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A PAPER ON A COMPARATIVE STUDY BLOCK TRUNCATING CODING, WAVELET, FRACTAL IMAGE COMPRESSION & EMBEDDED ZERO TREE

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ABSTRACT
Many different image compression techniques currently exist for the compression of different types of images. Image compression is fundamental to the efficient and cost-effective use of digital imaging technology and applications. In this study Image compression was applied to compress and decompress image at various compression ratios. Compressing an image is significantly different than compressing raw binary data. For this different compression algorithm are used to compress images. Fractal image compression has been widely used to compress the image. We undertake a study of the performance difference of different transform coding techniques i.e. Block Truncating Coding, Wavelet, Fractal and Embedded Zero Tree image compression. This paper focuses important features of transform coding in compression of still images, including the extent to which the quality of image is degraded by the process of compression and decompression. The above techniques have been successfully used in many applications. Images obtained with those techniques yield very good results. The numerical analysis of such algorithms is carried out by measuring Peak Signal to Noise Ratio (PSNR), Compression Ratio (CR). For the implementation of this proposed work we use the Image Processing Toolbox under Matlab software.

KEYWORDS: Image Compression, Block truncating coding (BTC), Discrete Wavelet Transform (DWT), Fractal image compression (FIC), Embedded Zero Tree Wavelet (EZW), Gabor filter and Image Processing.

INTRODUCTION
Compression of digital images plays an important role in the image storage and transmission. The advanced in the technology have made use of digital image very common in everyday life. We have seen that cost of storage and transmission of image is much more as compared to text. Therefore there need to compress the image before transmission. The principle behind image compression is that the neighboring pixels are correlated and therefore contain redundant information. The foremost task then is to find less correlated representation of the image and to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form.

There are varieties of image compression algorithm available. But broadly image compression algorithms are categorized into two i.e. lossy and lossless image compressions. The Lossless compression is preferred for archival purposes and often medical imaging, technical drawings, etc. This is because lossy compression methods, especially when used at low bit rates, introduce compression artifacts. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. In general, lossy techniques provide for greater compression ratios than lossless techniques i.e. Lossless compression gives good quality of compressed images, but yields only less compression whereas the lossy compression techniques lead to loss of data with higher compression ratio. The approaches for lossy compression include lossy predictive coding and transform coding. Transform coding, which applies a Fourier-related transform such as DCT and Wavelet Transform such as DWT are the most commonly used approach. Over the past few years, range of wavelet based image compression algorithm has been developed and implemented. The coders provide a better quality in the images. There are several algorithms for wavelet based compression such as Embedded

Zero tree Wavelet (EZW), Set Partitioning in Hierarchical Trees (SPHIT), Embedded Block Truncation Coding (EBOTC) etc.

In this paper we will analysis performance of transform coding techniques of lossy image compression i.e. Block Truncating Coding (BTC), Discrete Wavelet Transform (DWT), Fractal image compression (FIC) and Embedded Zero Tree (EZW) image compression. The performance is evaluated based on different performance measures such as Compression Ratio (CR), Peak to Noise Ratio (PSNR) and Mean Square Error (MSE).

Image compression means minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk more memory space. It also reduces the time required for image to be sent over the internet or downloaded from web pages. The recent growth of data intensive multimedia based web application have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signal central to storage and communication technology.

Dinesh Gupta, Pardeep Singh, Nivedita and Sugandha Sharma in 2012 present A comparative study of image compression between Singular value decomposition, Block truncating coding, Discrete cosine transform and Wavelet. With the growth of multimedia and internet, compression techniques have become the thrust area in the fields of computers. Popularity of multimedia has led to the integration of various types of computer data. Multimedia combines many data types like text, graphics, still images, animation, audio and video. Image compression is a process of efficiently coding digital image to reduce the number of bits required in representing image. Its purpose is to reduce the storage space and transmission cost while maintaining good quality.

Dr. Joab Winkler in 2002. He purposed Image Compression Using Wavelets. Images require substantial storage and transmission resources, thus image compression is advantageous to reduce these requirements. The report covers some background of wavelet analysis, data compression and how wavelets have been and can be used for image compression. An investigation into the process and problems involved with image compression was made and the results of this investigation are discussed.

The remainder of this paper is organized as the following. At first, in Section II we illustrate the various components of our proposed technique to image compression using fast wavelet transform. Further, in Section III we present some key experimental results and evaluate the performance of the proposed system. At the end we provide conclusion of the paper in Section IV and state some possible future work directions.

PROPOSED TECHNIQUE

This section illustrates the overall technique of our proposed image compression. In this paper we "A Comparative Study Block Truncating Coding, Wavelet, Fractal Image Compression & Embedded Zero Tree". In this paper we selects grey scale image to stimulate for decomposition and reconstruction, and compare BTC, wavelet, Fractal algorithm and embedded zero tree algorithm results. In this we propose analysis performance of transform coding techniques of lossy image compression i.e. Block Truncating Coding (BTC), Discrete Wavelet Transform (DWT), Fractal image compression (FIC) and Embedded Zero Tree (EZW) image compression. The performance is evaluated based on different performance measures such as Compression Ratio (CR), Peak to Noise Ratio (PSNR) and Mean Square Error (MSE).

Wavelet transform is the latest method of compression where its ability to describe any type of signals both in time and frequency domain. JPEG2000 which is the standards of international image coding is adopted the method of wavelet transform coding. An M*N image is decomposed using wavelet transform. The image is decomposed into four sub-bands after passing a high- pass filter and low- pass filter. The four sub-bands are LL, HL, LH and HH respectively. The one obtained by low pass filtering rows and columns is referred as LL sub band contains horizontal details of the image. The one obtained by low pass filtering the rows and high pass filtering the columns is referred to as the LH sub band contains vertical details of the image and HH sub band contains the diagonal details of the image. The process is called the first level of wavelet decomposition. The low frequency sub-band can be continually decomposed into four sub-bands. The image of low frequency sub-band contains major information. The values of high frequency sub-band approximate zero, the more high frequency the more obvious this situation. For image, the part of the low frequency is primary part which can represent the image information. So researchers take full advantage of the characteristic after wavelet transform and employ proper method to process the image coefficients for achieving effective compression.

Why Compression is needed?

In the last decade, there has been a lot of technological transformation in the way we communicate. This transformation includes the ever present, ever growing internet, the explosive development in mobile communication and ever increasing importance of video communication. Data Compression is one of the technologies for each of the aspect of this multimedia revolution. Cellular phones would not be able to provide communication with increasing clarity without data compression. Data compression is art and science of representing information in compact form. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technologies. In a distributed environment large image files remain a major bottleneck within systems. Image Compression is an important component of the solutions available for creating image file sizes of manageable and transmittable dimensions. Platform portability and performance are important in the selection of the compression/decompression technique to be employed.

Principle behind Image Compression

Images have considerably higher storage requirement than text; Audio and Video Data require more demanding properties for data storage. An image stored in an uncompressed file format, such as the popular BMP format, can be huge. An image with a pixel resolution of 640 by 480 pixels and 24-bit colour resolution will take up 640 * 480 * 24/8 = 921,600 bytes in an uncompressed format. The huge amount of storage space is not only the consideration but also the data transmission rates for communication of continuous media are also significantly large. An image, 1024 pixel x 1024 pixel x 24 bit, without compression, would require 3 MB of storage and 7 minutes for transmission, utilizing a high speed, 64 Kbits /s, ISDN line. Image data compression becomes still more important because of the fact that the transfer of uncompressed graphical data requires far more bandwidth and data transfer rate. For example, throughput in a multimedia system can be as high as 140 Mbits/s, which must be transferred between systems. This kind of data transfer rate is not realizable with today's technology, or in near the future with reasonably priced hardware.

Discrete Wavelet Transform

The discrete wavelet transform (DWT) refers to wavelet transforms for which the wavelets are discretely sampled. A transform which localizes a function both in space and scaling and has some desirable properties compared to the Fourier transform. The transform is based on a wavelet matrix, which can be computed more quickly than the analogous Fourier matrix. Most notably, the discrete wavelet transform is used for signal coding, where the properties of the transform are exploited to represent a discrete signal in a more redundant form, often as a preconditioning for data compression. The discrete wavelet transform has a huge number of applications in Science, Engineering, Mathematics and Computer Science. Wavelet compression is a form of data compression well suited for image compression (sometimes also video compression and audio compression). The goal is to store image data in as little space as possible in a file. A certain loss of quality is accepted (lossy compression). Using a wavelet transform, the wavelet compression methods are better at representing transients, such as percussion sounds in audio, or high-frequency components in two-dimensional images, for example an image of stars on a night sky. This means that the transient elements of a data.

Block Truncating Coding

A simple effective lossy image compression method is block truncation coding (BTC). The BTC is an efficient image coding method that has been adopted to obtain the statistical properties of a block in image compression. Low computational complexity and superior channel error resisting ability make it attractive in real-time image compression. The BTC output data set includes a binary bit plane, which defines the quantization level of each pixel, and two reconstruction level values (a and b), determined by the mean and standard deviation of the block.

Fractal Image Compression

A fractal is a structure that is made up of similar forms and patterns that occur in many different sizes. The term fractal was first used by Benoit Mandelbrot to describe repeating patterns that he observed occurring in many different structures. These patterns appeared nearly identical in form at any size and occurred naturally in all things. Mandelbrot also discovered that these fractals could be described in mathematical terms and could be created using very small and finite algorithms and data.

Embedded Zero tree Wavelet

The embedded zero tree wavelet algorithms (EZW) is a simple, yet remarkable effective, image compression algorithm, having the property that the bits in the bit stream are generated in order of importance, yielding a fully embedded code. Using an embedded coding 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 stream. In addition to producing a fully embedded bit stream, EZW consistently produces compression results that are competitive with virtually all known compression algorithms. Embedded Zero trees of Wavelet transforms (EZW) is a lossy image compression algorithm. At low bit rates, i.e. high compression ratios, most of the coefficients produced by a sub-band transform (such as the wavelet transform) will be zero, or very close to zero.

Gabor Filter

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. J. G. Daugman discovered that simple cells in the visual cortex of mammalian brains can be modeled by Gabor functions. Thus, image analysis by the Gabor functions is similar to perception in the human visual system. Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

Complex

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma)=\exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)\exp\left(i\left(2\pi\frac{x'}{\lambda}+\psi\right)\right)$$

Real

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma)=\exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

Imaginary

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma)=\exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)\sin\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

Where

$$x' = x\cos\theta + y\sin\theta$$

And

$$y' = -x\sin\theta + y\cos\theta$$

In this equation, λ represents the wavelength of the sinusoidal factor, θ represents the orientation of the normal to the parallel stripes of a Gabor function, ψ is the phase offset, σ is the sigma/standard deviation of the Gaussian envelope and γ is the spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function. Gabor filters are directly related to Gabor wavelets, since they can be designed for a number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of bi-orthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex.Jones and Palmer showed that the real part of the complex Gabor function is a good fit to the receptive field weight functions found in simple cells in a cat's striate cortex. The Gabor space is very useful in image processing applications such as optical character recognition, ocular detection and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation.

EVALUATION AND RESULTS

To verify the effectiveness (qualities and robustness) of the proposed Image Compression Using Wavelet Transform, we conduct several experiments with this procedure on several images. There are some steps of our proposed technique are given below:

Phase 1: Firstly we develop a particular GUI for this implementation. After that we develop a code for the loading the image file in the Matlab database.
Phase 2: Develop a code for the filter technique using Gabor filter and edge detection using canny edge detector and after that apply on the image.
Phase 3: Develop a code for the different type of the compression techniques which proposed in this paper like Block Truncating Coding (BTC), Discrete Wavelet Transform (DWT), Fractal image compression (FIC) and Embedded Zero Tree (EZW) image compression.
Phase 4: After that we develop code for the calculation of different parameters i.e. PSNR, MSE CR etc.

Flow Chart of proposed method

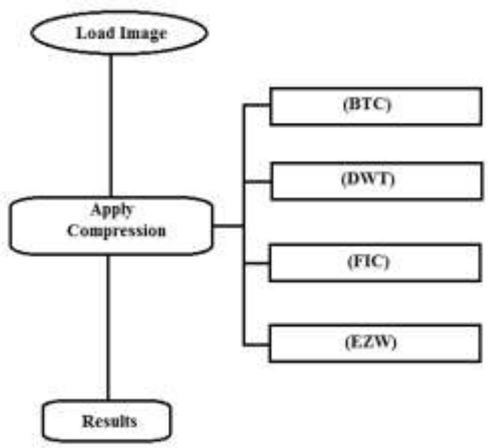

Figure: 1. Flow chart of proposed method

Fig.1. Main Figure Window

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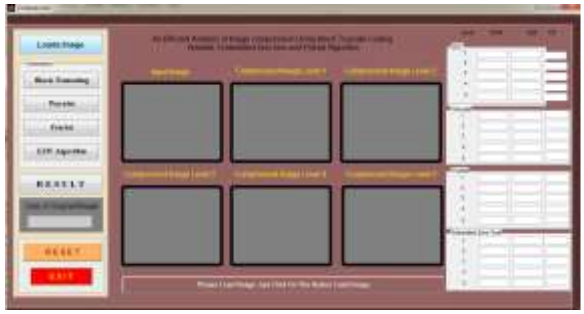

Fig.2. Work Figure Window

Fig.3. Running Figure Window with BTC

Fig.4. Running Figure Window with Wavelet

Fig.5. Running Figure Window with FIC

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Fig.6. Running Figure Window with EZW

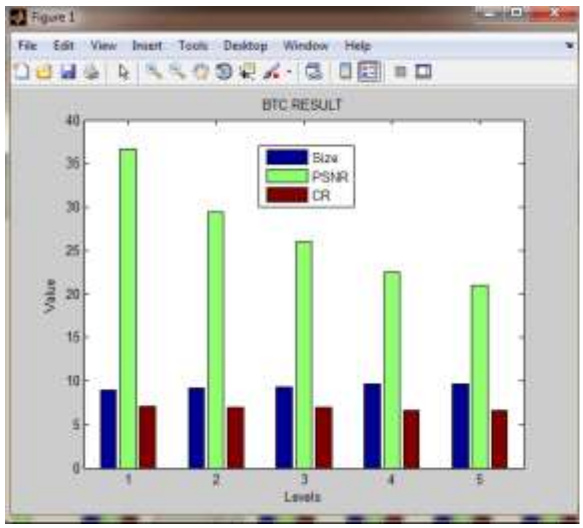

Fig.7. Result with BTC

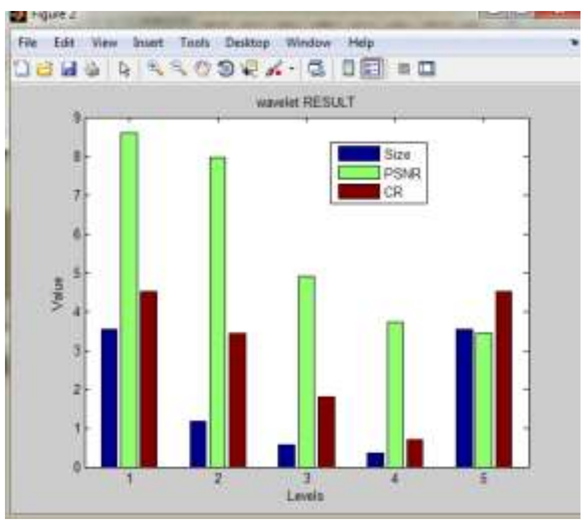

Fig.8. Result with Wavelet

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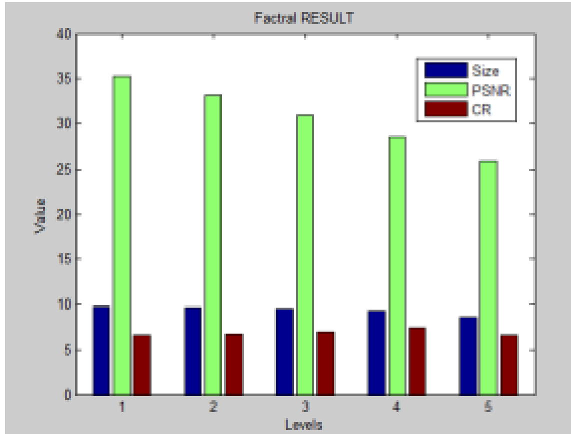

Fig.9. Result with FIC

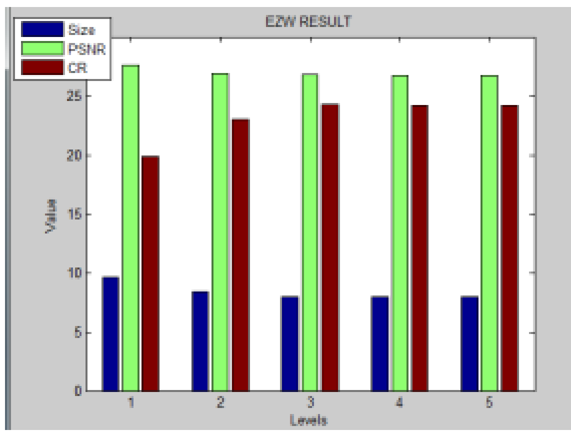

Fig.10. Result with EZW

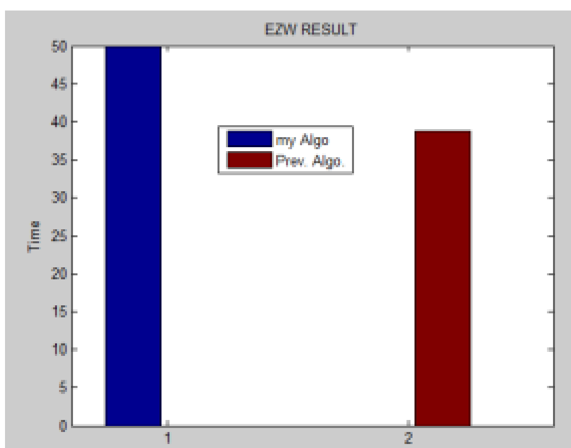

Fig 11. Result of elapsed time with EZW

CONCLUSION & FUTURE WORK

In this paper we "A Comparative Study Block Truncating Coding, Wavelet, Fractal Image Compression & Embedded Zero Tree". In this paper we selects grey scale image to stimulate for decomposition and reconstruction, and compare BTC, wavelet, Fractal algorithm and embedded zero tree algorithm results. Wavelets are better suited to time-limited data and wavelet based compression technique maintains better image quality by reducing errors. Block Truncation Coding is a lossy image Compression techniques.BTC is a recent technique used for compression of monochrome image data. It is one bit adaptive moment-reserving quantizer that preserves certain statistical moments of small blocks of the input image in the quantized output. The original algorithm of BTC preserves the standard mean and the standard deviation. Embedded zero-tree coding of wavelet coefficients (EZW) was introduced by Shapiro. Shapiro design the algorithm based on empirical true hypothesis that if a wavelet coefficient at a coarse scale is insignificant with respect to a threshold T, then all wavelet coefficients of the same orientation in the same spatial location at finer scale are likely to be insignificant with respect To T. These trees induce a parent–child relationship among the coefficients of sub-bands having the same spatial orientation. These parent–child dependencies are generally credited for the excellent performance of zero-tree coders. Fractal image compression is also called as fractal image encoding because compressed images are represented by contractive transforms. These transforms are composed of collection of a number of affine mappings on the entire image. The wavelet transform achieves better energy compaction than the DCT and hence can help in providing better compression for the same Peak Signal to Noise Ratio (PSNR).Compression Size is more and Elapsed time is less than previous result.

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