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Image Compression Using Fast Wavelet Transform

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Abstracts

In general, image compression reduces the number bits required to represent an image. The main significance of image compression is that the quality of the image is preserved. This in turn increases the storage space and thereby the volume of the data that can be stored. Image compression is the application of data compression technique on digital images. Wavelet Transform based image compression remain the most common among diverse techniques proposed earlier. Data compression which can be lossy or lossless is required to decrease the storage requirement and better data transfer rate. One of the best image compression techniques is using wavelet transform. It is comparatively new and has many advantages over others. Wavelet transform uses a large variety of wavelets for decomposition of images. The state of the art coding techniques like EZW, SPIHT (set partitioning in hierarchical trees) and EBCOT(embedded block coding with optimized truncation)use the wavelet transform as basic and common step for their own further technical advantages. The wavelet transform results therefore have the importance which is dependent on the type of wavelet used .In our thesis we have used different wavelets to perform the transform of a test image and the results have been discussed and analyzed. For the implementation of this proposed work we use Image Processing Toolbox under the Matlab software.

Keywords: Edge detection, Image Processing, wavelet transform and fast wavelet transform..

Introduction

Often signals we wish to process are in the time-domain, but in order to process them more easily other information, such as frequency, is required. Mathematical transforms translate the information of signals into different representations. For example, the Fourier transform converts a signal between the time and frequency domains, such that the frequencies of a signal can be seen. However the Fourier transform cannot provide information on which frequencies occur at specific times in the signal as time and frequency are viewed independently. To solve this problem the Short Term Fourier Transform introduced the idea of windows through which different parts of a signal are viewed. For a given window in time the frequencies can be viewed. However Heisenberg Uncertainty Principle states that as the resolution of the signal improves in the time domain, by zooming on different sections, the frequency resolution gets worse. Ideally, a method of Multiresolution is needed, which allows certain parts of the signal to be resolved well in time, and other parts to be resolved well in frequency. The power and magic of wavelet analysis is exactly this Multiresolution. Images contain large amounts of information that requires much storage space, large transmission bandwidths and long transmission times. Therefore it is advantageous to compress the image by storing only the essential information needed to reconstruct the image. An image can be thought of as a matrix of pixel (or intensity) values. In order to compress the image, redundancies must be exploited, for example, areas where there is little or no change between pixel values. Therefore images having large areas of uniform colour will have large redundancies, and conversely images that have frequent and large changes in colour will be less redundant and harder to compress. Wavelet analysis can be used to divide the information of an image into approximation and detail sub signals. The approximation sub signal shows the general trend of pixel values, and three detail sub signals show the vertical, horizontal and diagonal details or changes in the image. If these details are very small then they can be set to zero without significantly changing the image. The value below which details are considered small enough to be set to zero is known as the threshold. The greater the number of zeros the greater the compression that can be achieved. The amount of information retained by an image after compression and decompression is known as the 'energy retained', and this is proportional to the sum of the squares of the pixel values. If the energy retained is 100% then the

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compression is known as 'lossless', as the image can be reconstructed exactly. This occurs when the threshold value is set to zero, meaning that the detail has not been changed. If any values are changed then energy will be lost and this is known as 'lossy' compression. Ideally, during compression the number of zeros and the energy retention will be as high as possible. However, as more zeros are obtained more energy is lost, so a balance between the two needs to be found. The first part of the report introduces the background of wavelets and compression in more detail. This is followed by a review of a practical investigation into how compression can be achieved with wavelets and the results obtained. The purpose of the investigation was to find the effect of the decomposition level, wavelet and image on the number of zeros and energy retention that could be achieved. For reasons of time, the set of images, wavelets and levels investigated was kept small. The power of Wavelets comes from the use of Multiresolution. Rather than examining entire signals through the same window, different parts of the wave are viewed through different size windows (or resolutions). High frequency parts of the signal use a small window to give good time resolution; low frequency parts use a big window to get good frequency information. An important thing to note is that the 'windows' have equal area even though the height and width may vary in wavelet analysis. The area of the window is controlled by Heisenberg's Uncertainty principle, as frequency resolution gets bigger the time resolution must get smaller. Uncompressed multimedia (graphics, audio and video) data requires considerable storage capacity and transmission bandwidth. 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. 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. To enable Modern High Bandwidth required in wireless data services such as mobile multimedia, email, mobile, internet access, mobile commerce, mobile data sensing in sensor networks, Home and Medical Monitoring Services and Mobile Conferencing, there is a growing demand for rich Content Cellular Data Communication, including Voice, Text, Image and Video.

We focus in this paper on developing energy efficient, computing efficient and adaptive image compression and communication techniques. Based on a popular image compression algorithm, namely, wavelet image compression, we present an Implementation of Advanced Image Compression Algorithm Using Fast Wavelet Transform.

Dr.P.Subashini and M.Krishnaveni in 2011. He purposed Segmentation Based Multilevel Wide Band Compression for SAR Images Using Coiflet Wavelet. Synthetic aperture radar (SAR) data represents a significant resource of information for a large variety of researchers. Thus, there is a strong interest in developing data encoding and decoding algorithms which can obtain higher compression ratios while keeping image quality to an acceptable level. In this work, results of different wavelet-based image compression and segmentation based wavelet image compression are assessed through controlled experiments on synthetic SAR images. The effects of dissimilar wavelet functions, number of decompositions are examined in order to find optimal family for SAR images.

Dr. Adnan Khashman (SMIEEE) and Kamil Dimililer in 2010. He purpose Image Compression Using Biorthogonal Wavelet and Discrete Cosine Transforms. Digital Image Processing generally creates significant numbers of large files containing digital image data. Very often, these must be archived or exchanged among different users and systems. This calls for efficient methods for the storage and transfer of digital image data files. Considerable interest has arisen in recent years regarding new transform techniques that specifically address the problems of image compression. These techniques include discrete cosine transforms, and wavelet transforms, which are based on Fourier Transform.

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

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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 proposed 'Image Compression Using Wavelet Transform'. 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. Wavelets are useful for compressing signals but they also have far more extensive uses. They can be used to process and improve signals, in fields such as medical imaging where image degradation is not tolerated they are of particular use. They can be used to remove noise in an image, for example if it is of very fine scales, wavelets can be used to cut out this fine scale, effectively removing the noise. The wavelet transform can be used to perform lossy compression so that the compressed image retains its quality. First, the compression ratio of an image is the ratio of the non-zero elements in the original to the non-zero elements in the compressed image. In this paper we apply the all wavelet techniques on the selected image and finding the differences.

A. 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.

B. 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.

C. 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

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components in two-dimensional images, for example an image of stars on a night sky. This means that the transient elements of a data.

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 in the Matlab database.

Phase 2: Develop a code for the wavelet transform. After that we apply the wavelet transform on the loaded image and we got the compressed image.

Phase 4: After that we develop code for the parameter calculation like PSNR, MSE, image size, compression ration etc.

Flow Chart of proposed method

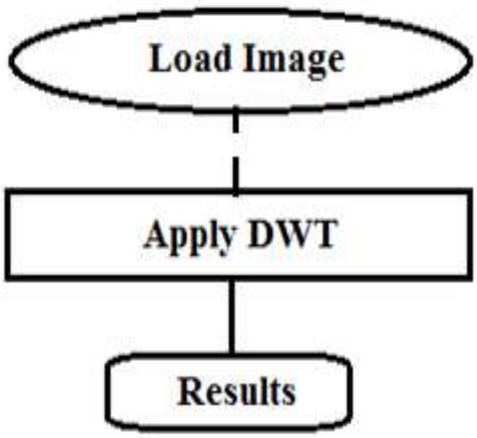

Figure: 1. Flow chart of proposed method

Evaluation & Results

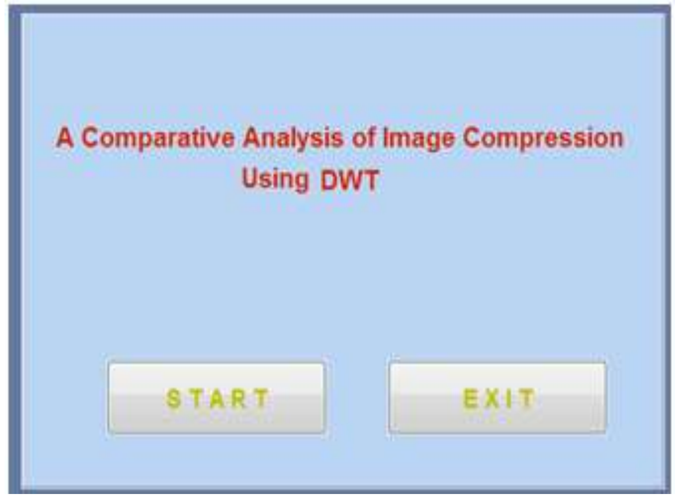

Figure: 2. Main window of model

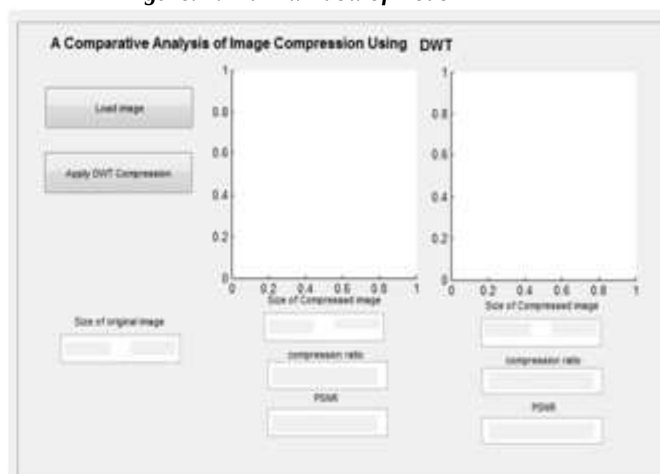

Figure: 3. Work window of model

Results:

Figure: 4. Original image

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Figure: 5. Compressed image using DWT

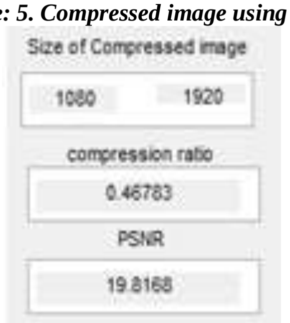

Figure: 7. Results

Conclusion & future work

In this paper, we proposed 'Image Compression Using Wavelet Transform'. Image compression is a key technology in transmission and storage of digital images because of vast data associated with them. This research suggests a new image compression scheme with pruning proposal based on discrete wavelet transformation (DWT). The effectiveness of the algorithm has been justified over some real images, and the performance of the algorithm has been compared with other common compression standards. A new image compression scheme based on discrete wavelet transform is proposed in this research which provides sufficient high compression ratios with no appreciable degradation of image quality. The effectiveness and robustness of this approach has been justified using a set of real images. To demonstrate the performance of the proposed method, a comparison between the proposed technique and other common compression techniques has been revealed. From the experimental results it is evident that, the proposed compression technique gives better performance compared to other traditional techniques. Wavelets are better suited to time-limited data and wavelet based compression technique maintains better image quality by reducing errors. The future direction of this research is to implement a compression technique using Fast Wavelet Transform.

Figure: 8.Original image

Figure: 9. Compressed image

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