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COMPRESSION OF IMAGE BY USING WAVELET TRANSFORM

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Abstract: - 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 project we have used different wavelets to perform the transform of a test image and the results have been discussed and analyzed. The analysis has been carried out in terms of PSNR (peak signal to noise ratio) obtained and time taken for decomposition and reconstruction.

1. INTRODUCTION

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. One of the major challenges in enabling mobile multimedia data services will be the need to process and wirelessly transmit very large volume of this rich content data. This will impose severe demands on the battery resources of multimedia mobile appliances as well as the bandwidth of the wireless network. While significant improvements in achievable bandwidth are expected with future wireless access technology, improvements in battery technology will lag the rapidly growing energy requirements of the future wireless data services. One approach to mitigate this problem is to reduce the volume of multimedia data transmitted over the wireless channel via data compression technique such as JPEG, JPEG2000 and MPEG. These approaches concentrate on achieving higher compression ratio without sacrificing the quality of the Image. However these Multimedia data Compression Technique ignore the energy consumption during the compression and RF transmission. Here one more factor, which is not considered, is the processing power requirement at both the ends i.e. at the Server/Mobile to Mobile/Server. Thus in this paper we have considered all of these parameters like the processing power required in the mobile handset which is limited and also the processing time considerations at the server/mobile ends which will handle all the loads. Since images will constitute a large part of future wireless data, 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 Wavelet Transform*.

2. IMAGE COMPRESSION TECHNIQUES

There are basically two methods of Image Compression:

1. Lossless Coding Techniques
2. Lossy Coding Techniques

Lossless Coding Techniques:

In Lossless Compression schemes, the reconstructed image, after compression, is numerically identical to the original image. However Lossless Compression can achieve a modest amount of Compression. Lossless coding guaranties that the decompressed image is absolutely identical to the image before compression. This is an important requirement for some application domains, e.g. Medical Imaging, where not only high quality is in the demand, but unaltered archiving is a legal requirement. Lossless techniques can also be used for the compression of other data types where loss of information is not acceptable, e.g. text documents and program executables. Lossless compression algorithms can be used to squeeze down images and then restore them again for viewing completely unchanged.

Lossy Coding Techniques:

Lossy techniques cause image quality degradation in each Compression / De-compression step. Careful consideration of the Human Visual perception ensures that the degradation is often unrecognizable, though this depends on the selected compression ratio. An image reconstructed following Lossy compression contains degradation relative to the original. Often this is because the compression schemes are capable of achieving much higher compression. Under normal viewing conditions, no visible loss is perceived (visually Lossless).

Lossy Image Coding Techniques normally have three Components:

1. Image Modelling:

It is aimed at the exploitation of statistical characteristics of the image (i.e. high correlation, redundancy). It defines such things as the transformation to be applied to the Image.

2. Parameter Quantization:

The aim of Quantization is to reduce the amount of data used to represent the information within the new domain.

3. Encoding:

Here a code is generated by associating appropriate code words to the raw produced by the Quantizer. Encoding is usually error free. It optimizes the representation of the information and may introduce some error detection codes.

Measurement of Image Quality

The design of an imaging system should begin with an analysis of the physical characteristics of the originals and the means through which the images may be generated. For example, one might examine a representative sample of the originals and determine the level of detail that must be preserved, the depth of field that must be captured, whether they can be placed on a glass platen or require a custom book-edge scanner, whether they can tolerate exposure to high light intensity, and whether specular reflections must be captured or minimized. A detailed examination of some of the originals, perhaps with a magnifier or microscope, may be necessary to determine the level of detail within the original that might be meaningful for a researcher or scholar. For example, in drawings or paintings it may be important to preserve stippling or other techniques characteristic

3. WAVELET RELATED TRANSFORM

1. Continuous wavelet transform

A continuous wavelet transform is used to divide a continuous-time function into wavelets. Unlike Fourier transform, the continuous wavelet transform possesses the ability to construct a time frequency represented of a signal that offers very good time and frequency localization.

2 .Multi resolution analysis

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A multi resolution analysis (MRA) or multi scale approximation (MSA) is the design methods of most of the practically relevant discrete wavelet transform (DWT) and the justification for the algorithm of the fast Fourier wavelet transform (FWT)

3. Discrete wavelet transform

In numerical analysis and functional analysis, a discrete wavelet transform (DWT) is any wavelet transform for which the wavelets are discretely sampled. As with other wavelet transforms, a key advantage it has over Fourier transforms is temporal resolution: it captures both frequency *and* location information.

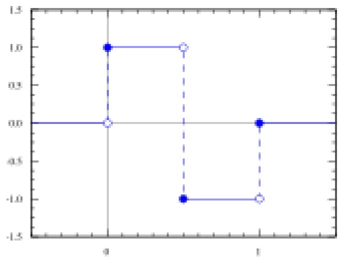
4. Fast wavelet transform

The Fast Wavelet Transform is a mathematical algorithm designed to turn a waveform or signal in the time domain into a sequence of coefficients based on an orthogonal basis of small finite waves, or wavelets. The transform can be easily extended to multidimensional signals, such as images, where the time domain is replaced with the space domain

4. HAAR WAVELET

In mathematics, the **Haar wavelet** is a certain sequence of functions. It is now recognised as the first known wavelet. This sequence was proposed in 1909 by Alfred Haar. Haar used these functions to give an example of a countable orthonormal system for the space of square integrable functions on the real line. The study of wavelets, and even the term "wavelet", did not come until much later.

The Haar wavelet is also the simplest possible wavelet. The technical disadvantage of the Haar wavelet is that it is not continuous, and therefore not differentiable.



The Haar wavelet's mother wavelet function $\psi(t)$ can be described as

$$\psi(t) = \begin{cases} 1 & 0 \le t < 1/2, \\ -1 & 1/2 \le t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

and its scaling function $\varphi(t)$ can be described as

$$\phi(t) = \begin{cases} 1 & 0 \le t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

Wavelets are mathematical functions that were developed by scientists working in several different fields for the purpose of sorting data by frequency. Translated data can then be sorted at a resolution which matches its scale. Studying data at different levels allows for the development of a more complete picture. Both small features and large features are discernable because they are studied separately. Unlike the discrete cosine transform, the wavelet transform is not Fourier-based and therefore wavelets do a better job of handling discontinuities in data. The Haar wavelet operates on data by calculating the sums and differences of adjacent elements. The Haar wavelet operates first on adjacent horizontal elements and then on adjacent vertical elements. The Haar transform is computed using:

$$\frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

5. RESULTS

The image on the left is the original image and the image on the right is the compressed one (The point is that the image on the left you are right now viewing is compressed using Haar wavelet method and the loss of quality is not visible. Of course, image compression using Haar Wavelet is one of the simplest ways.)

Original image compressed image

6. CONCLUSION

Haar wavelet transform for image compression is simple and crudest algorithm as compared to other algorithms it is more effective. The quality of compressed image is also maintained

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