Journal of Information Engineering and Applications
ISSN 2224-5782 (print) ISSN 2225-0506 (online)
Vol 2, No.5, 2012 www.iiste.org

Image Compression Techniques by using Wavelet Transform

V. V. Sunil Kumar[1*] M. Indra Sena Reddy[2]
1. Dept. of CSE, PBR Visvodaya Institute of Tech & Science, Kavali, Nellore (Dt), AP, INDIA
2. School of Computer science & Enginering, RGM College of Engineering & Tech. Nandyal, A.P, India
* E-mail of the corresponding author: sunil.vemula1981@gmail.com

Abstract

This paper is concerned with a certain type of compression techniques by using wavelet transforms. Wavelets are used to characterize a complex pattern as a series of simple patterns and coefficients that, when multiplied and summed, reproduce the original pattern. The data compression schemes can be divided into lossless and 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. A MinImage was originally created to test one type of wavelet and the additional functionality was added to Image to support other wavelet types, and the EZW coding algorithm was implemented to achieve better compression.
Keywords: Wavelet Transforms, Image Compression, Lossless Compression, Lossy Compression

1. Introduction

Digital images are widely used in computer applications. Uncompressed digital images require considerable storage capacity and transmission bandwidth. Efficient image compression solutions are becoming more critical with the recent growth of data intensive, multimedia based web applications.
Data compression is the process of converting data files into smaller files for efficiency of storage and transmission. As one of the enabling technologies of the multimedia revolution, data compression is a key to rapid progress being made in information technology. It would not be practical to put images, audio, and video alone on websites without compression. Data compression algorithms are used in those standards to reduce the number of bits required to represent an image or a video sequence. Compression is the process of representing information in a compact form.
Data compression treats information in digital form as binary numbers represented by bytes of data with very large data sets. Compression is a necessary and essential method for creating image files with manageable and transmittable sizes. In order to be useful, a compression algorithm has a corresponding decompression algorithm that, given the compressed file, reproduces the original file. There have been many types of compression algorithms developed.
These algorithms fall into two broad types, lossless algorithms and lossy algorithms. A lossless algorithm reproduces the original exactly. A lossy algorithm, as its name implies, loses some data. Data loss may be unacceptable in many applications. Depending on the quality required of the reconstructed image, varying amounts of loss of information can be accepted.

2. Literature Review

The compression algorithms are applied to graphical images, the basic concepts of graphical image storage (color space) are also discussed by several researchers some of them are Hong Pan et al [1] proposed a novel Context based Binary Wavelet Transform Coding approach (CBWTC) that combines the BWT with a high order context based arithmetic coding scheme to embedded compression of grayscale images. Delaunay, X et al [2] proposed a novel compression scheme with a tunable complexity rate distortion trade off. As images increase in size and resolution, more efficient compression schemes with low complexity are required on board Earth observation satellites. Guojin Liu et al [3] presented the estimated image statistics by the structure tensor, a novel directional lifting image coder locally adapting the filtering directions to image content. Jae W. Cho et al [4] presented two compression methods for irregular 3D mesh sequences with constant connectivity by using an exact integer spatial wavelet analysis (SWA) technique. Yi Zhang and Xingyuan Wang [5] proposed a fractal image compression coding scheme based on wavelet transform with diamond search. Hui Liu and Siliang Ma [6] proposed a new image coding method based on discrete directional wavelet transform (S-WT) and quad tree decomposition. Tanzeem Muzaffar and Tae Sun Choi [7] proposed a new linked significant tree (LST) wavelet coding method for improved compression of images together within a wavelet tree to facilitate encoding algorithm. Jianhua Chen et al [8] presented a new wavelet transform image coding algorithm with the discrete wavelet transform (DWT) is applied on the original image. Isa Servan

Uzun and Abbes Amira [9] reported the design and field programmable gate array (FPGA) implementation of a non-separable 2-D DBWT compression system. Guang-Ming Zhang et al [10] studied the two categories of transform coding and subband coding and for compressing ultrasonic NDE images. Ellinas, J, N and Sangriotis, M, S [11] proposed a new stereo image compression scheme that is based on the wavelet transform of both images and the disparity estimation between the stereo pair subbands. Jurate Puniene et al [12] presented compression techniques to improve the ultrasound and angio images by applying the wavelet transform outperforms the discrete cosine transform. Hyung Jun Kim and Li, C, C [13] presented a fast image compressor using biorthogonal wavelet transforms which gives high computational speed and excellent compression performance. Angelidis, P, A [14] presented a technique for MR image compression based on a transform coding scheme using the wavelet transform and vector quantization.

3. Methodology

This paper is concerned with a certain type of compression that uses wavelets. Wavelets are used to characterize a complex pattern as a series of simple patterns and coefficients that, when multiplied and summed, reproduce the original pattern. There are a variety of wavelets for use in compression. Several methods are compared on their ability to compress standard images and the fidelity of the reproduced image to the original image.

4. Compression Techniques

Compression takes an input X and generates a representation XC that hopefully requires fewer bits. There is a reconstruction 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.

4.1 Lossless Compression:

If data have been losslessly 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.

4.2 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.

5. 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. The simplest form of wavelets, the Haar wavelet function is defined as Figure 1.

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.

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 high-frequency 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.

6. 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 as shown in figure 2. 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.

7. Wavelet Applied In Image Compression

In order to compare wavelet methods, a MinImage was originally created to test one type of wavelet and the additional functionality was added to Image to support other wavelet types, and the EZW coding algorithm was implemented to achieve better compression results.

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.

Enbedded Zerotree Wavelet (EZW) Coding: After the 2-D wavelet decomposition, the wavelet transform blocks contain the wavelet coefficients. This section introduces the Enbedded Zerotree Wavelet coding to code the transformed wavelet coefficients.

Subbands in the Wavelet Transform Blocks: For a 1-D wavelet transform, a vector of the wavelet coefficients can be divided into subbands after the wavelet rows decomposition.

EZW Coding: An EZW encoder was specially designed by Shapiro [1] to use with wavelet transforms. In fact, EZW coding is more like a quantization method. It was originally designed to operate on images (2D-signals), but it can also be used on other dimensional signals. The EZW encoder is based on progressive encoding to compress an image into a bit stream with increasing accuracy. This means that when more bits are added to the stream, the decoded image will contain more detail, a property similar to JPEG encoded images. Progressive encoding is also known as embedded encoding, which explains the E in EZW.

Entropy Coding: The basic idea of entropy coding is to apply one or more lossless compression methods on EZW coded data to obtain a better compression ratio.

8. 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 functionality was added to Image to support other wavelet types, and the EZW coding algorithm was implemented to achieve better compression results.

quality systems in higher education as to implementing ISO 9000 international standards. Their model contains a set of seven holons to carry out parallel series of tasks on documenting a service organisation. Bell *et al.* (2000) proposed a "holon planning and costing framework" based on system dynamics (SD) and soft systems thinking (SST) to assist in improving the teaching and research qualities given the cost constraints. Montilva *et al.* (2010) used the combination of holonic networks and business models to design an academic organisation devoted to professional training programmes (PTP) on software engineering.

Despite the flourishing research works listed above, the extension of HMS on the subject of labour planning is barely seen. As the gap in the literature is addressed, this paper intends to formulate a holonic model called Workforce Sizing Plan (WOZIP), which is particularly suitable for job-shop production

will handle the machines. At the threshold of workforce sizing, both the MH and OH, which compose the input holon, will generate their respective data items via Equations (1) to (3), for the use of FH (i.e. the intermediate product holon) to conduct the exponential smoothing. The forecast outcomes of Equation (4) of FH will be channelled into ZH (i.e. the final product holon), which completes the procedure using Equation (5) — adjust the workforce size of OH. Essentially, the FH and ZH belong to the output holon. Some negotiation might take place around the beginning and the end of the process flow, between the MH and the customer side (i.e. the external environment) as well as between the ZH and the human resources division (i.e. the internal environment). As the whole process will repeat for every production period, a database has to be integrated into each of the holons for efficient information storage and retrieval.

References

Hong Pan., Li-Zuo Jin., Xiao-Hui Yuan., Si-Yu Xia., Liang-Zheng Xia "Context-based embedded image compression using binary wavelet transform" Image and Vision Computing, Vol. 28, Issue 6, (June 2010), pp 991–1002

Delaunay, X., Chabert, M., Charvillat, V and Morin, G "Satellite image compression by post-transforms in the wavelet domain" Signal Processing, Vol. 90, Issue 2, (February 2010), pp 599–610

Guojin Liu., Xiaoping Zeng., Fengchun Tian., Kadri Chaibou and Zan Zheng "A novel direction adaptive wavelet based image compression" AEU - International Journal of Electronics and Communications, Vol. 64, Issue 6, (June 2010), pp 531–539

Jae W. Cho., Valette, S., Ju H. Park., Ho Y. Jung and Prost, R "3-D mesh sequence compression using wavelet-based multi-resolution analysis" Applied Mathematics and Computation, Vol. 216, Issue 2, (March 2010), pp 410–425

Yi Zhang and Xingyuan Wang "Fractal compression coding based on wavelet transform with diamond search" Nonlinear Analysis: Real World Applications, Vol. 13, Issue 1, (February 2012), pp 106–112.

Hui Liu and Siliang Ma "R-D optimized tree-structured compression algorithms with discrete directional wavelet transform" Journal of Computational and Applied Mathematics, Vol. 219, Issue 1, (September 2008), pp 302–311

Tanzeem Muzaffar and Tae Sun Choi "Linked significant tree wavelet-based image compression" Signal Processing, Vol. 88, Issue 10, (October 2008), pp 2554–2563

Jianhua Chen., Yufeng Zhang and Xinling Sh "Image coding based on wavelet transform and uniform scalar dead zone quantizer" Signal Processing: Image Communication, Vol. 21, Issue 7, (August 2006), pp 562–572

Isa Servan Uzun and Abbes Amira "Real-time 2-D wavelet transform implementation for HDTV compression" Real-Time Imaging, Vol. 11, Issue 2, (April 2005), pp 151–165

Guang-Ming Zhang., Tomas Olofsson and Tadeusz Stepinski "Ultrasonic NDE image compression by transform and subband coding" NDT & E International, Vol. 37, Issue 4, (June 2004), pp 325–333

Ellinas, J, N and Sangriotis, M, S "Stereo image compression using wavelet coefficients morphology" Image and Vision Computing, Vol. 22, Issue 4, (April 2004), pp 281–290

Jurate Puniene., Vytenis Punys and Jonas Punys "Ultrasound and angio image compression by cosine and wavelet transforms" International Journal of Medical Informatics, Vol. 64, Issues 2–3, (December 2001), pp 473–481.

Hyung Jun Kim and Li, C, C "Unified Image Compression Using Reversible and Fast Biorthogonal Wavelet Transform" Proceedings IWISP '96, 4–7 (November 1996), Manchester, United Kingdom, 1996, pp 263–266

Angelidis, P, A "MR image compression using a wavelet transform coding algorithm" Magnetic Resonance Imaging, Vol. 12, Issue 7, (1994), pp 1111–1120

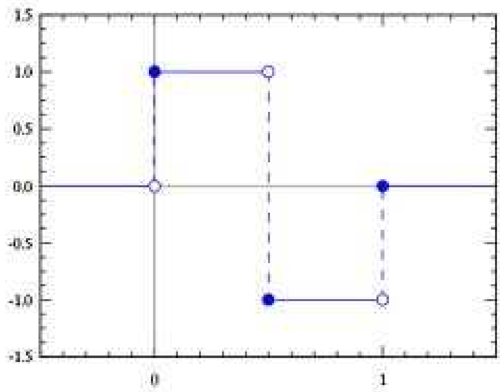

Figure 1. The Haar Wavelet Function

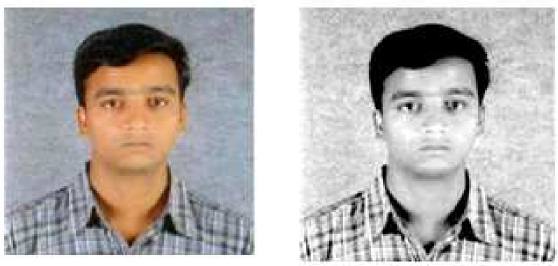

Fig. 2: (a) Original Image (b) Reconstructed image

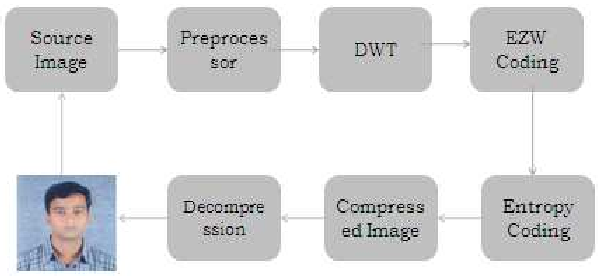

Figure 2. The Baseline Schema of Image