image compressions have two components, one is redundancy & another one is Irrelevancy. The duplication of an image is removed by redundancy component. A signal is produced by human visual system by the use of irrelevancy component [3]. Since the limitation of bandwidth and high speed data transfer image compression technique is used. There are two process involve during the transmission of data [4]. One is data encoding and another one is data decoding. Encoding, known as compression involve reduction of bits from the original message or image [5]. It means reduce the size of data due to band limitation of channel. In the receiver end, reverse process occur. That process is known as decompression or decoding. It means to recover the original data from the compressed data. The lossless compression is also known as reversible compression. In this compression , image or video can be reconstructed without any loss in the image.

The main problem of lossless image compression is peak signal to noise ratio (PSNR). There is degradation of peak signal to noise ratio. Lempel-Ziv-Welch (LZW) and Enhanced Set-Partitioning In Hierarchical trees (ESPIHT) techniques is best algorithm for such type of problem.

The rest of paper is design as follows. The overall past work is describe in Section II. Section III describes the framework of the implementation used for proposed work. Result discussion describe in section IV. Finally, Section V describes the conclusion of paper.

II. LITERATURE REVIEW

Many researchers have adopted different method for enhancement of PSNR in lossless compression.

Ma, Kede *et. al.* in 2015 proposed an algorithm to compress high dynamic range to low dynamic range. In this toned image quality index is performed to search out the compressed image. The average value was improved upto 0.60[1].

Rinaldi, Pierluigi *et. al.* in 2016 proposed the methodology for different medical images. In respect to survey, Mean Square Error (MSE), PSNR and Compression Ratio (CR) were the performance parameter. Mean square error, peak signal to noise ratio and compression ratio is achieved up to 95.57, 28.33 and 7.783 respectively [2].

Ding, Jian-Jiun *et. al.* in 2016 offered the context based adaptive lossless image coding for compression. Bit per pixel is improved with this technique. It was improved up to 4.9649 [3].

Dong, *et. al.* in 2017 described invertible update-then-predict integer lifting wavelets approach. Bit rate was achieved upto 5.808060 [4] .

Rahman, M. A *et. al.* in 2016 utilized powerful diffusion methods. Bit Per Pixel (BPP), PSNR and entropy are the performance parameter. These were improved up to 0.344, 16.83 and 7.83 [5].

García Sobrino *et. al. in* 2017 demonstrated improved lossless technique. It was based on predicting temperature and dew point temperature. For the delta values , Bit Rate and signal to noise ratio was achieved up to 5.06 and 75.55 [6]

M. J. Weinberger *et. al.* in 2000 offered low complexity lossless compression technique. The average bit rate was 3.51. Performance was improved 2.5% that of Context Based Adaptive Lossless Image Compression (CALIC). The bit rate was improved by applying various algorithms [7].

X. Li *et. al.* in 2001 proposed a most efficient Least Square Error Minimization (LS) based adaption method . In this, BPP is performance parameter in different order of images. For the 1st order , it was improved up to 5.02 and for the 2nd order it was improved up to 4.5 [8]

J. Kim *et. al.* in 2009 proposed a significant truncation coding in which reduction ratio and throughput is improved. Reduction Ratio and throughput was achieved up to 60.4 and 14.2 [9].

Elfitrin Syahrul *et. al.* in 2008 proposed improved Burrows-Wheeler Transform (BWT). In this average compression ratio is calculated for different bits. The compression ratio for 1 bit, 2 bit, 4 bit, 8 bit was 2172, 2229, 2189 and 2231 respectively [10] .

Taubman *D* et. al. in 2000 proposed embedded block coding with optimized truncation of embedded bit stream method. The PSNR was achieved for different values of bits . The PSNR value for 0.125, 0.25, 0.5 and 1 was 31.10, 34.11, 37.21 and 40.41 respectively [11].

III. FRAMEWORK OF THE IMPLEMENTATION

In the proposed work, there are two methods are applied one is Embedded Zero Tree Wavelet (EZW) and another one is Set Partitioning In

Hierarchical Trees (SPIHT). (EZW) is basically improved version of discrete wavelet encoding. It is competently representing portions of the encoded symbol stream that can be safety eliminated. This could be done by aggregate energy below predetermined threshold. The overall image encoding gives pruned which gives a sub band images falls below threshold. This encoding process is called zero tree of sub band image. This image does not require further encoded. As it can be encoded into zero. The flow chart of EZW encoding and decoding is shown in figure 1.

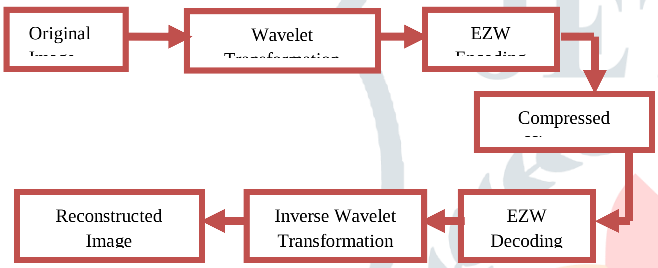

Fig 1. Flow Chart of EZW Decoding [9]

The improved compression technique is Set Partitioning in Hierarchical Trees (SPIHT) algorithm. In this algorithm, a threshold magnitude scan Discrete Wavelet Transform (DWT) coefficient in Sparse Orthonormal Transforms (SOT) having significant test. After that test results transmit to the images and remaining Most Significant Bit (MSB) of significant coefficient. This process repeats and decrease the threshold value.

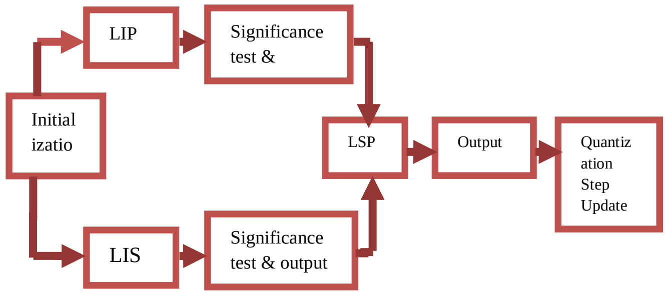

Fig 2. Flow Chart of ESPIHT algorithm

Figure 2 represent the ESPIHT algorithm. The proposed ESPIHT technique involves 4 phases. 1^{st} is initialization, 2^{nd} is sorting pass, 3^{rd} is refinement pass and last 4^{th} is quantization-step update. In the first phase, empty the List of Significant Pixels (LSP). Now, add all coordinates from Set of coordinates of all spatial orientation tree roots (H) to List of insignificant Pixels (LIP). Another one type A entry consist descendants to List of insignificant Set (LIS). In the 2^{nd} stages, each coordinates in LIS and LIP is fed to significance test and output result comes in form of code stream. If output result is correct then it will move to LSP and if is not correct, it will move to end of LIS or LIP. In the 3^{rd} stage, except the newly added bits in significant passes having significant bits. In the last stage, significant bits decrease rapidly and repeated until termination conditions is satisfied.

IV. RESULT AND DISCUSSION

There are different set of images taken out from the dataset. In proposed work, cameraman, tiffany, house, light house images are taken out for compression. Table 1 indicates the comparison of different algorithm like Context-Based Adaptive Lossless Image Compression (CALIC), EZW and ESPIHT. This table indicates BPP of an image. For the best compression image bit per pixels should be minimum. In the calculated results, ESPIHT method gives very less bit per pixel for airplane image.

Table 1 : Comparison with base paper for standard test images

Images	CALIC by the original AAC	EZW	ESPIHT
Cameraman	4.2438	4.2191	4.026287
Airplane	3.7777	3.756	3.584351
Tiffany	4.0505	4.0444	3.859571
House	4.1452	4.1285	3.939828
Lighthouse	4.9649	4.9203	4.695442

Fig 3 represents the graphical comparison of the different methodology. For airplane image bit per pixels becomes very less.

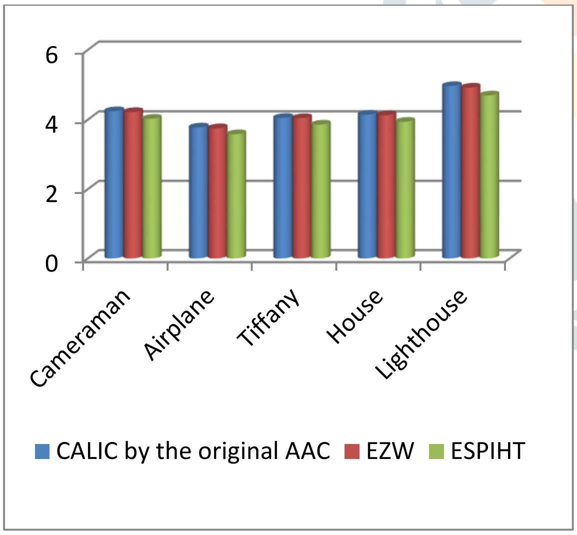

Fig 3: Bit per Pixel Comparison with base paper

Table 2 gives peak signal to noise ratio. This should be maximum. ESPIHT method gives highest PSNR. Peak signal to noise ratio for cameraman, airplane, tiffany, house and lighthouse is 35.66, 40.3, 44.17, 39.133 and 38.345 respectively. It shows that tiffany image have highest peak signal to noise ratio.

Table 2: PSNR Comparison with base paper (higher is better)

Images	CALIC by the original AAC	EZW	ESPIHT
Cameraman	21.69116	32.93713	35.66
Airplane	25.23014	33.43848	40.3
Tiffany	29.38068	27.82307	44.17
House	21.16858	27.77105	39.133
Lighthouse	31.09469	32.76526	38.345

Table 3 gives a comparison of various techniques for mean square error. It should be minimum.

Table 3: MSE Comparison with base paper (lower is better)

Images	CALIC by the original AAC	EZW	ESPIHT
Cameraman	5.57134	5.237059	0.546225
Airplane	5.130528	4.822696	0.503007
Tiffany	6.846618	6.435821	0.671256
House	7.648345	7.189444	0.749859
Lighthouse	6.794815	6.387126	0.666177

ESPHIT technique gives minimum mean square error. MSE for cameraman, airplane, tiffany, house and lighthouse is 0.546225, 0.503007, 0.671256, 0.749859 and 0.666177 respectively. The comparison show that airplane have minimum mean square error.

V. CONCLUSION

The methodology has been developed in this paper, is based on least significant bits. The proposed techniques have high PSNR, least mean square error and least bits per pixels. ESPIHT technique gives peak signal to noise ratio is 44.17, mean square error is 0.503007 and bits per pixel is 3.5835. Future scope of research work is to transmit the data without any loss with high peak signal to noise ratio , minimum mean square error.

REFERENCES:

[1] Ma, Kede, Yeganeh H.T. and Zeng K.;2015. High dynamic range image compression by optimizing tone mapped image quality index. IEEE Transactions on Image Processing, 10:3086-3097.

[2] Mofreh, Amira, Barakat T.M. and Refaat A.M.; 2016. A New Lossless Medical Image Compression Technique using Hybrid Prediction Model. Signal Processing An International Journal (SPIJ),12:327-332.

[3] Ding, Jiun J. and Wang I.H. ;2016. Improved frequency table adjusting algorithms for context-based adaptive lossless image coding. Consumer Electronics-Taiwan (ICCE-TW).IEEE International Conference on. IEEE, 5 : 566-570.

[4] Chen D., Li Y., Zhang H. and Chen W.G.; 2017. Invertible update-then-predict integer lifting wavelet for lossless image compression. EURASIP Journal on Advances in Signal Processing, 8 : 121-127.

[5] Rahman and A. M., et al; 2016. Efficient colour image compression using fusion approach. The Imaging Science Journal, 12:166-177.

[6] Sobrino G. and Joaquín, et al.; 2017. Statistical Atmospheric Parameter Retrieval Largely Benefits From Spatial-Spectral Image Compression. IEEE Transactions on Geoscience and Remote Sensing 10:276-280.

[7] Weinberger M. J., Seroussi G. and Sapiro G.;2000. The Low Complexity Lossless Compression for Images (LOCO-I) lossless image compression algorithm: principles and standardization into JPEGLS. IEEE Transactions on Image Processing, 9: 1309-1324.

[8] Li X. and Orchard M.; 2001. Edge directed prediction for lossless compression of natural images. IEEE Transactions on Image Processing , 10: 813-817.

[9] Kim J. and Kyung C. M.; 2010. A lossless embedded compression using significant bit truncation for HD video coding. IEEE Transactions on Circuits System. Video Technology, 20:848-860.

[10] Syahrul E. and Atri M.; 2008. Lossless Image Compression Using Burrows Wheeler Transform (Methods and Techniques). IEEE International Conference on Signal Image Technology and Internet Based Systems, 5 : 128-132.

[11] D. T.; 2000. High performance scalable image compression with Embedded Block Coding with Optimized Truncation of the embedded bit-streams (EBCOT). IEEE Transactions on Image Processing, 9: 1151-1170.

[12] Mozammil, Zakariya S.M. and Inamullah; 2012. Analysis of video compression algorithms on different video files. 4th International conference on computational Intelligence and Communication network, 257-262.

[13] Kaur D. and Kaur K.J. ; 2013. Analysis of lossless data compression techniques. International Journal of Computational Engineering Research, 03 :123-127.

[14] Kodituwakku S.R. and Amarasinghe U.S.; 2015. Comparison of lossless data compression algorithms for text data. Indian Journal of Computer Science and Engineering, 1:416-425.

[15] Shahbahrami A., Ramin and Subbaghi M.;2012. Evaluation of huffman and arithmetic algorithms for multimidea compression standards. International Journal of computational engineering, 224-230.

[16] Apostolopoulos J.G. and Wee S.J. ; 1999. Video compression standards, wiley Encyclopedia of Electrical and Electronics Engineering. Jonh Wiley and sons. Inc .New York.

[17] Cabeen K. and Gent P.;1998.Image compression and the discrete cosine transform. Math 45, college of the Redwoods,1-11.

[18] Kavitha, V., kumar E. and S.K.; 2008. Enhancing privacy in arithmetic coding. International Conference on Computer Science and Engineering-International Journal on Artificial intelligence and Machine Learning (ICGST-AIML) Journal, 8:47-52.

[19] Horng, Huwi M.; 2012.Vector quantization using the firefly algorithm for image compression. Expert Systems with Applications,12 : 1078-1091.

[20] Gorley, Paul, and Holliman N.; 2008. Stereoscopic image quality metrics and compression. Electronic Imaging, International Society for Optics and Photonics, 11: 42-54.