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IMAGE COMPRESSION USING EZW AND WDR TECHNIQUES WITH DIFFERENT WAVELET CODES

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ABSTRACT

In this paper, two different wavelet bassed Image compression methods are compared. The methods involved in the comparision process are Embedded Zero-tree Wavelet (EZW) and Wavelet Different Reduction (WDR). The above two methods are implemented with different types of wavelet codecs. All the numerical results is carried out by Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) for globe. To compare the result here the seven wavelets at level-5 are observed. The above two methods are more appropriate methods for image compression. Discrete Wavelet Transform (DWT) is one of the most common methods used in signal and image compression. It is very powerful compared to other transform because its ability to represent any type of signals both in time and frequency domain simultaneously.

Keywords: *Discreate Wavelet Transform, EZW, WDR, harr, db, sym, coif, bior, rbio, dmey, Image compression.*

1. INTRODUCTION

Image compression has been the key technology for transmitting massive amount of real time image via limited bandwidth channels [6]. The data are in the form of graphics, audio, video and image. These types of data have to be compressed during the transmission process. Some of the compression algorithms are used in the earlier days [3] and [5] and it was one of the first to be proposed using wavelet methods [1]. Wavelet transforms have been widely studied over the last decade [9]. For still images the widely used coding algorithms based on wavelet transform include the Embedded Zero-tree Wavelet (EZW) algorithm [9], and the Wavelet Difference Reduction (WDR) algorithm [12,13]. The SPIHT algorithm improves upon the EZW concept by replacing the raster scan with a number of stored lists that contain sets of coefficients (i.e zero-trees) and individual coefficients. Already the results are compared and it is identified that WDR provides better results than SPIHT.

2. EZW ALGORITHM

The Embedded Zero-tree Wavelet algorithm (EZW) [9] is an effective image compression algorithm. A fully embedded bit stream for image coding by this method. EZW algorithm is an evident advantage. The user can select a bit rate and encode [10] the image to exactly the wanted bit rate. Features of EZW algorithm:
(1) Compact binary maps are provided by zero-tree coding of significant wavelet coefficients.
(2) Successive approximation quantization of wavelet coefficients.
(3) Huffman coding.

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2.1 Embedded Coding

The Embedded Zero-tree Wavelet algorithm (EZW) is a simple and efficient image compression algorithm. The image coder has three main blocks: transform, quantizer and entropy coder. In the case of the DWT (image transform), image is decomposed and producing the wavelet coefficients at different scales. We use next block in figure is a quantizer. It quantizes the transformed matrix into a sequence of integers. After that using an entropy coding scheme. In addition the EZW encoder is based on two important annotations:

1. The progressive encoding is a very normal option for compressing wavelet transformed images, since the higher sub-bands only add detail.
2. Large wavelet coefficients are more substantial than smaller wavelet coefficients. Shapiro is a person who introduced Embedded zero-tree coding of the wavelet coefficients (EZW). In the EZW algorithm if a wavelet coefficient at a coarse scale is insignificant with rating to a threshold T. Then all wavelet coefficients of the same orientation in the same spatial location at finer scale will be insignificant with respect to T. The trees induce a parent-child relationship among the coefficient of sub-bands having the same spatial orientation. These parent-child dependencies are at all events credited for the excellent performance of zero-tree coders. [An image is first decomposed into four parts based on frequency sub-bands, by critically sub sampling horizontal and vertical channels using sub-band filters and named as Low-Low (LL), Low-High (LH), High-Low (HL) and High-High (HH) sub-bands. To obtain the next coarser we will further decompose LL sub-band]. Figure. 1 shows the coarse scale coefficient is called the parent and all coefficients corresponding to the same spatial location at the next finer scale of orientation are called children.

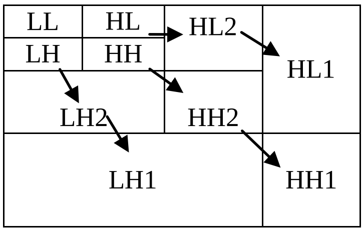


Figure 1: Parent-child dependencies

The EZW coding algorithm includes the first step to determine the initial threshold, if we choose bitplane coding then our intial threshold T_0 Will be

$$T_0=2^{[\log(MAX((U^{(X,Y)})))]}$$

MAX (*U*(X,Y)) is the maximum coefficient with this threshold we enter the main coding loop.

```
Threshold = initial_threshold:
do {
dominant_pass(image);
subordinate_pass(image);
threshold = threshold/2;
}while (threshold > minimum_threshold);
```

We see that the image is coded by using two passes, the dominant pass is the first pass, and a symbol is outputted for every coefficient after scanning the image. If the coefficient is larger than the threshold a P (positive) is coded, if the coefficient is smaller than the minus the threshold an N (negative) is coded. If the coefficient is the root of a zero-tree then a T (zero-tree) is coded and finelly, if the coefficient is smaller than the threshold but it is not the root of a zero-tree, then a Z (isolated zero) is coded. This happens when there is a coefficient is found to be larger than the threshold in the tree. The effect of using the N and P codes is that when a coefficient is found to be larger than the threshold (in absolute value or magnitude) its two most significant bits are outputted (if we forget about sign extension). Note that in order to determine if a coefficient is the root of a zero-tree or an isolated zero, the subordinate pass is the second pass and is called the refinement pass. In this list is ordered so that the largest coefficients are again transmitted first. The main loops stops when the threshold reaches minimum value. For integer coefficient is minimum value equals zero and the divided by two and after that can be replaced by a shift right operation. If we append another ending condition based on the number of outputted bits by the Huffman coder then we can apply any target bit rate exactly without doing too muc muc mmuch work.

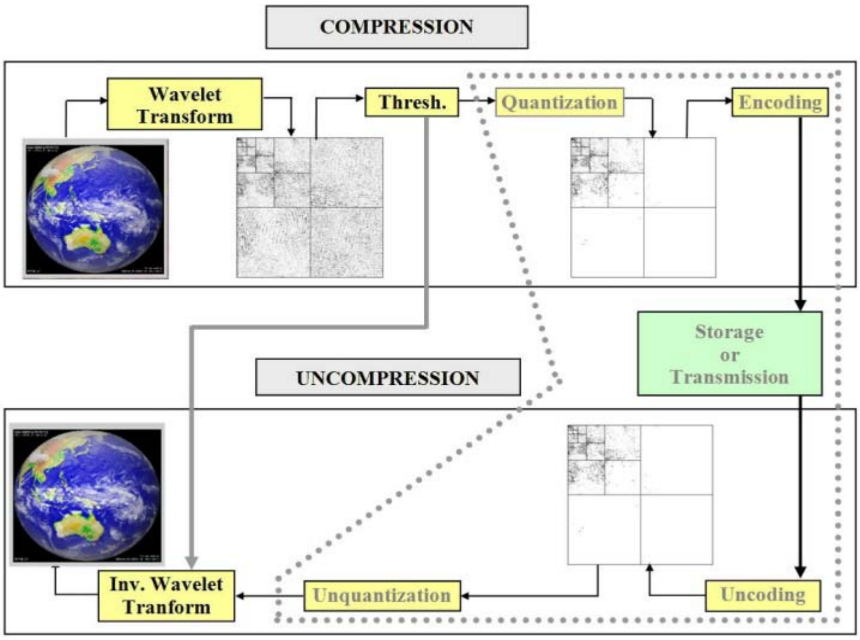


Figure 2: The image processing based on wavelets

3. WDR ALGORITHM

The WDR algorithm combines run-length coding of the significance map with an efficient representation of the run-length symbols to produce an embedded image coder in both SPIHT and WDR techniques. The zero structure is precluded, but the embedding principles of lossless bit plane coding and set partitioning are preserved. In the WDR algorithm instead of employing the zero-trees, each coefficient in a decomposed wavelet pyramid assigned a linear position index. The output of the WDR encoding can be arithmetically compressed [10, 11]. The method that they describe is based on the elementary arithmetic coding algorithm described in [14].

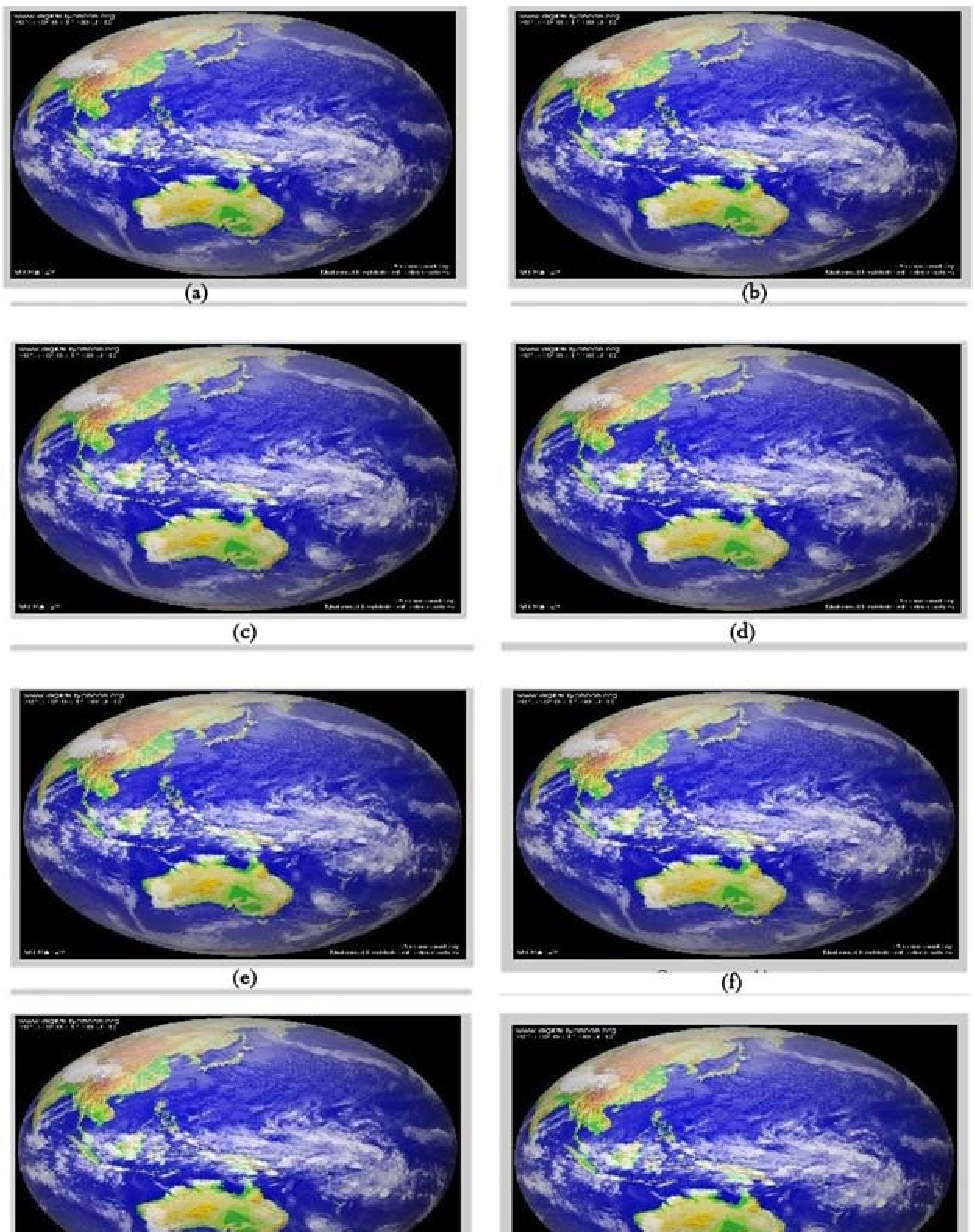
Figure 3: WDR Compression & Decompression system.

One of the defects of SPIHT is that it only implicitly locates the position of significant coefficients. This makes it difficult to perform operations, such as region selection on compressed data, which depend on the exact position of significant transform values. By region selection also known as region of interest (ROI). Which means selecting a portion of a compressed image. Which requires increased resolution. Such compressed data operations are possible with the Wavelet Difference Reduction (WDR) algorithm of Tian and Wells [12,13]. The WDR algorithm is a very simple procedure. A wavelet transform is first applied to the image, and then the bit-plane based WDR encoding algorithm for the wavelet coefficients is carried out. WDR mainly consists of five steps as follows:

1. Initialization: During this step an assignment of a scan order should first be made. For an image with P pixels a scan order is a one-to-one and onto mapping $F_{i,j=}$ X_k , for k=1,2…..P between the wavelet coefficient 0 and a linear ordering (X_k). The scan order is a zigzag through sub-bands, row-based scaninig is used in the horizontal sub-bands, column-based scaning is used in the vertical sub-band, and zigzag scaninig is used for the diagnol and low-pass sub-bands. As the scaninig order is made, an initial threshold T_0 is chosen so that all the transform values satisfy (X_m) < T_0 and at least one transform values satisfies (X_m) >= T_0 /2.
2. Update threshold: Let $T_{k\,=}$ T_{k-1} /2.
3. Significance pass: In this part transform values are deemed significant if they are greater than or equal to the threshold value. Then their index values are encoded using the difference reduction method of Tian and Wells [6]. The difference reduction method essentially consists of a binary encoding of the number of steps to go from the index of the last significant value to the index of current significant value. The output from the significance pass includes the sign of significant values along with sequences of bits, generated by difference reduction, which describes the precise locations of significant values.
4. Refinenment pass: The refinement pass is to generate the refined bits via the standard bit-plane quantization procedure like the refinement process is SPIHT method [5]. Each refined value is a better approximation of an exact transform value.
5. Repeat steps (2) through (4) until the bit budget is reached.

4. EXPERIMENTS

The image globe for the experiments of size was considered to be 512*512 pixels. The results of experiments are used to find the PSNR (Peak Signal to Noise Ratio) values, MSE (Mean Square Error) values from the reconstructed images.



The above figure shows that EZW compressions using wavelets (a) Original picture (b) harr (c) db (d) sym (e) coif (f) bior (g) rbio (h) dmey.

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5. PERFORMANCE ANALYSIS

The above two methods are implemented and the results are shown in the above figures. The PSNR and MSE values for the images compresses by the two methods by using different wavelet transforms are tabulated in Table 1. The PSNR and MSE values are calculated by using the following formula.

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_1^2}{MSE}\right)$$

$$= 20 \cdot \log_{10}\left(\frac{MAX_1}{\sqrt{MSE}}\right)$$

$$= 20 \cdot \log_{10}\left(MAX_1\right) - 10 \cdot \log_{10}\left(MSE\right) \quad (1)$$

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left[I\left(i.j\right) - K\left(i.j\right)\right]^2 \quad (2)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255.

Table-1: MSE & PSNR values for compression methods EZW and WDR

Wavelets	EZW		WDR	
	MSE	PSNR	MSE	PSNR
Harr	1.285	47.04	3.347	42.88
Db-5	1.368	46.77	3.376	42.85
Sym-8	1.344	46.85	3.486	42.71
Coif-5	1.358	46.8	3.385	42.83
Bior-6.8	1.409	46.64	3.514	42.67
Rbio-6.8	1.306	46.97	3.454	42.75
Dmey	1.41	46.64	3.59	42.58

6. CONCLUSION

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

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