Study and Analysis of Wavelet based Image Compression Algorithms: A Review

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Abstract— Image compression means reducing the image size without any effect on the quality of image. Due to this compression maximum number of images to be stored in the available memory space. In this paper we discuss about image compression, types of compression, types of redundancy, and algorithms of image compression. There are many algorithms available in the image compression, but now days wavelet transform based image compression algorithms are mostly used. In this paper we review about two wavelet based algorithms SPIHT (Set-partitioning in Hierarchical Trees), EZW (Embedded Zero-tree Wavelet).

Key words: Image compression, wavelet transform, EZW (Embedded Zero-tree Wavelet), SPIHT (Set-partitioning in Hierarchical Trees)

I. INTRODUCTION

A. *Image Compression:*

Image compression is reducing the number of bits to express or represent an image. Due to this transmission time and bandwidth for transmission is less required. The main aim of image compression is to eliminate the redundancies which are present in the pixel. There are basic three types of redundancies that follow:

1) Psycho-visual Redundancy:

This redundancy eliminates some less relative important data that human visual system may be acceptable. .

2) Inter-pixel Redundancy:

This redundancy mainly occurs in neighboring pixels. Compression is achieved by reducing the correlation between interpixels.

3) Coding Redundancy:

In this type of redundancy image is coded by assigning fixed length to each pixel.

B. *Compression Methods:*

Basically image compression is classified into two type's lossless and lossy compression. In lossy compression some data degradation occurs which is acceptable i.e. in this compression original image cannot be completely reconstructed from compressed image. It gives high compression ratio but loss of data. On the other hand in lossless compression we can reconstruct same original image but it reduces compression ratio. There are many compression techniques like vector quantization, predictive coding, differential image coding, transform coding have been introduced. Now days wavelet transform coding is mostly used due to its multiresoulation property. It gives higher image quality even at higher compression ratios. Wavelets are mathematical tools that can be used to cutup information from images. Wavelet based image coding, such as the JPEG2000 standard [2], is widely used because of its high compression efficiency. There are three important wavelet-based image coding algorithms that have embedded coding property enabling easy bit rate control with progressive transmission of information for a wavelet-transformed image. They are the embedded zero-tree wavelet algorithm (EZW) [3], embedded block coding with optimized truncation algorithm (EBCOT) [4], and set partitioning in hierarchical trees algorithm (SPIHT) [5].In this paper we made a comparative analysis of two wavelet based algorithms EZW and SPIHT based on different performance measure like Peak signal to noise ratio (PSNR), Mean Square error (MSE).

II. EZW ALGORITHM

EZW is wavelet based lossy image compression algorithm. When compression ratio is high i.e. at low bit rats more coefficients of the wavelet transform will be mostly zero or approximately equal to zero. This is because most of images contain low frequency components and a high frequency component occurs in edges in the image. Importance of this is in human perception of image quality. Hence it must be represented in coding. There are some characteristics of this algorithm. First is it is possible to stop the encoder i.e. compression algorithm at any time and we can achieve an approximation of input image. If more number of bits are received image quality is better. second is decoder is used to reconstruct the same coefficients by decoding the same algorithm but decisions are depend on order of incoming bit stream. EZW uses binary arithmetic coding.

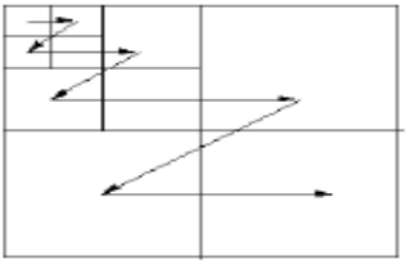

Fig. 1: Scan order used in EZW coding

III. SPIHT ALGORITHM

Another wavelet based algorithm is Set Partitioning in Hierarchical Trees (SPIHT) which does not need binary arithmetic coding and providing a cheaper and faster hardware solution. SPIHT image compression coder offers a many good characteristics. Good image quality achieved with a high PSNR value. It can be used for lossless compression and gives fully progressive bit stream. The main advantage of SPIHT is that it is fully progressive. This algorithm codes the most important wavelet transform coefficients first and transmits the bits so that an increasingly refined copy of the original image can be obtained progressively.

(SPIHT) provides better performance than the EZW that surpass the performance of the original EZW [5].

In addition SPIHT encoding and decoding procedures are extremely fast. SPIHT image compression algorithm is very efficient, has low computational complexity, and generates an embedded compressed bit-stream that can be efficiently decoded at several data rates.

IV. PERFORMANCE MEASURE PARAMETERS

There are many performance measure parameters but here we use two parameters Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) to achieve desirable compression ratios. The MSE between two images f and g, where f represents the original image and g represents the reconstructed image, is defined as:

$$MSE = 1/N \sum_{x,y} [f(x, y) - g(x, y)]^2$$

Where N is the total number of pixels in each image and the sum over x,y denotes the sum over all pixels in the image. The PSNR between two images, in decibels is given by:

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

V. RELATED WORK

A lot of work has been done on image compression and still it is going on. Wavelets were extended in different fields like mathematics, quantum physics, electrical engineering and seismic geology. In Fourier analysis the local properties of the signal are not detected easily. STFT (Short Time Fourier Transform) was introduced this overcome this difficulty. Later on during the last decade use of wavelets was increased in the field of image compression, human vision & earthquake prediction. The first use of wavelets was found by Haar in 1909. Image compression using orthogonal wavelet transform is proposed by liu. An approach towards MATLAB implementation of the Discrete Wavelet Transform (DWT) for image compression is presented [8].

Amir said et al. (1996) [5] in paper "A New, Fast and Efficient Image Codec Based On Set Partitioning in Hierarchical Trees have described which provides better performance than the previously reported extension of EZW that surpass the performance of the original EZW. In addition SPIHT encoding and decoding procedures are extremely fast. The Set Partitioning in Hierarchical Trees (SPIHT) image compression algorithm is very efficient, has low computational complexity, and generates an embedded compressed bit-stream that can be efficiently decoded at several data rates.

Jerome M. Shapiro et al. [3] in paper "Embedded Image Coding Using Zero Trees of Wavelet Coefficients" have described in an embedded zero-tree wavelet (EZW) algorithm, an encoder can terminate the encoding at any point thereby allowing a target rate or target distortion metric to be met exactly. Also, given a bit stream the decoder can cease decoding at any point in the bit stream and still produce exactly the same image that would have been encoded at the bit rate corresponding to the truncated bit stream. This algorithm efficiently utilizes the self-similarity between the sub-bands of similar orientation and achieves significant data reduction.

Ali Kadhim Al-Janabi [12] in paper "Low Memory Set-Partitioning in Hierarchical Trees Image Compression Algorithm" have described very low memory requirements for SLS algorithm because it needs six times less memory as compare to the original SPIHT.

Sunny Arora et al. [7] 2014in paper "Image compression Algorithm Using Wavelets A review" this paper describe various wavelets on wavelet family are applied on SPIHT and EZW and observed different results. For SPIHT embedded coding and for EZW Huffman coding is used.

Rehna V.J et al. [8] in paper "Wavelet Based Image Coding Schemes a Recent Survey" this paper describe a detailed survey on some of the popular wavelet coding techniques is summarized. This paper also gives recommendations and discussions are presented for algorithm development and implementation.

VI. SIMULATION RESULT

Fig. 2: SPIHT Compression

Fig. 3: EZW Compression

In this paper comparative analysis of SPIHT and EZW is done on the basis of parameters such as mean square error (MSE), peak signal to noise ratio (PSNR).

VII. CONCLUSION

We have reviewed and summarized the basics of image compression, image compression algorithms based on Wavelet, SPIHT and EZW. SPIHT algorithm overcomes the limitations of traditional EZW algorithm. In this paper comparative analysis of SPIHT and EZW is done on the basis of parameters such as mean square error (MSE), peak signal to noise ratio (PSNR). Analysis shows that SPIHT having better result as compared to EZW.

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