Analysis of Color Image Compression Using Wavelet Transform Method at Particular Decomposition Level

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Abstract— **This paper is concerned with a certain type of compression that uses wavelet transform techniques. Several methods are compared on their ability to compress standard images and the fidelity of the reproduced image to the original image. This also means that lossy compression techniques can be used in this area. Image compression is now essential for applications such as transmission and storage in data bases. In this paper we review and discuss about the image compression, need of compression, its principles, and classes of compression and various algorithm of image compression. This paper attempts to give a recipe for selecting one of the popular image compression algorithms based on Wavelet, JPEG/DCT, Fractal approaches give an experimental comparison on 256×256 commonly used image of Lenna *[3]***

Keywords— **J JPEG, Wavelet transform techniques, Haar wavelet transforms.**

I. Introduction

Compression takes an input X and generates a representation XC that hopefully requires fewer bits. There is are construction algorithm that operates on the compressed representation XC to generate the reconstruction Y. Based on the requirements of reconstruction, data compression schemes can be. divided into two broad classes. One is lossless compression and the other is lossy compression, which generally provides much higher compression than lossless compression.*[1]*

Compression Techniques

A) LOSSLESS COMPRESSION:

If data have been loss lessly compressed, the original data can be recovered exactly from the compressed data. It is generally used for applications that cannot allow any difference between the original and reconstructed data.

b) Lossy Compression Methods:

Lossy compression techniques involve some loss of information and data cannot be recovered or reconstructed exactly. In some applications, exact reconstruction is not necessary. For example, it is acceptable that a reconstructed video signal is different from the original as long as the differences do not result in annoying artifacts. However generally obtain higher compression ratios than is possible with lossless compression.

II. Wavelet Transform:

Wavelets are functions defined over a finite interval. The basic idea of the wavelet transform is to represent an arbitrary function $f(x)$ as a linear combination of a set of such wavelets or basis functions. These basis functions are obtained from a single prototype wavelet called the mother wavelet by dilations (scaling) and translations (shifts).The purpose of wavelet transform is to change the data from time-space domain to time-frequency domain which makes better compression results. As discussed earlier, for image compression, loss of some information is acceptable. Among all of the above lossy compression methods, vector quantization requires many computational resources for large vectors; fractal compression is time consuming for coding; predictive coding has inferior compression ratio and worse reconstructed image quality than those of transform based coding. So, transform based compression methods are generally best for image compression.*[1][2]*

The fundamental idea behind wavelets is to analyze the signal at different scales or resolutions, which is called multi resolution. Wavelets are a class of functions used to localize a given signal in both space and scaling domains. A family of wavelets can be constructed from a mother wavelet. Compared to Windowed Fourier analysis, a mother wavelet is stretched or compressed to change the size of the window. In this way, big wavelets give an approximate image of the signal, while smaller and smaller wavelets zoom in on details. Therefore, wavelets automatically adapt to both the highfrequency and the low-frequency components of a signal by different sizes of windows. Any small change in the wavelet representation produces a correspondingly small change in the original signal, which means local mistakes will not influence the entire transform. The wavelet transform is suited for non stationary signals, such as very brief signals and signals with interesting components at different scales.

a)Why wavelet based compression?

As discussed earlier, for image compression, loss of some information is acceptable. Among all of the above lossy compression methods, vector quantization requires many computational resources for large vectors; fractal compression is time consuming for coding; predictive coding has inferior compression ratio and worse reconstructed image quality than those of transform based coding. So, transform based compression methods are generally best for image compression. For transform based compression, JPEG compression schemes based on DCT (Discrete Cosine Transform) have some advantages such as simplicity, satisfactory performance, and availability of special purpose hardware for implementation. However, because the input image is blocked, correlation across the block boundaries cannot be eliminated. This results in noticeable and annoying "blocking artifacts"' particularly at low bit rates . wavelet-based schemes achieve better performance than other coding schemes like the one based on DCT. Since there is no need to block the input image and its basis functions have variable length, wavelet based coding schemes can avoid blocking artifacts. Wavelet based coding also facilitates progressive transmission of images.*[2][3]*

The wavelet image compressor, MinImage, is designed for compressing either 24-bit true color or 8-bit gray scale digital images. It was originally created to test Haar wavelet using subband coding. To compare different wavelet types, other wavelet types, including Daubechies and birothogonal spline wavelets were implemented. Also, the original subband coding were changed to EZW coding to obtain better compression results and shown in figure 2. A very useful property of MinImage is that different degrees of compression and quality of the image can be obtained by adjusting the compression parameters through the interface. The user can trade off between the compressed image file size and the image quality. The user can also apply different wavelets to different kind of images to achieve the best compression results.

Discrete Wavelet Transform (DWT): The discrete wavelet transform usually is implemented by using a hierarchical filter structure. It is applied to image blocks generated by the preprocessor. We choose the Daubechies 4-tap wavelet and Spline2_2 wavelet to demonstrate the implementation. *[4]*

III. Methodology:

a) Haar Wavelet Transform:-

The Haar Transform (HT) is one of the simplest and basic transformations from the space domain to a local frequency domain. A HT decomposes each signal into two components, one is called average (approximation) or trend and the other is known as difference (detail) or fluctuation.[7] A precise formula for the values of first average subsignal, a1 = (a1 , a2 ,..., aN / 2), at one level for a signal of length N i.e. f = (f1 , f 2 ,..., f N) is

$$a_n = \frac{f_{2n-1} + f_{2n}}{\sqrt{2}}, n = 1,2,3,\ldots,N/2,$$

and the first detail sub signal, d^1 =□(d1 , d 2 ,..., d N / 2), at the same level is given as

$$d_n = \frac{f_{2n-1} - f_{2n}}{\sqrt{2}}, n = 1,2,3,\ldots,N/2$$

Each piece shown in example 1 has a dimension (number of rows/2) × (number of colums/2) and is called A, H, V and D respectively. A (approximation area) includes information about the global properties of analysed image. Removal of spectral coefficients from this area leads to the biggest distortion in original image. H (horizontal area) includes information about the vertical lines hidden in image. Removal of spectral coefficients from this area

excludes horizontal details from original image. V (vertical area) contains information about the horizontal lines hidden in image. Removal of spectral coefficients from this area eliminates vertical details from original image. D (diagonal area) embraces information about the diagonal details hidden in image. Removal of spectral coefficients from this area leads to minimum distortions in original image. To get the value at next level, again HT is applied row and column wise on the piece A, obtained earlier as in example 1. Thus the HT is suitable for application when the image matrix has number of rows and columns as a multiple of 2.Fast Haar Transform (FHT) involves addition, subtraction and division by 2, due to which it becomes faster and reduces the calculation work in comparison to HT. For the decomposition of an image, we first apply 1D FHT to each row of pixel values of an input image matrix. These transformed rows are themselves an image and we apply the 1D FHT to each column. The resulting values are all detail coefficients except for a single overall average coefficient. From the above two tables we can see that the compression ration goes on increasing as the number of levels goes on increasing. Fig 3.3. below shows how the frame shifts in each level as the segments are discarded.*[7][8]*

***b) Results*:**

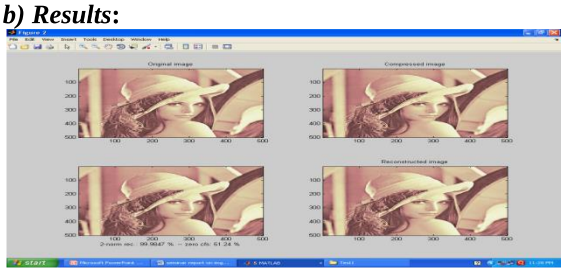

Fig 3.1. Results for Color Image at decomposition level 1 with CR=51%

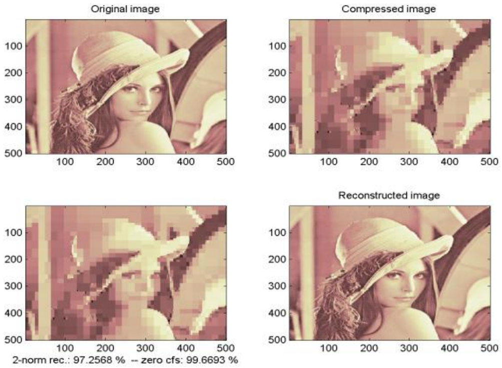

Fig 3.2. Results for Color Image at decomposition level5 with CR=99.66 %

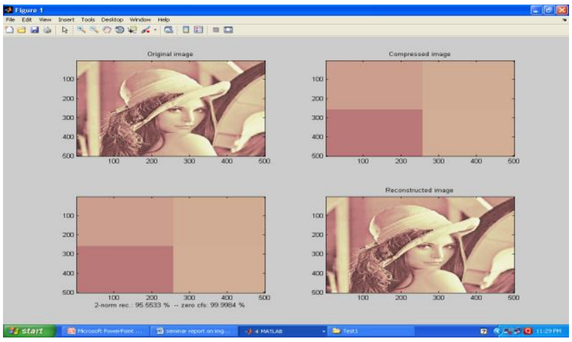

Fig.3.3 Results for Color Image at decomposition level 10 with CR=99.99 %

From the above figures we can see that the compression ration goes on increasing as the number of decomposition levels goes on increasing.

IV. Conclusion

The data compression schemes can be divided into two classes. One is lossless compression and the other is lossy compression. Lossy compression generally provides much higher compression than lossless compression. Wavelets are a class of functions used to localize a given signal in both space and scaling domains. In order to compare wavelet methods, a MinImage was originally created to test one type of wavelet and the additional to Image to support other wavelet types, and the Harr wavelet transform coding algorithm was implemented to achieve better compression results. A low complex 2D image compression method using Haar wavelets as the basis functions along with the quality measurement of the compressed images have been presented here. As for the further work, the tradeoff between the value of the threshold ε and the image quality can be studied and also fixing the correct threshold value is also of great interest

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