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Color Image Compression with Different Algorithms of Wavelet Transform

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Abstract— **Color Digital Images require huge storage and transmission resources. Moreover downloading and uploading of these images in internet requires high time. Therefore, image compression is very important and reduces the time required for these requirements. This paper gives the review of various algorithm of image compression based on wavelet transform. The performance of various algorithm based on wavelet transform is evaluated in this paper.**

Keywords— **CR, BPP, Image Compression, PSNR.**

I.INTRODUCTION

Image compression is an important field of research and address the problem of reducing the amount of data required to represent the digital image. It has become very difficult to manage uncompressed multimedia (graphics, audio and video) data because it requires considerable storage capacity and transmission bandwidth. Image compression is therefore essential and accomplishment of higher compression ratio while retaining good image quality is needful in the present demanding environment. The recent growth of data intensive multimedia-based web applications have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signals central to storage and communication technology.

Demand for communication of multimedia data through the telecommunications network and accessing the multimedia data through Internet is growing explosively. Another important application is browsing, where the focus is on getting high compression [1. 2]. Compression is achieved by the removal of one or more of three basic data redundancies: (a) Coding redundancy, which is present when less than optimal (i.e. the smallest length) code words are used; (b) Inter-pixel redundancy, which results from correlations between the pixels of an image & (c) psycho visual redundancy which is due to data that is ignored by the human visual system (i.e. visually nonessential information).

II.VARIOUS IMAGE COMPRESSION ALGORITHMS

Over the past years, a variety of powerful and sophisticated wavelet based algorithms for image compression have been developed.

Thomas Stutz and Polytech Nantes [3] describe the image compression on the basis of optimal selection of wavelet packet. They present the wavelet packet selection in JPEG2000 and compared to more efficient wavelet packet selection schemes. Lei Chen, Chao Bei, Yujia Zhai and Jing Wu [4] proposed DWT based image compression to efficiently and directly utilize the various properties of hyper-spectral images, such as their statistic characteristics, spectral and spatial correlation. Bahriye Akay and Dervis Karaboga [5] extract approximation and detail coefficients from the signal by filtering. Both approximation and detail coefficients are re-decomposed up to some level to increase frequency resolution. Once coefficients are generated, the optimum threshold values are determined to obtain the best reconstructed image, which can be considered as an optimization task. Zhenghua Shu , Guodong Liu, Qing Xie, Lvming Zeng and Lixin Gan [6] gives a method of image coding algorithm based on a rate distortion optimized wavelet based contourlet packets (WBCP) decomposition and on a block-partitioning coding scheme. Alessandro J. S. Dutra [7] presents the wavelet coding for image compression of hyper spectral image as lossy compression algorithms which build on a state-of-the-art codec. The Set Partitioned Embedded Block Coder (SPECK) incorporating a lattice vector quantizer codebook, therefore allowing it to process multiple samples at one time. Guo Hui and Wang Yongxue [8] present new method of compression on medical image. They decompose and reconstruct the medical image by wavelet packet. X. Z. Yao, S. C. Chan, Z. Y. Zhu, K. T. Ng and H. Y. Shum [9] present image compression based on prioritized transmission and progressive rendering as an efficient algorithm for the compression, prioritized transmission and progressive rendering of circular light field (CLF) for ancient Chinese artifacts. Jing-Siang Wei, Zeng-Yao Lin, and Chian C. Ho [10] gives the slice group of unit H.264 flexible macro block ordering and embedding technique as evolved from conventional Flexible Macro block Ordering

(FMO) that is coded out of raster sequence in spatial domain. They present wavelet domain slice group partition and unequal error protection for H.264/AVC video communication. Huseyin Kusetogullari, Amir Yavariabdi, Mark S. Leeson and Evor L. Hines [11] present the code flow optimization of bit in image coding for compression. They use Multi-path optimization using genetic algorithm (GA) & rainbow network flow (RNF) for maximizing the received multiple description coding (MDCs) in a lossy network model. Chen proposed Particle Swarm Optimization algorithm to find a global threshold and a step size to reach a target bit rate [12].

III.IMAGE COMPRESSION USING WAVELET TRANSFORM

Wavelets are functions defined over a finite interval and having an average value of zero. The basic idea of the wavelet transform is to represent any arbitrary function (t) as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts).
The methods of wavelet transform are the following: the EZW algorithm, the SPIHT algorithm, the WDR algorithm, and the ASWDR algorithm. These are relatively recent algorithms which achieve some of the lowest errors per compression rate and highest perceptual quality yet reported.
The purpose served by the Wavelet Transform is that it produces a large number of values having zeroed, or near zero, magnitudes. Two commonly used measures for quantifying the error between images are Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). The MSE between two images f and g is defined by

$$MSE = \frac{1}{N}\sum_{j,\ k}(f[j\ ,k] - \ g[j,k])^2$$

where the sum over j; k denotes the sum over all pixels in the images, and N is the number of pixels in each image. The PSNR between two (8 bpp) images is, in decibels,

$$PSNR = \ 10\log_{10}\left(\frac{255^2}{MSE}\right)$$

a. *EZW algorithm*

The EZW algorithm was one of the first algorithms to show the full power of wavelet based image compression. It was introduced in the groundbreaking paper of Shapiro [13]. Many algorithms build upon the fundamental concepts that were first introduced with EZW. EZW stands for Embedded Zerotree Wavelet. We shall explain the terms Embedded, and Zerotree, and how they relate to Wavelet-based compression. An embedded coding is a process of encoding the transform magnitudes that allows for progressive transmission of the compressed image. Zerotrees are a concept that allows for a concise encoding of the positions of significant values that result during the embedded coding process. The embedding process used by EZW is called bit-plane encoding. EZW stands for Embedded Zerotree Wavelet. We shall explain the terms Embedded, and Zerotree, and how they relate to Wavelet-based compression. An embedded coding is a process of encoding the transform magnitudes that allows for progressive transmission of the compressed image. Zerotrees are a concept that allows for a concise encoding of the positions of significant values that result during the embedded coding process. We shall first discuss embedded coding, and then examine the notion of zerotrees.

b. *Set Partitioning in Hierarchical Trees (SPIHT encoding)*

The SPIHT [14-15] image coding algorithm was developed in 1996 by Said and Pearlman and is another more efficient implementation of the embedded zerotree wavelet algorithm by Shapiro.
Some of the best results-highest PSNR values for given compression ratios for a wide variety of images have been obtained with SPIHT. Consequently, it is probably the most widely used wavelet-based algorithm for image compression, providing a basic standard of comparison for all subsequent algorithms. SPIHT stands for Set Partitioning in Hierarchical Trees. The term Hierarchical Trees refers to the quadtrees that we defined in our discussion of EZW. Set Partitioning refers to the way these quadtrees divide up, partition, the wavelet transform values at a given threshold. By a careful analysis of this partitioning of transform values, Said and Pearlman were able to greatly improve the EZW algorithm, significantly increasing its compressive power. Our discussion of SPIHT will consist of three parts. First, we shall describe a modified version of the algorithm introduced in. We shall refer to it as the Spatial orientation Tree Wavelet (STW) algorithm. STW is essentially the SPIHT algorithm, the only difference

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is that SPIHT is slightly more careful in its organization of coding output. Second, we shall describe the SPIHT algorithm. It will be easier to explain SPIHT using the concepts underlying STW. Third, we shall see how well SPIHT compresses images.

c. WDR Algorithm

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), we mean selecting a portion of a compressed image which requires increased resolution. This can occur, for example, with a portion of a low resolution medical image that has been sent at a low bpp rate in order to arrive quickly. Such compressed data operations are possible with the Wavelet Difference Reduction (WDR) algorithm of Tian and Wells. The term difference reduction refers to the way in which WDR encodes the locations of significant wavelet transform values, which we shall describe below. Although WDR will not typically produce higher PSNR values than SPIHT, we shall see that WDR can produce perceptually superior images, especially at high compression ratios. The only difference between WDR and the Bit-plane encoding described above is in the significance pass. In WDR, the output from the significance pass consists of the signs of significant values along with sequences of bits which concisely describe the precise locations of significant values.

d. ASWDR algorithm

One of the most recent image compression algorithms is the Adaptively Scanned Wavelet Difference Reduction (ASWDR) algorithm of Walker. The adjective adaptively scanned refers to the fact that this algorithm modifies the scanning order used by WDR in order to achieve better performance. ASWDR adapts the scanning order so as to predict locations of new significant values. If a prediction is correct, then the output specifying that location will just be the sign of the new significant value the reduced binary expansion of the number of steps will be empty. Therefore a good prediction scheme will significantly reduce the coding output of WDR.

III.RESULTS

We have implemented and tested the various algorithms of image compression based on wavelet transform. The performance of color image compression using EZW, SPIHT, WDR and ASWDR algorithm are evaluated with various quality measures like compression ratio (CR), Bit per Pixel (BPP), PSNR and MSE.

Table 1: QUALITY MEASUREMENT BIOR1.1

	MSE	PSNR	CR	BPP
EZW	6.4264	40.0511	24.4929	5.8783
SPIHT	21.7522	34.7558	11.0789	2.6589
STW	15.5033	36.2266	15.9256	3.8221
WDR	6.4264	40.0511	28.4643	6.8314
ASWDR	6.4264	40.0511	27.1474	6.5154

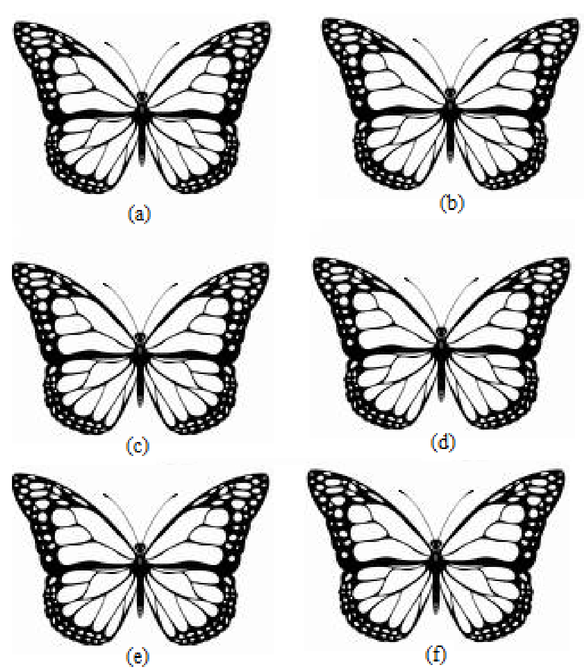

Fig1 (a): Original image. Compressed Image using (b) EZW (c) SPIHT (d)STW (e) WDR (f) ASWDR

Table 2: QUALITY MEASUREMENT BIOR5.5

	MSE	PSNR	CR	BPP
EZW	14.7731	36.4361	24.2320	5.8157
SPIHT	19.7626	35.1724	16.2028	3.8887
STW	13.3234	36.8847	24.5539	5.8929
WDR	14.7731	36.4361	27.6260	6.6302
ASWDR	14.7731	36.4361	26.9155	6.4597

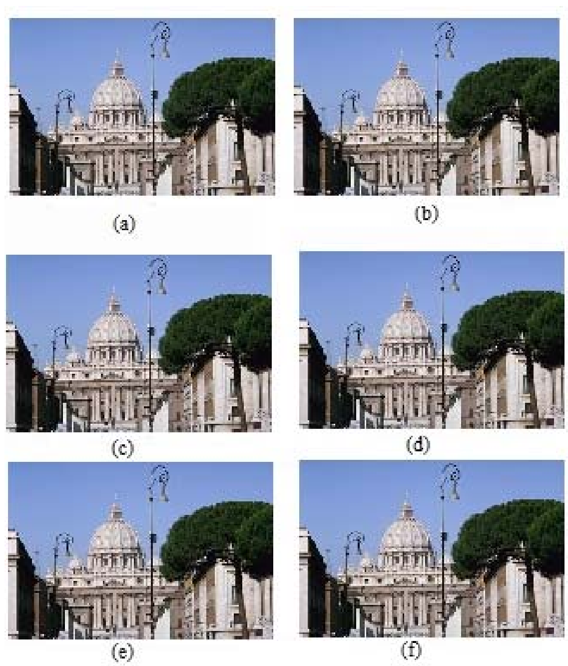

Fig 2 (a): Original image. Compressed Image using (b) EZW (c) SPIHT (d) STW (e) WDR (f) ASWDR

IV.CONCLUSIONS

We have implemented and tested the quality assessment of image compression with various algorithms of wavelet transform. With Bior1.1 wavelet family, EZW, WDR and ASWDR perform well in terms of quality of images (PSNR) whereas the WDR gives the better compression ratio (CR).

Similarly in Bior5.5 wavelet family, STW give the better quality of images whereas WDR gives the better compression ratio (CR).

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